Exaggerated Self-Referencing in Body Dysmorphic Disorder

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Abstract

The self-prioritisation effect demonstrates that people have a bias to learn and process self-relevant compared to other-relevant information. This tendency may provide a tool to understand how body image and perception become disrupted in people with such a pre-occupation with self-related perceptions, behaviours, and affect (Body Dysmorphic Disorder (BDD)). Using an associative learning matching paradigm, participants were presented with geometric shapes that were paired with either themself, a named friend, or an unnamed stranger. Participants were presented with different label-shape pairings and indicated 'match' or 'mismatch' to the original associations. In Experiment 1, higher BDDQ scores were significantly associated with improved accuracy in identifying the self-related association compared with the Stranger association, Friend was intermediate. Experiment 2 showed that higher BDDQ scores were significantly associated with improved accuracy in identifying 'You' matches compared to 'Friend' matches as well as an effect found in Reaction Time that was not found in Experiment 1. Across both experiments, higher BDDQ scores were significantly associated with overall faster reaction times. In Study 2 we assessed whether the reaction time effects were related to impulsivity and depression for which we found no evidence. We discuss these results in relation to the exaggerated salience that person centred cues may play in BDD and show how this process extends to new learning of self-related cues.

Keywords: self-prioritisation, association, Body Dysmorphic Disorder

Public Significance Statement

This experimental paradigm reveals that individuals with body dysmorphic disorder learn self-relevant associations more strongly than those involving 'other' associations. This increased self-prioritisation may provide a causal mechanism that contributes to the persistent focus on self-appearance seen in body dysmorphic disorder.

Introduction

Behaviourally, Body Dysmorphic Disorder (BDD) is an atypical preoccupation with one's appearance, involving perceived, 'imagined' or exaggerated physical anomalies, which is causally relevant to significant distress or impairments in functioning (APA, 2010). These preoccupations are most often centred around the skin, hair, or nose, but over a lifetime, individuals with BDD can be preoccupied with multiple different body parts (Phillips et al., 2005). Patient diagnosis requires that an individual should be concerned about their defect for at least one hour a day, however, there are individuals with BDD checking their area of concern for up to six hours a day (Bjornsson et al., 2010) and that can significantly disrupt an individual's social life or ability to work (Phillips, 2009). How this preoccupation emerges is of significant scientific interest and here we propose that BDD may reflect an enhanced associative processing mechanism sensitive to the attention 'grabbing' salience of self-relevant stimuli.

A cognitive behavioural model of BDD proposed by Veale (2004) describes how an external stimulus, such as seeing oneself in the mirror, can trigger a negative misinterpretation of one's body-image. Then, safety-seeking behaviours, such as altering one's appearance, prevent disconfirmation of these distorted beliefs, and instead perpetuate the distorted self-image. Furthermore, cognitive biases also contribute to the maintenance of an individual's negative self-appraisal. One example of a cognitive bias in BDD is heightened, or selective, self-focused attention. For example, Buhlmann et al. (2006) reported that BDD individuals were more likely to misinterpret neutral emotional expressions selectively as angry or contemptuous. This type of effect illustrates a bias but here we are interested in understanding how the bias might emerge.

One suggestion for how BDD emerges considers how interoceptive cues related to the self are processed and relate to exteroceptive experience. Disturbed (either diminished or enhanced) interoception ─ the ability to perceive one's internal state ─ has been associated with eating disorders (Jenkinson et al., 2018) and muscle dysmorphia (Grunewald et al., 2023), and BDD may similarly involve dysfunctional interoception (Jenkinson & Rossell, 2024), although there is little current empirical evidence to support this hypothesis. A disruption in interoception may lead to mistrust in internal signals, manifesting in 'not just right' experiences (NJREs) – an uncomfortable sensation that something is not as it should be – which are often observed in BDD (Summers et al., 2017).

Although NJREs can occur in response to both self- and externally related stimuli, interoceptive disturbances are inherently tied to internal states, and thus more likely to be linked to self-referential processing. If individuals with BDD experience dysregulated interoceptive signals, this may drive increased self-focus. Subsequently, this could result in an enhanced attention for self-related stimuli. However, whether this dysfunctional interoception reflects a deficit in interoceptive processing, or an overactive system remains unclear. Here we test whether BDD is related to an enhanced learning about self-relevant content using an associative learning choice task.

In the general population, although the body and perception of the body are part of our daily experience, there is substantial evidence that people show greater attention, memory and learning of self-related stimuli compared to other-related stimuli. One demonstration for such bias is the *self-prioritisation effect*. For example, Sui, He and Humphreys (2012) identified a low-level perceptual self-prioritisation effect when using arbitrary stimuli paired with self and other oriented words. These researchers adopted an associative-matching paradigm, whereby participants were told to associate a label (self, friend, or stranger) to a set of arbitrary geometric shapes (triangle, circle, or square). Once provided with specific pairings, participants were then presented with label-shape pairings that either matched or mismatched the original mapping. Reaction times and accuracy were significantly faster, and greater, for stimuli associated with the self, compared to friends or strangers.

Self-related processing has been suggested to be an indicator for psychological disorders (Sui et al., 2021) and more generally may be transdiagnostic of mental health (e.g., Murphy et al., 2017). For example, Hobbs et al. (2021) hypothesised that depressed individuals might display reduced self-prioritisation, as did McIvor et al. (2021), based on reports of a diminished self-prioritisation effect following a negative mood induction (Sui, Ohrling & Humphreys, 2016). However, neither Hobb et al. (2021), nor McIvor et al. (2021), found a significant association between depression severity and self-prioritisation. Humphreys and Sui (2016) proposed a theoretical model. This model suggests that underlying the self-bias is the Self-Attention Network (SAN) which allocates attentional resource and expectancy to self-related stimuli. They propose that this network involves the ventromedial prefrontal cortex (vmPFC) and the posterior superior temporal sulcus (pSTS), dynamically interacting. SAN suggests that self-biases can be both modulated by attention whilst also modulating top-down attentional mechanisms. In this context then, BDD may reflect an enhanced SAN functioning to enhance attention and learning of self-related cues.

The current study investigates whether people with body image preoccupations show enhanced learning using the self-prioritisation task. Enhanced self-biasing may emerge as a compensation for a weak interoceptive signal that directs attention to search for more information, or alternatively, that a heightened interoceptive signal causes them to focus excessively on the self. This label-association paradigm expands the concept of interoception beyond internal bodily signals, instead investigating how internal self-signals contribute to self-representation. As empirical evidence investigating self-representation and interoception remains limited, further research is needed to clarify the nature of self-representation in BDD.

Aberrant associations between internal states and external stimuli could further disrupt the ability to form accurate self-representations, potentially leading to maladaptive learning about one's body or appearance. Over time, these distorted associations may reinforce negative self-perceptions, feeding into the persistent preoccupation with perceived flaws characteristic of BDD.

The idea that individuals with BDD might differentially process stimuli unrelated to their appearance has been supported by Feusner et al. (2011). In their study, individuals with BDD completed a forced-choice, two-alternative spatial processing task in which they had to decide, as quickly and accurately as possible, which house or shape presented at the bottom of the screen matched the house or shape shown at the top. Stimuli were presented in high, low, or normal spatial frequencies, and both accuracy and reaction time were measured. Although individuals with BDD did not differ from controls in accuracy, they showed significantly slower reaction times across all tasks. At a neural level, individuals with BDD demonstrated reduced dorsal medial prefrontal cortex (dmPFC) deactivation compared with controls. As the dmPFC is a core region of the default mode network associated with self-referential thought, this reduced deactivation suggests a difficulty disengaging from self-focused processing. This tendency to remain in a self-referential mode of thinking may have interfered with spatial task performance, contributing to the overall slower response times in individuals with BDD. Moreover, these findings suggest that heightened prioritisation of self-related information in BDD may bias information processing more generally. Therefore, in a person-label association task, BDD participants may be more likely to exhibit greater self-prioritisation, reflecting an underlying bias toward processing self-relevant information at both neural and behavioural levels.

Furthermore, Dent and Martin (2023) investigated how participants responded, using six different emojis, to fabricated social media comments either about themselves, their friend, or a celebrity. Following this, participants completed a surprise memory task where they judged whether they, their friend, and the celebrity had received more negative or positive comments. The authors found that individuals with greater body image concern demonstrated a stronger self-referential bias, where they identified negative body-image-related words to be about themselves more often than to a friend or a celebrity. This suggests that heightened self-referential processing in those with body image concern extends beyond visual appearance and into cognitive-emotional domains. The present study extends this line of research by examining self-referential processing using emotionally neutral, non-disorder-related stimuli.

Taken together, converging evidence suggests that body image disturbance is characterised by a tendency toward heightened self-referential processing across perceptual, attentional, and cognitive-emotional domains. Findings from Feusner et al. (2011) indicate that individuals with BDD show slowed information processing alongside altered engagement of medial prefrontal regions implicated in self-referential thought. Similarly, Dent and Martin (2023) demonstrate that individuals with higher body image concern show a stronger self-referential bias in attributing and remembering self-relevant social-emotional information. Within the Self-Attention Network (SAN) framework (Humphreys & Sui, 2016), such effects may reflect enhanced weighting of self-associated representations through interactions between ventromedial prefrontal and posterior temporal systems that bias attention and learning toward self-relevant stimuli. Consequently, heightened body image concern may be associated with an enhanced self-prioritisation effect, reflecting increased attentional prioritisation of self-related information.

To test this possibility, we recruited participants to complete a self-prioritisation task, equivalent to that in Sui, He and Humphreys (2012). First, we predicted that the self-prioritisation effect would be replicated, where participants would respond faster and more accurately to self-associated stimuli than to friend- or stranger-associated stimuli. Second, we predicted that individuals with more body dysmorphic symptoms would demonstrate an exaggerated self-prioritisation, reflected in greater reaction time and accuracy advantages for self-associated relative to other-associated stimuli.

Experiment 1

Methods

Power Analysis

An a priori power analysis was conducted using G*Power v.3 (Faul et al., 2009) to determine the required sample size. Based on Cohen's (1988) convention for a small effect size ($f = 0.10$), with a desired power of $(1–\beta) = 0.80$ and a significance level of $\alpha = 0.05$, the analysis indicated that a minimum of 43 participants would be required to detect a statistically significant effect in an ANOVA design. This approach is consistent with that used by Hobbs et al. (2023).

Participants

Participants were recruited using the crowdsourcing platform Amazon Mechanical Turk (MTurk®). Contractors registered on the website could access the experiment if they were female and aged between 18-65 years old. The original sample consisted of 107 participants; however, participants were removed if their overall accuracy was below 0.65, as this indicates that they could not learn the task, which meant the final sample consisted of 87 participants between the ages of 32 and 71 ($M = 45.82$, $SD = \pm 10.72$).

Participants completed a consent form prior to conducting this experiment, and upon completion of the study, participants were reimbursed MTurk credits to the sum of $6 USD. Ethical approval was granted by local university Research Ethics Committee, with the Ethics Approval Reference: R83819/RE001.

Stimuli

Participants were exposed to one of three black geometric shapes (triangle, circle and square, see Appendix A) presented on the right-hand side of the screen, and one of three words (you, friend's name, or stranger) displayed on the left. The shapes were positioned at the coordinates x = 3 and y = -2 and the words were positioned at x = -4 and y = -2. Using Gorilla's scaling system, the size of the fixation cross was 120 (default), and the size of the shapes and the words were x = 4 and y = 4. These stimuli were shown on a white background and participants were asked to judge whether a label-shape pairing was a match or a mismatch. Following their response, participants were given feedback, with a green tick or a red cross (size, x = 3 and y = 2; position, x = -0.5, y = 1).

Measures

Body Dysmorphic Disorder Questionnaire *(BDDQ; Phillips et al., 1995)*

The BDDQ is a brief self-report screening tool consisting of four questions, used to diagnose BDD in psychiatric settings (see Appendix D). The first two questions are close-ended, asking if the participant worries about their appearance and if this concern preoccupies them. Each positive answer (*i.e.*, 'Yes') scores 1 point. In question three, participants are asked whether these concerns interfere with relationships, school/occupation, and/or cause them to avoid certain things. A positive answer to any part of this question scores 1 point, with an option for the participant to elaborate on the interference. The fourth question assesses the duration of the preoccupation with the perceived appearance flaw. To screen for BDD, the participant must fulfil the DSM-V's diagnostic criteria, meaning that they must be preoccupied with a perceived appearance flaw for more than 1 hour a day, which causes moderate distress or an impairment in social or academic functioning. If a participant answers 'yes' to the first 2 questions, 'yes' to any part of question 3, and selects (b) or (c) on question 4, thereby cumulatively scoring '4' on the BDDQ, this is indicative of a positive screen for BDD (Phillips, 1998).

Phillips et al. (1995) reported that the BDDQ has an adequate sensitivity (100%) and adequate specificity (89%) in a psychiatric setting, which was reproduced by Grant et al.

(2001). Moreover, Brohede et al. (2013) validated the BDDQ against the Structured Clinical Interview for DSM-IV (SCID) as the gold standard in a community sample of 2891 Swedish women. These researchers found that the BDDQ had a good concurrent validity, with adequate sensitivity (94%) and specificity (90%). Consequently, one can support the value of the BDDQ when screening females in the general population, as has been done in this study, to suggest that BDD may be present, albeit not surely diagnosed.

Procedure

The experiment was accessed via a link contained in the study description, which took the participants to the Gorilla Experiment Builder Platform (www.gorilla.sc) and a participant information sheet and consent form, see Appendix B. This was followed by a demographic questionnaire, the Body Dysmorphic Questionnaire (BDDQ; Phillips et al., 1995), the Acceptance of Cosmetic Surgery Scale (ACSS; Henderson-King & Henderson-King, 2005) and the Sense of Agency Scale (SoAS; Tapal et al., 2017). Note that the latter two questionnaires (ACSS and SoAS) are not analysed in this report. There was also a simple elimination question to check for bots, in which no bots were detected. Participants then completed the self-referencing task, explained below, and finished with a debriefing document, see Appendix C.

Self-Referencing Task

Design

A within-subjects design was used, with two independent and two dependent variables. The independent variables were the person label (you, friend, or stranger) and the congruency of the pairing (match or mismatch). Sui and Humphreys (2012) used the term ‘shape labels’, however, going forward, we have chosen to refer to the use of You, Friend, or Stranger as ‘person labels’. The dependent variables were the accuracy of detecting whether the person label-shape pairing was a match or a mismatch, and reaction time, which was the time between the onset of the stimulus and the participants pressing the ‘F’ or ‘J’ key to indicate their answer, in milliseconds.

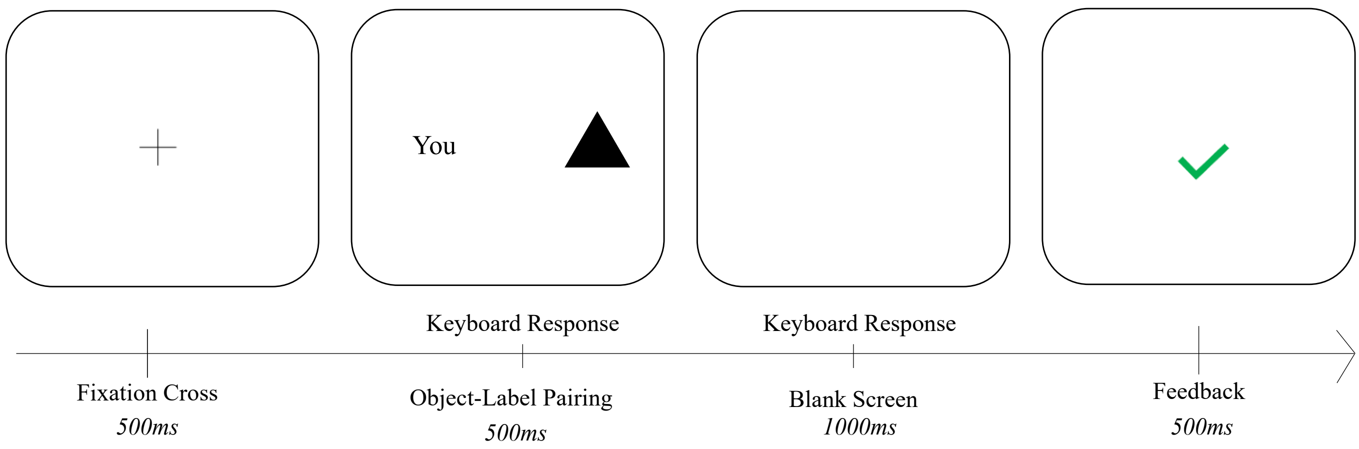
The assignment of the shape stimulus to the person labels was partially counterbalanced to control for the influence of the particular label shape pairing on self-prioritisation. Participants were trained with one of three stimulus assignments: You-Triangle, Friend-Circle, Stranger-Square or You-Circle, Friend-Square, Stranger-Triangle or You-Square, Friend-Triangle, Stranger-Circle (n = 49, 35, and 23 respectively).

Procedure

Participants were presented with instructions (see Appendix E) before inputting the first name of their best friend, which was used as the ‘friend’ label for the task. Participants were told that they would be presented with multiple label-shape (You, Friend, or Stranger; triangle, circle, or square) pairings and asked to judge whether the pairing ‘matched’, with the key ‘F’, or ‘mismatched’, with the key ‘J’, the previously instructed person label-shape pairings, followed by 5 practice trials.

Each trial began with a fixation cross being presented for 500ms, followed by the randomised person label-shape pairing, also for 500ms. From the onset of the person label-shape pairing, participants were able to respond with an ‘F’ for a match or ‘J’ for a mismatch. The next frame was blank for 1000ms, giving participants a total of 1500ms to respond. Responses faster than 200ms were excluded from the analysis to avoid including unprocessed trials (see Sui et al., 2012). Participants were encouraged to answer as accurately and as quickly as possible. After a response, or after 1500ms had elapsed, participants received feedback (a green tick for correct or a red cross for incorrect) for 500ms as shown in Figure 1.

Figure 1.
An Overview of a Trial Sequence.



What followed were 3 blocks of 60 trials, with an opportunity to have a break in between each block. In total there were 30 presentations of each stimulus type (self-match, self-mismatch, friend-match, friend-mismatch, stranger-match, and stranger-mismatch), which were pseudorandomised across the 3 blocks, so that 10 presentations of each stimulus type, presented in a random order, occurred in each block. Therefore, there were an equivalent number of match (i.e., congruent) and mismatch (i.e., incongruent) trials during each block.

Once the experiment was complete, the participants were debriefed about the purpose of the study and who to contact if they had any queries or concerns (see Appendix C).

Data Analysis

Mixed-effects modelling was conducted to examine the effects of person label (You, Friend, Stranger) and congruency (match vs. mismatch) on accuracy and reaction time. Accuracy was analysed using logistic mixed-effects models, while reaction time was analysed using linear mixed-effects models, with Participant ID included as a random intercept. To assess whether task performance was influenced by stimulus pairing (i.e., whether a circle, square, or triangle was associated with You), an additional model including 'selfShape' was fitted and compared against the primary model. If the model including stimulus pairing had a better fit, the variable stimulus pairing was included in the models going forward.

Next, to examine the relationship with BDDQ, a linear mixed model was used to predict reaction time with person label, BDDQ score, congruency, and block (one block = 30 trials) as predictors, with 'You' as the reference person label variable. This meant that the reaction times for the other words, 'Friend' and 'Stranger', were compared to the reaction time for 'You', which revealed any difference in self-prioritisation on reaction time. The model included block as a fixed effect, and Participant ID as a random intercept effect, which allows for individual differences in both baseline levels and responses to the different blocks.

Similarly, a logistic mixed model was used to predict accuracy with person label, BDDQ score, congruency, and block (one block = 30 trials) as predictors, again with 'You' as the reference person label variable, block as a fixed effect, and Participant ID as random intercept effect. This meant that the accuracy in identifying the other words, 'Friend' and 'Stranger', was compared to the accuracy for 'You', which revealed any difference in self-prioritisation on accuracy.

Transparency and Openness

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study, and we follow JARS (Appelbaum et al., 2018). Cleaning the data reduced the total number of trials by 4,272, from 19,261 to 14,989 trials. Statistical analyses were conducted using R studio 2022.12.0 (R Core Team, 2022) and SPSS v28. Results were reported to two decimal places, using the standard significance level ($p < .05$).

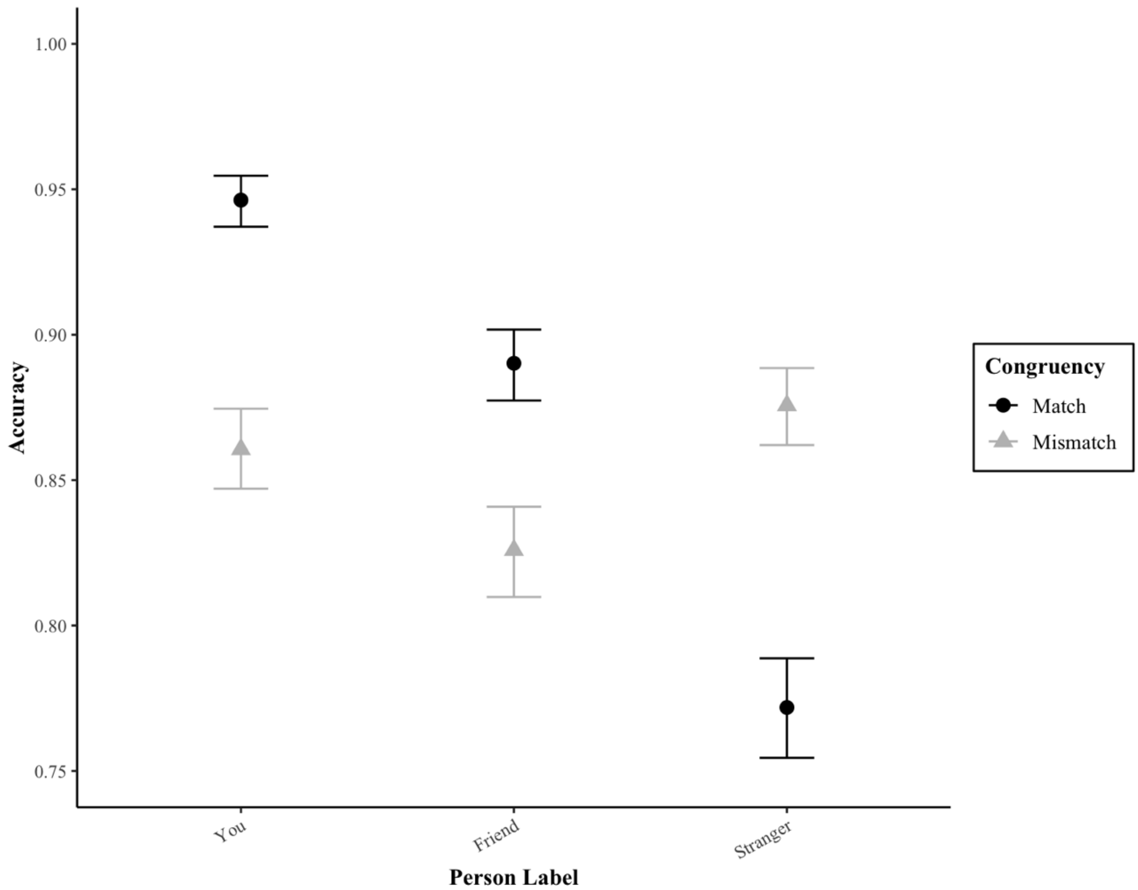
Experiment 1 was not preregistered. Finally, all data, analysis code, and research materials are available upon request.

Results

Self-Referencing Effect and Accuracy

Figure 2 visually confirms a demonstration of the self-prioritisation effect. Participants were more accurate for You-matches compared to both Friend and Stranger-matches.

Figure 2.
Participants' Mean Accuracy at Identifying Person-Label Pairings in Experiment 1 by Person Label and Congruency.



Note. The error bars represent the 95% confidence intervals of the mean accuracy.

To determine whether the particular stimulus counterbalancing (i.e., whether a circle, square, or triangle was associated with You) contributed additional explanatory power to accuracy, we compared two logistic mixed models. Adding stimulus pairing to a model containing only person label and congruency did not significantly enhance the model fit

($\chi^2(2) = 2.54$, p = .281), suggesting that participants' accuracy did not vary with their self–shape association. Therefore, going forward, stimulus pairing was not included in the analysis.

A logistic mixed model was fitted to predict accuracy with person label and congruency, with random participant effects. Matches were identified significantly more accurately than mismatches, as demonstrated by a statistically significant and negative main effect of congruency (ß = -1.08, $p < .001$, Std. ß = -1.08, 95% CI [-1.29, -0.87]). Moreover, overall accuracy was lower for Friend and Stranger pairings relative to You pairings (Friend: ß = -0.80, $p < .001$, Std. ß = -0.80, 95% CI [-1.02, -0.58]); Stranger: ß = -1.72, $p < .001$, Std. ß = -1.72, 95% CI [-1.92, -1.52]).

Additionally, significant interactions between person label and congruency indicated that the effect of person label differed as a function of congruency (i.e., whether the word matched the feedback contingency). Specifically, the accuracy advantage for identifying You-pairings over Friend-pairings was greater for matches than for mismatches (ß = 0.52, $p < .001$, Std. ß = 0.52, 95% CI [0.25, 0.79). Similarly, the prioritisation of identifying You-pairings over Stranger-pairings was seen in matches but not mismatches (ß = 1.86, $p < .001$, Std. ß = 1.86, 95% CI [1.60, 2.11]). Together, these findings indicate that congruency had the strongest influence on accuracy for identifying self-related stimuli, with self-prioritisation emerging most clearly in matching trials.

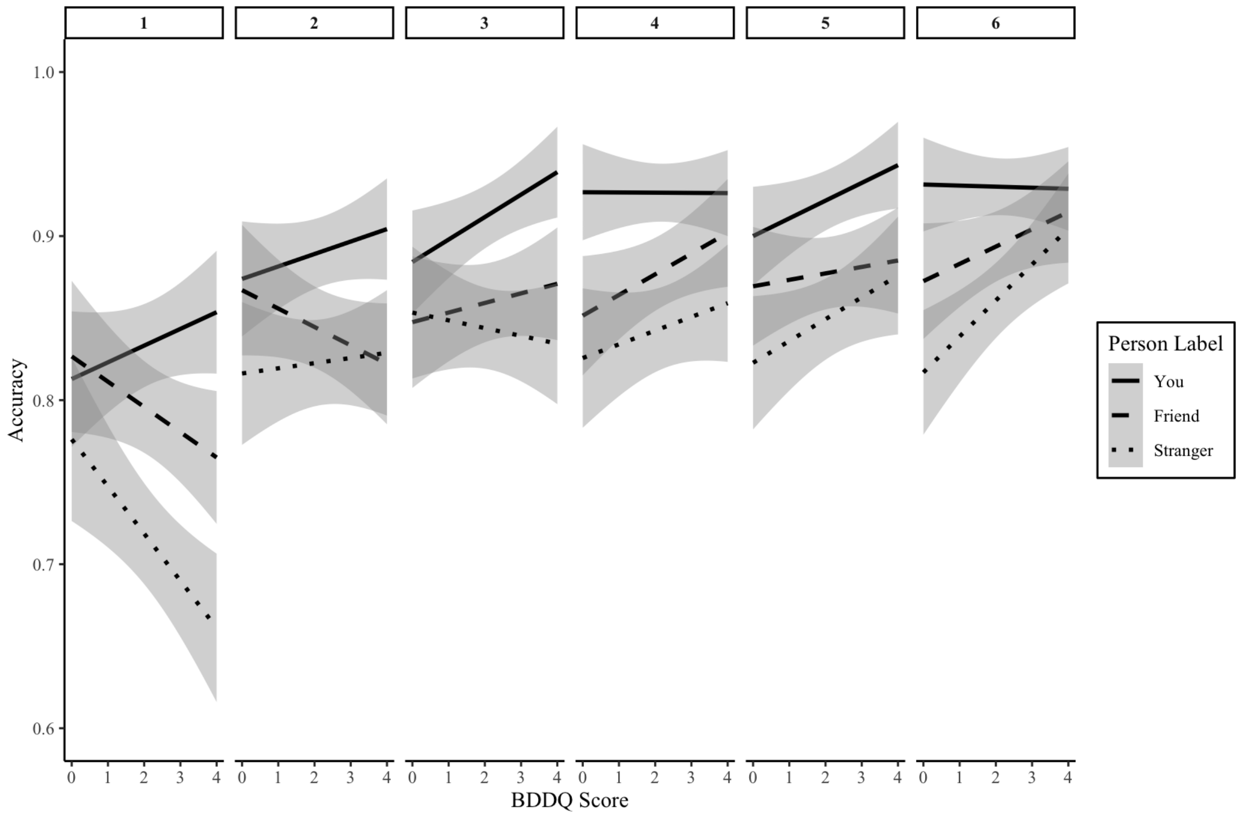
Having established the basic self-prioritisation effect we conducted analyses to examine the relation with BDDQ.

BDDQ and Accuracy

BDDQ scores in the sample were moderate on average (M = 2.18, SD = 1.68), spanning the full possible range from 0 to 4. Figure 3 displays the mean accuracy by the three person label pairing types. It supports the conclusion that accuracy was higher for You-pairings (matches and mismatches combined) compared to Stranger-pairings and this was correlated with higher BDDQ scores. Moreover, Figure 3 demonstrates how this stronger self-prioritisation effect in higher BDDQ scores diminished across the six blocks of trials.

Figure 3.

Participants' Mean Accuracy across the 6 blocks (each of 30 trials) of Experiment 1, as a function of Person label and BDDQ score.



Note. The grey shaded areas show the standard error (SE) of the mean accuracy.

A generalised mixed-effects model was fitted to investigate the relationship between person label, BDDQ, congruency, and blocks of trials (included as both a covariate and a fixed effect), as well as their interactions, on accuracy, whilst accounting for random participant effects. To support our conclusions, a statistically significant and negative interaction between the factor representing Stranger (Person Label) and BDDQ was found (ß = -0.34, p = .006, Std. ß = 0.05, 95% CI [-0.16, 0.26]). However, the interaction between

Friend and BDDQ, although in the same direction, did not reach significance (ß = -0.23, *p* = .087, Std ß = 0.02, 95% CI [-0.21, 0.24]).

Further, the model identified an influence of learning, where the self-prioritisation differences diminished across trials blocks. A statistically significant and positive interaction between the factor representing You and Stranger (Person Label), BDDQ, and Trial Block (ß = 0.11, *p* = .004, Std. ß = 0.30, 95% CI [0.09, 0.51]) was found.

To explore BDDQ effects in early learning, we conducted a follow-up analysis on the first block of trials. A logistic mixed model was used to predict accuracy with Person Label, congruency, and BDDQ score. As shown in Figure 3, Block 1 illustrates how increasing BDDQ scores were related to a stronger difference in accuracy between Stranger and You-pairings. A statistically significant negative interaction was found between Stranger (Person Label) and BDDQ (ß = -0.28, *p* = .016, Std. ß = -0.47, 95% CI [-0.85, -0.09]) on Block 1. However, the interaction between BDDQ and Stranger (Person Label) was not significant in blocks 2-6 (Block 2 – Std. ß = 0.01, *p* = 0.967; Block 3 – Std. ß = -0.36, *p* = 0.210; Block 4 – Std. ß = 0.50, *p* = 0.078; Block 5 – Std. ß = 0.21, *p* = 0.451; Block 6 – Std. ß = 0.34, *p* = 0.254). There was no significant interaction between BDDQ and Friend in Block 1, or any of the following blocks either (Block 1 – Std. ß = -0.33, *p* = 0.123; Block 2 - ß = -0.04, *p* = 0.865; Block 3 – Std. ß = -0.21, *p* = 0.484; Block 4 – Std. ß = 0.31, *p* = 0.291; Block 5 – Std. ß = 0.34, *p* = 0.251; Block 6 – Std. ß = 0.008, *p* = 0.979).

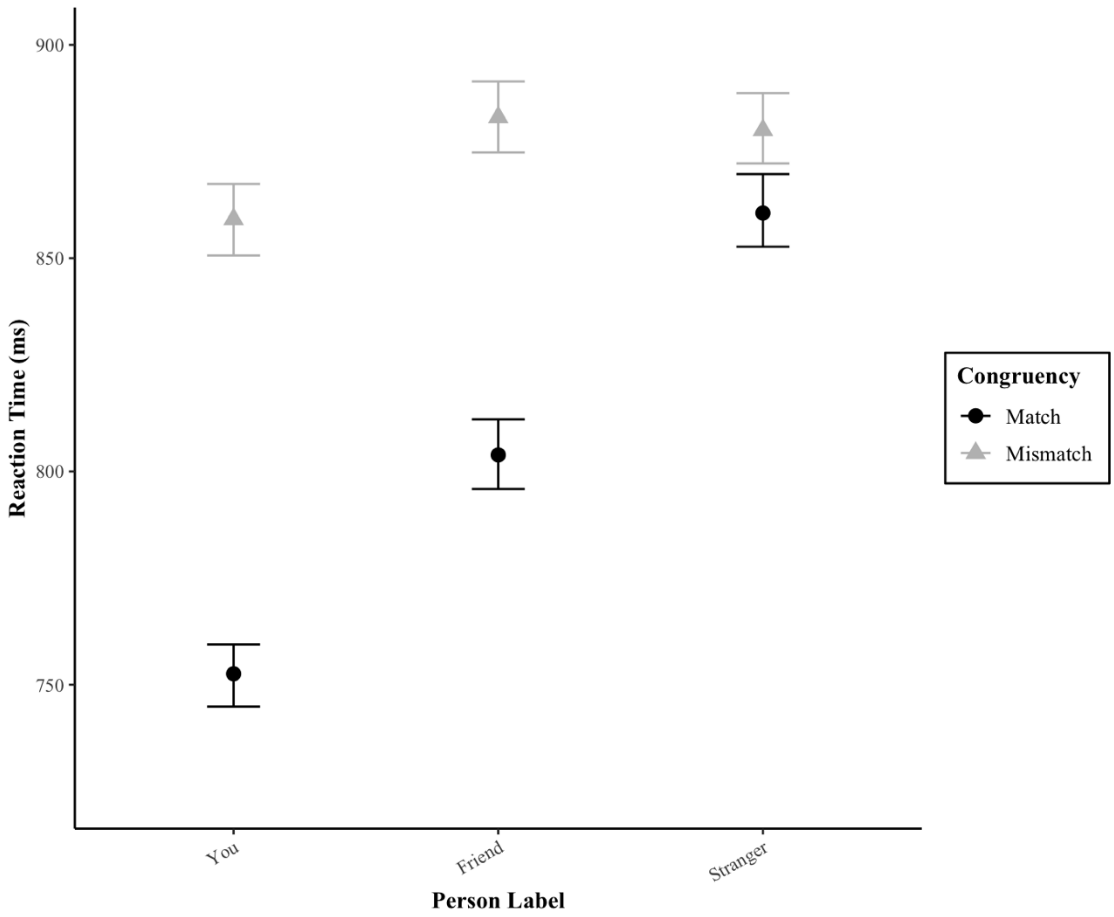
Taken together, these findings are consistent with the hypothesis that higher BDDQ scores are related to more accurate identification of You-pairings compared to Stranger-pairings, although not Friend-Pairings, implying a relation between body preoccupation and the self-prioritisation effect.

Self-Referencing Effect and Reaction Time

Figure 4 visually confirms a demonstration of the self-prioritisation effect in reaction times. Participants were faster at identifying You-matches compared to Friend and Stranger-matches.

Figure 4.

Participants' Mean Reaction Time at Identifying Person-Label Pairings in Experiment 1 by Person label and Congruency.



Note. The error bars represent the 95% confidence intervals of the mean accuracy.

We tested whether there were differences in learning between the three counterbalancings and found that adding the stimulus pairing to a model containing only person label and congruency significantly enhanced model fit ($\chi^2(2) = 6.25$, $p = .044$), suggesting that participants' response times varied systematically with their self–shape association. Therefore, going forward, stimulus pairing was included in the models investigating reaction times.

A linear mixed-effects model was fitted to predict reaction time with person label, congruency, and stimulus pairing. There were significant interactions between person label and congruency, indicating that the effect of match differed across word types. Specifically, the difference in reaction time between match and mismatch trials was significantly reduced for Friend stimuli (ß = −27.66, $p < .001$, Std. ß = -0.13, 95% CI [-0.19, -0.07]) and further reduced for Stranger stimuli (ß = −87.80, $p < .001$, Std. ß = -0.40, 95% CI [-0.47, -0.34]), compared to You pairings. This indicates that congruency had the strongest influence on reaction time for self-related stimuli, with self-prioritisation expressed most clearly on matching trials.

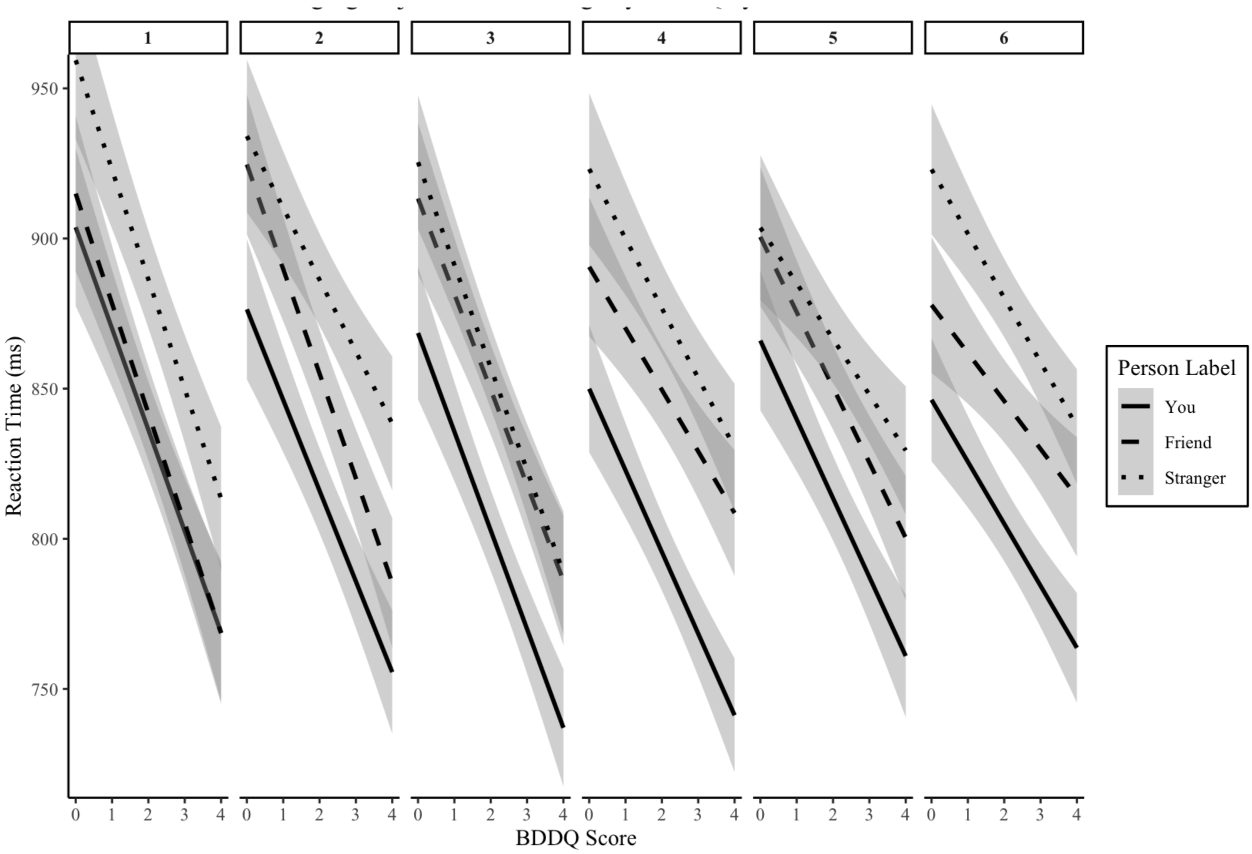
Regarding the counterbalanced stimulus pairings, responses were slower for You–triangle pairings relative to You–circle pairings, as reflected by a significant, positive main effect of the You–triangle condition (ß = 55.19, $p = .068$, Std. ß = 0.25, 95% CI [-0.02, 0.52]), where You-circle was the reference variable. In contrast, no difference was observed between You–square and You–circle pairings and this stimulus difference did not interefe with the self prioritisation effect.

BDDQ and Reaction Time

Figure 5 visually illustrates that, across all blocks, higher BDDQ scores respond faster across all person labels, with You-pairings (matches and mismatches combined) the fastest and Stranger-pairings the slowest.

Figure 5.

Participants' Mean RT across the 6 blocks (each of 30 trials) of Experiment 1, as a function of Person label and BDDQ score.



Note. The grey shaded areas show the standard error (SE) of the mean accuracy.

A linear mixed model (estimated using ML and nloptwrap optimizer) was fitted to predict RT with person label, BDDQ, congruency, stimulus pairing, and block. A significant and negative main effect of BDDQ score on RT was identified (ß = -35.00, $p < .001$, Std ß = -0.19, 95% CI [-0.31, -0.08]). There was no statistically significant interaction between BDDQ and block (Std. ß = 0.04, $p = 0.107$). Nor was there a significant interaction between BDDQ and person label (BDDQ:wordFriend – Std. ß = 0.01, $p = 0.579$; BDDQ:wordStranger – Std. ß = 0.01, $p = 0.890$), meaning that individuals with higher BDDQ scores demonstrated faster reaction times for each person label-shape pairings, but not specifically You-pairings.

Additionally, mismatches were identified significantly slower than matches, as indicated by the statistically significant and positive main effect of congruency (ß = 120.38, *p*

< .001, Std. ß = 0.50, 95% CI [0.45, 0.54]). However, there was no significant interaction between BDDQ and congruency (Std. ß = 0.0002, p = 0.889).

As with the accuracy data we tested whether the counterbalancing was related to our effects. There was no significant interaction between BDDQ and stimulus pairing (BDDQ:YouTriangle – Std. ß = -20.28, *p* = 0.215; BDDQ:YouSquare – Std. ß = -26.46, *p* = 0.203), indicating that the counterbalancing had no influence on the relationship between BDDQ and reaction time.

In sum, the RT analysis found strong evidence that reaction times were faster in people with higher BDDQ scores and that matches were identified more quickly across all participants. However, these findings do not support our hypothesis related to RT, as there was no increased self-prioritisation effect reflected in reaction times in individuals with higher BDDQ scores.

Exploratory Analyses

First, we investigated whether the time spent viewing the 'Pairings Screen' varied systematically with BDDQ score using Pearson's product-moment correlations to investigate the possibility that the time spent reading the label-object pairings influenced subsequent accuracy and or reaction time. Duration on the 'Pairings Screen' was not significantly correlated with BDDQ score, $r(83) = .03$, 95% CI [-0.25, 0.18], $p = .753$. These findings indicate that time spent viewing the pairing screen did not vary as a function of BDDQ.

There is a potential hypothesis that the type of You-mismatch, so whether You was presented with the Friend-shape or Stranger-shape, differentially influenced performance on the self-prioritisation task. Accordingly, generalised linear mixed-effects models were used to examine whether the type of You-mismatch (You-FriendShape vs You-StrangerShape) influenced RT. There was no significant main effect of mismatch type (Std. ß = -0.02, p = 0.440), indicating that RT did not vary as a function of the type of You-mismatch.

The same models were used to investigate whether You-mismatch type influenced accuracy. There was a significant and positive main effect of You-mismatch type (ß = 0.26, p = 0.029, Std. ß = 0.26, 95% CI [0.03, 0.49]), such that accuracy was greater in identifying You mismatched with a Stranger-shape compared to a Friend-shape.

To further explore whether individual differences in BDDQ modulated these accuracy effects, BDDQ score and its interaction with mismatch type were added to the models. There was neither a main effect of BDDQ (Std. ß = 0.12, p = 0.326) nor an interaction between mismatch type and BDDQ (ß = 0.13, p = 0.271). These results suggest that the influence of the You-mismatch type on accuracy was not modulated by BDDQ.

Discussion

This experiment investigated the relationship between self-prioritisation in a perceptual matching paradigm and BDD. The self-prioritisation effect (SPE) was observed in all participants. Interestingly and consistent with our prediction BBDQ scores were related to an exaggerated self-prioritisation effect for accuracy during the first block of trials. Higher BDDQ scores reflected a stronger difference in accuracy for Self compared with Stranger. While reaction times were faster across trials for those with higher BBDQ scores, reaction time did not show a differential SPE effect on the basis of BBDQ,

Consistent with Sui et al. (2012) findings, faster reaction times and increased accuracy were observed in all participants when matching geometric shapes to a self-label, compared to when the shapes were associated with a friend or stranger. These findings complement the body of evidence suggesting that self-prioritisation occurs across domains, even in a simple perceptual task (Sui et al., 2012).

Contrary to our first hypothesis, this study found no significant effect of the interaction between BDDQ score and person label on reaction time. However, the effect of BDDQ score on reaction time overall was significant, with higher BDDQ scores responding significantly faster than lower BDDQ scores, regardless of the label-shape pairing. This finding reflects the literature demonstrating how BDD is associated with impulsive decision-making. For example, Jefferies-Sewell et al. (2017) found that increased delay aversion was observed in BDD patients compared to controls when partaking in the Cambridge Gambling Task, indicating higher levels of impatience in BDD. Therefore, higher BDDQ scores responding significantly faster adds to the suggestion that individuals with BDD make decisions more impulsively than the general population.

We also found evidence to support the hypothesis that individuals with higher BDDQ scores were more accurate at identifying You pairings than Stranger pairings compared to individuals with lower BDDQ scores. This implies that BDD is associated with an exaggerated self-prioritisation effect in this associative task. Importantly, this pattern did not extend to Friend pairings, consistent with the idea that the effect of Friend fell between Self and Stranger, indicating that the observed self-prioritisation effect in Experiment 1 was specific to the self–stranger contrast rather than reflecting a general advantage over close others.

However, one should acknowledge the limitations of this experiment. It is possible that personal differences other than BDD are mediating this effect. One possible relation involves the high comorbidity between BDD and depression (Veale et al., 2004). The increased self-prioritisation effect could be attributable to depressive symptoms, which similarly include a heightened focus on the self (Northoff, 2007). However, as previously mentioned, Hobbs et al. (2021), and McIvor et al. (2021), replicated Sui et al.'s perceptual matching paradigm, measuring depression severity using the Beck Depression Inventory (BDI; Beck et al., 1996), and found no association between depression severity and self-prioritisation. Moreover, interoceptive accuracy has not been found to be impaired in major depressive disorder (MDD), so atypical interoception is unlikely to be attributed to depression either (Jenkinson et al., 2024). This suggests that the associations in this study may be meaningfully attributable to BDD, rather than depression. Nevertheless, to enhance the internal validity, in Experiment 2 we employed the Patient Health Questionnaire (PHQ-8; Kroenke et al., 2001), alongside the BDDQ, to control for depression as a potential mediator in the relationship between BDD severity and self-prioritisation.

Experiment 2

Experiment 2 aimed to systematically replicate the findings of the previous experiment, as well as address some of its limitations. First, to control for the potential mediator of depression in the relationship between BDDQ and self-referencing, this experiment added the PHQ-8 (Kroenke et al., 2009). Therefore, this experiment had two additional hypotheses that individuals with higher PHQ scores will not display significantly reduced reaction times when identifying self-pairings, as opposed to friend or stranger-pairings, compared to those with lower PHQ scores. We also hypothesise that individuals with higher PHQ scores will not display significantly increased accuracy when identifying self-pairings, as opposed to friend or stranger-pairings, compared to those with lower PHQ scores.

Additionally, to explore whether RT effects might have been mediated by general impulsivity we included a further measure of impulsivity. Moreover, both males and females were recruited to investigate any potential sex differences in BDD and self-prioritisation.

Methods

The methods (*i.e.*, the ethical approval, power analysis, stimuli, data analysis, and measures) of Experiment 2 are equivalent to Experiment 1, apart from the changes and/or additions stated below.

Participants

The original sample consisted of 184 participants; however, participants were removed if their overall accuracy was below 0.65, which meant the final sample consisted of 176 participants, with 135 females and 41 males, between the ages of 19 and 71 (*M* = 44.49, SD = ±11.18).

Pre-Registration

For this final experiment, the original hypotheses (1 + 2) were pre-registered on AsPredicted on 25/10/2023 (see https://aspredicted.org/N8Q_NLQ). Although we collected data from males and females, sampling limitations resulted in more females than males.

Procedure

To control for the potential mediators of depression or impulsivity in the relationship between BDDQ and self-referencing, this experiment added the Patient Health Questionnaire (Kroenke et al., 2009) and the Barratt Impulsiveness Scale (Patton, Stanford & Barratt, 1995). There was also a change so that participants completed the self-referencing task first, followed by the questionnaires, so that participants were not primed to think about depression, impulsivity or BDD before completing the self-referencing task.

Measures

Patient Health Questionnaire (PHQ-8; Kroenke & Spitzer, 2002)

The PHQ-8 is a self-report questionnaire consisting of eight questions, often used in clinical settings, that assesses the severity of an individual's depressive symptoms (see Appendix F). The questions are based off of eight of the nine DSM-4 criteria for a diagnosis of a depressive disorder (APA, 1994). For example, the questions ask the participant to rate, over the past two weeks, how often they have been struggling with sleep, energy levels, appetite, etc., with the options being not at all (0 points), several days (1 point), more than half the days (2 points) or nearly every day (3 points). Thus, higher scores on the PHQ indicate that the individual has more depressive symptoms. The points for each question are totalled, with an overall score of 10 or greater representing clinically significant depression (Kroenke et al., 2001).

Barratt Impulsiveness Scale (BIS-11; Patton, Stanford & Barratt, 1995)

The BIS-11 is one of the most widely used measures for self-reported impulsivity. This questionnaire uses 30 items to explore 3 dimensions of impulsivity: attentional, motor, and non-planning (see Appendix G). These three domains can be further subdivided into 6 dimensions of impulsivity, including attention, motor, self-control, cognitive complexity, perseverance, and cognitive instability. The questions ask the participant to rate whether each statement applies to them, with the answer options being rarely/never (1 point), occasionally (2 points), often (3 points), or almost always/always (4 points). The points for each question are totalled, meaning that the total scores range from 30 to 120, with high scores indicating higher impulsivity.

Self-Referencing Task

The identical task was used as in Experiment 1 except given the significant effect of block on accuracy in Experiment 1, and that the increased self-prioritisation was observed selectively in the first block (30 trials), the self-referencing task in Experiment 2 was reduced to 120 trials. Moreover, the person label-shape pairing was presented for only 250ms, as opposed to 500ms. This change was made with the intention of making the task more difficult, so that a wider range of accuracy scores might be observed.

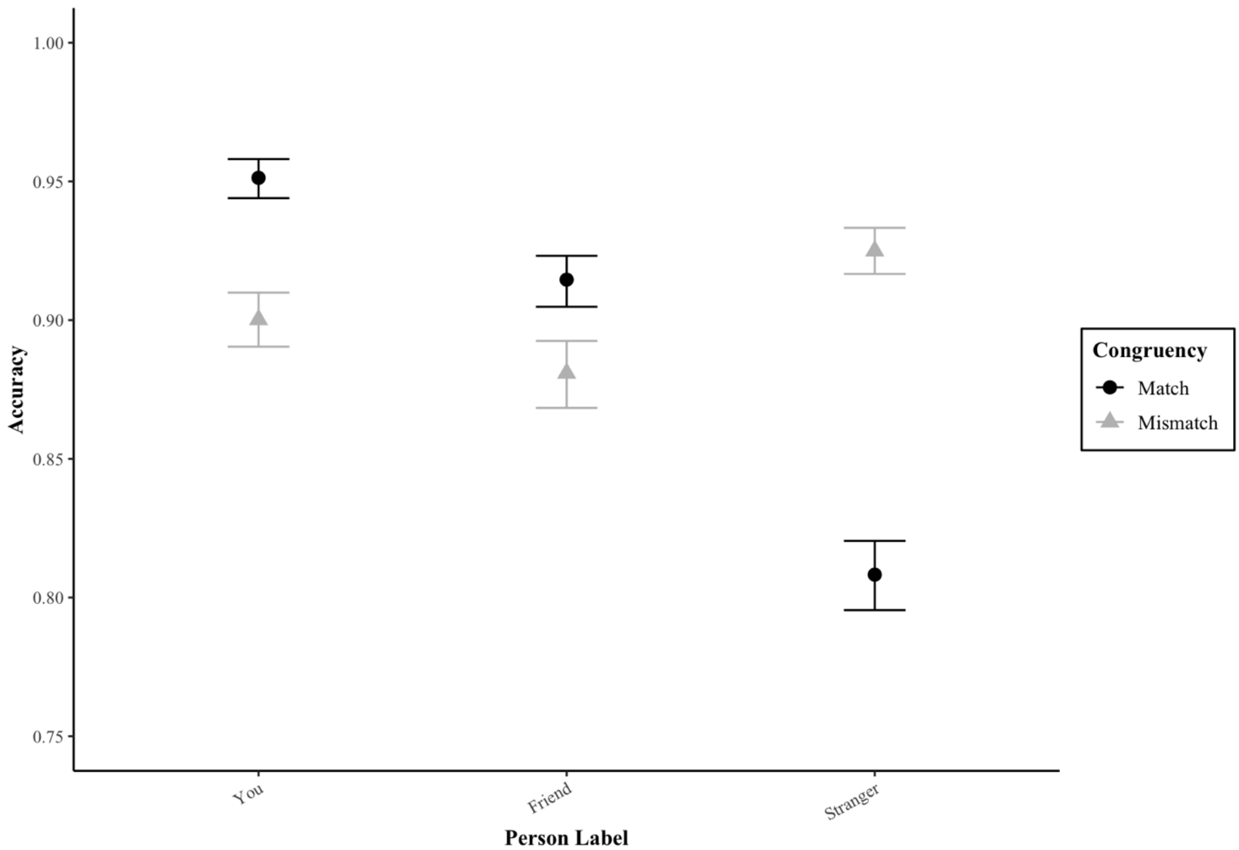
Results

As preregistered, participants were removed from the analysis if their overall accuracy on the self-referencing task was < 0.65, which reduced the sample from 184 to 173 participants. Similarly, individual trials were omitted if the reaction times were <200ms or >1400ms, which reduced the total number of trials by 1,815, from 22,080 to 20,265 trials. Results were reported to two decimal places, using the standard significance level ($p < .05$).

Self-Referencing Effect and Accuracy

As in Experiment 1, Figure 6 visually demonstrates that, again, people were most accurate for You-matches compared to Friend and Stranger-matches.

Figure 6.
Participants' Mean Accuracy at Identifying Person-Label Pairings in Experiment 2 by Person label and Congruency.



Note. The error bars represent the 95% confidence interval of the mean accuracy.

As with experiment 1, two logistic mixed models were compared that contained person label and congruency, differing only in the inclusion of the predictor 'self Shape' (i.e., whether a circle (n = 65), square (n =59), or triangle (n =60) was associated with You). Adding the stimulus pairing to a model containing only person label and congruency did not significantly enhance the model fit ($\chi^2(2) = 4.83$, $p = .09$). Therefore, going forward, stimulus pairing was not included in the models investigating accuracy.

A logistic mixed-effects model was fitted to predict accuracy with person label and congruency. There were significant interactions between person label and congruency, indicating that the effect of match differed across word types. Specifically, You-mismatch trials were identified significantly less accurately than You-match trials, yet this congruency effect was attenuated for Friend stimuli (ß = 0.42, $p = .001$, Std. ß = 0.42, 95% CI [0.17, 0.67]) and further reduced for Stranger stimuli (ß = 1.95, $p < .001$, Std. ß = 1.95, 95% CI [1.70, 2.20]). This pattern indicates that congruency had the strongest influence on accuracy for self-related stimuli, with self-prioritisation emerging most clearly on matching trials, akin to Experiment 1.

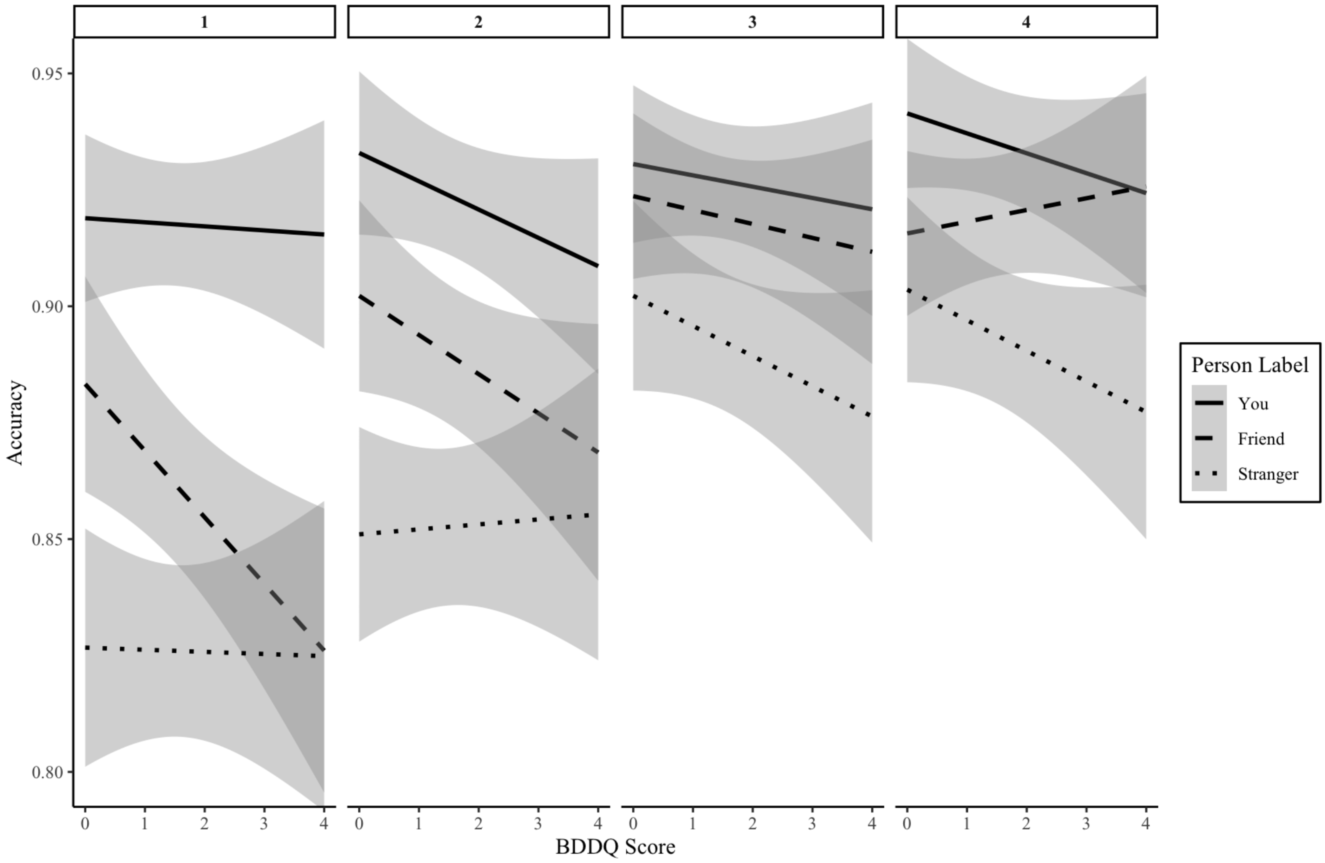
BDDQ and Accuracy

The scores on BDDQ scores in the sample (M = 1.50, SD = 1.61), spanned the full possible range from 0 to 4.

Figure 7 displays the mean accuracy percentages by the three person label pairing types and BDDQ. It shows that accuracy was lower for Friend-pairings compared to You-pairings as BDDQ scores increased, and that this effect diminished as the experiment progressed. Stranger-pairings were identified with lower accuracy overall, but this was not related to BDDQ.

Figure 7.

Participants' Mean Accuracy across the 4 blocks (each of 30 trials) of Experiment 2, as a function of Person label and BDDQ score.



Note. The grey shaded areas show the standard error (SE) of the mean accuracy.

A generalised mixed-effects model was fitted to investigate the relationship between person label, BDDQ, congruency, and blocks of trials, as well as their interactions, on accuracy, whilst accounting for random participant effects. The model revealed a statistically significant negative interaction between Friend (Person label) and BDDQ (ß = -0.29, *p* = 0.044, Std. ß = 0.02, 95% CI [-0.18, 0.22]). This means that, with increasing BDDQ scores, the difference in accuracy between Friend and You-pairings significantly increased. However, unlike in Experiment 1, the difference in accuracy between Stranger and You-pairings was not related to BDDQ score (Std. ß = -0.0005, *p* = 0.692).

Moreover, the model revealed a statistically significant positive interaction between Friend (Person label), BDDQ, and block (ß = 0.12, *p* = 0.031, Std. ß = 0.22, 95% CI [0.02, 0.42]). The same triple order interaction was not seen with Stranger (Person label), BDDQ, and block (Std. ß = 0.04, $p = 0.678$). Nevertheless, this significant triple-order interaction justified further analysis that split the data into blocks, indicating that the relationship between Friend (Person label) and BDDQ on accuracy differed across blocks. When analysing the first block of trials, a statistically significant negative interaction was found between Friend (Person label) and BDDQ (ß = -0.31, $p = .010$, Std. ß = -0.49, 95% CI [-0.88, -0.11]). These findings indicate an enhanced self prioritisation of You-pairings over Friend-pairings, but not Stranger-pairings, during block 1 in individuals with higher BDDQ scores. This was not observed in blocks 2, 3, or 4 (Block 2 – Std. ß = 0.16, $p = 0.403$; Block 3 - ß = 0.109, $p = 0.397$; Block 4 - ß = 0.089, $p = 0.531$).

In sum, participants with higher BDDQ scores were less accurate at identifying Friend-pairings compared to You-pairings. Therefore, the data implies a relation between body preoccupation and the self-prioritisation effect.

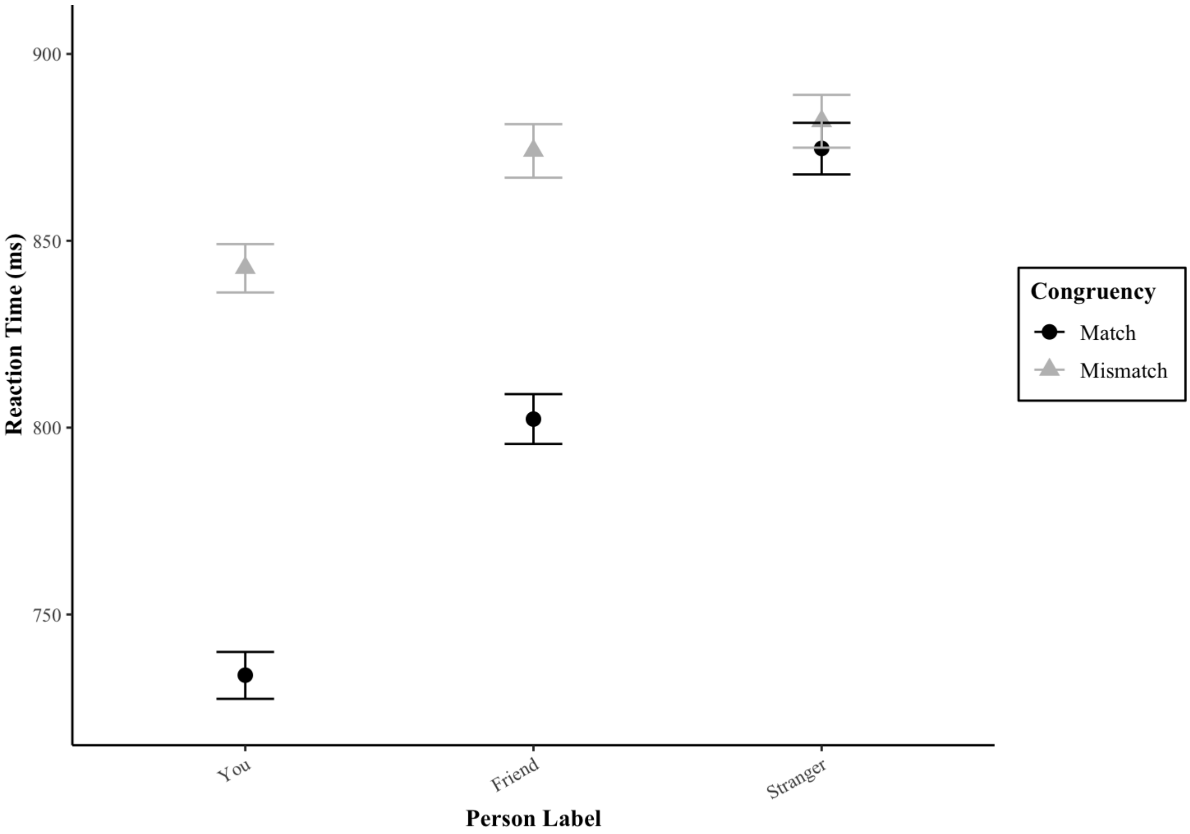
Self-Referencing and Reaction Time

Figure 8 visually demonstrates that, again, people were most accurate for You-matches compared to Friend and Stranger-matches.

To determine whether the stimulus association contributed additional explanatory power to reaction times, we compared two linear mixed-effects models that differed only in the inclusion of the predictor 'selfShape'. Adding stimulus association to a model containing only person label and congruency did not significantly enhance the model fit ($\chi^2(2) = 2.54$, $p = .280$), suggesting that participants' response times did not vary systematically with their self–shape association. Therefore, going forward, study version was not included in the models investigating reaction times.

Figure 8.

Participants' Mean Accuracy at Identifying Person-Label Pairings by Person label and Congruency.



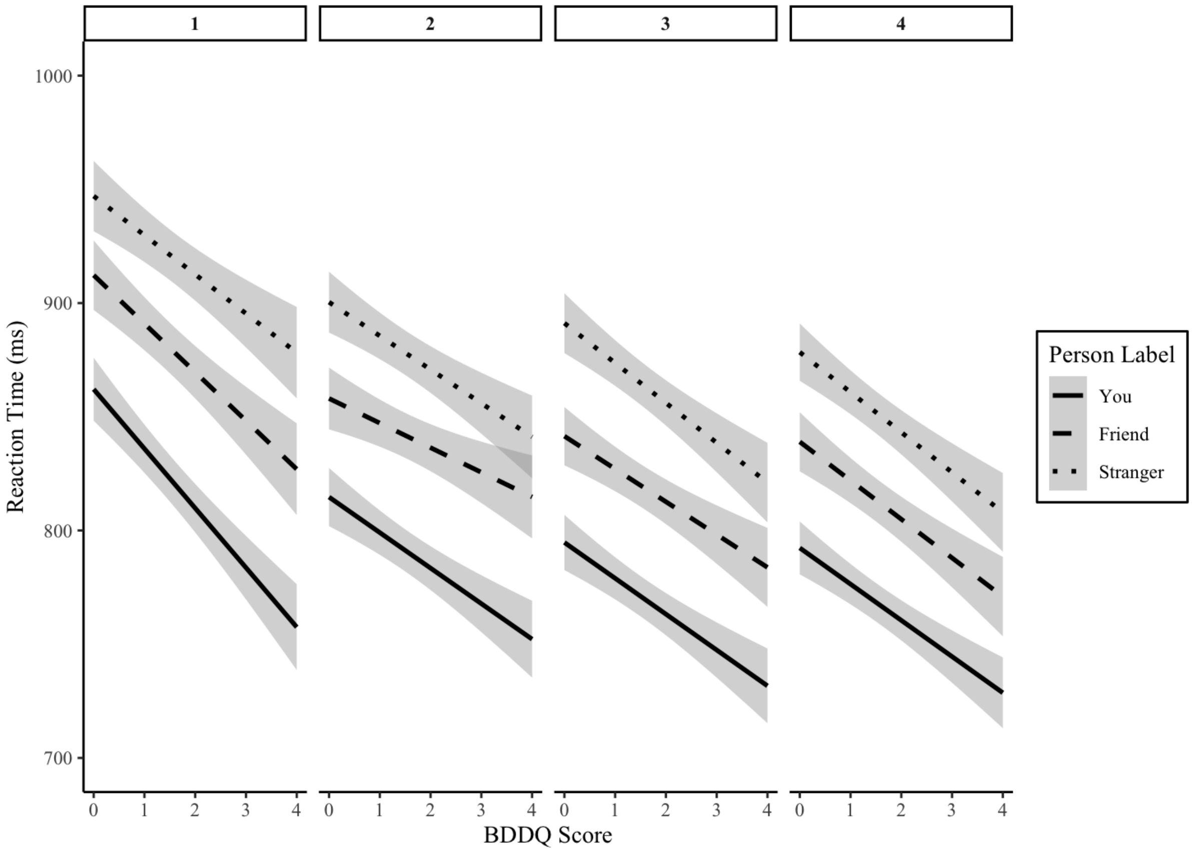
Note. The error bars represent the 95% confidence interval of the mean accuracy.

A linear mixed-effects model was fitted to predict reaction time with person label and congruency. There were significant interactions between person label and congruency, indicating that the effect of match differed across word types. Specifically, the reaction-time cost associated with mismatch trials, as described in experiment 1, was significantly reduced for Friend (ß = −36.93, p < .001, Std. ß = -0.18, 95% CI [-0.23, -0.12]) and substantially reduced for Stranger (ß = −102.20, p < .001, Std. ß = -0.49, 95% CI [-0.54, -0.43]), compared You. This pattern indicates that congruency had the strongest influence on reaction time for self-related stimuli, with self-prioritisation expressed most clearly on matching trials.

BDDQ and Reaction Time

Figure 9 visually illustrates that, across all blocks, higher BDDQ scores respond faster across all person labels, with You-pairings the fastest and Stranger-pairings the slowest. Additionally, the difference in reaction times between You-pairings and Friend- and Stranger-pairings was statistically related to BDDQ scores increased.

Figure 9.
Participants' Mean RT across the 4 blocks (each of 30 trials) of Experiment 2, as a function of BDDQ score.



Note. The grey shaded areas show the standard error (SE) of the mean accuracy.

Accordingly, a linear mixed model was fitted (estimated using ML and nloptwrap optimizer) to predict RT with person label, BDDQ, congruency, and block. There was a significant interaction between Friend and BDDQ (ß = 13.27, p = 0.032, Std. ß = 0.02, 95% CI [-0.02, 0.05]) and Stranger and BDDQ (ß = 12.20, p = 0.050, Std. ß = 0.01, 95% CI [-0.03, 0.05]).

Moreover, there was an influence of learning, as indicated by a significant interaction between Friend, BDDQ, and block (ß = -4.46, p = 0.049, Std. ß = -0.04, 95% CI [-0.08, -0.0002]), leading to a block-based analysis.

As in Experiment 1, in all 4 blocks, higher BDDQ scores respond faster to all person labels (see Figure 10). A linear mixed model was fitted to block 1 (first 30 trials) data to predict RT with person label and BDDQ and revealed a statistically significant negative main effect of BDDQ (ß = -25.64, p < .001, Std. ß = -0.18, 95% CI [-0.28, -0.08]). There was no significant interaction between BDDQ and Person label (BDDQ:WordFriend – Std. ß = 0.05, p = 0.196; BDDQ:WordStranger – Std. ß = 0.05, p = 0.133). Similarly, for blocks 2, 3, and 4, there was a significant main effect of BDDQ on RT but no significant interactions between BDDQ and Person label. Thus, there is evidence for an overall increased self-prioritisation effect in the RTs of individuals with BDD but this is not specific to any block.

PHQ-8 and Accuracy

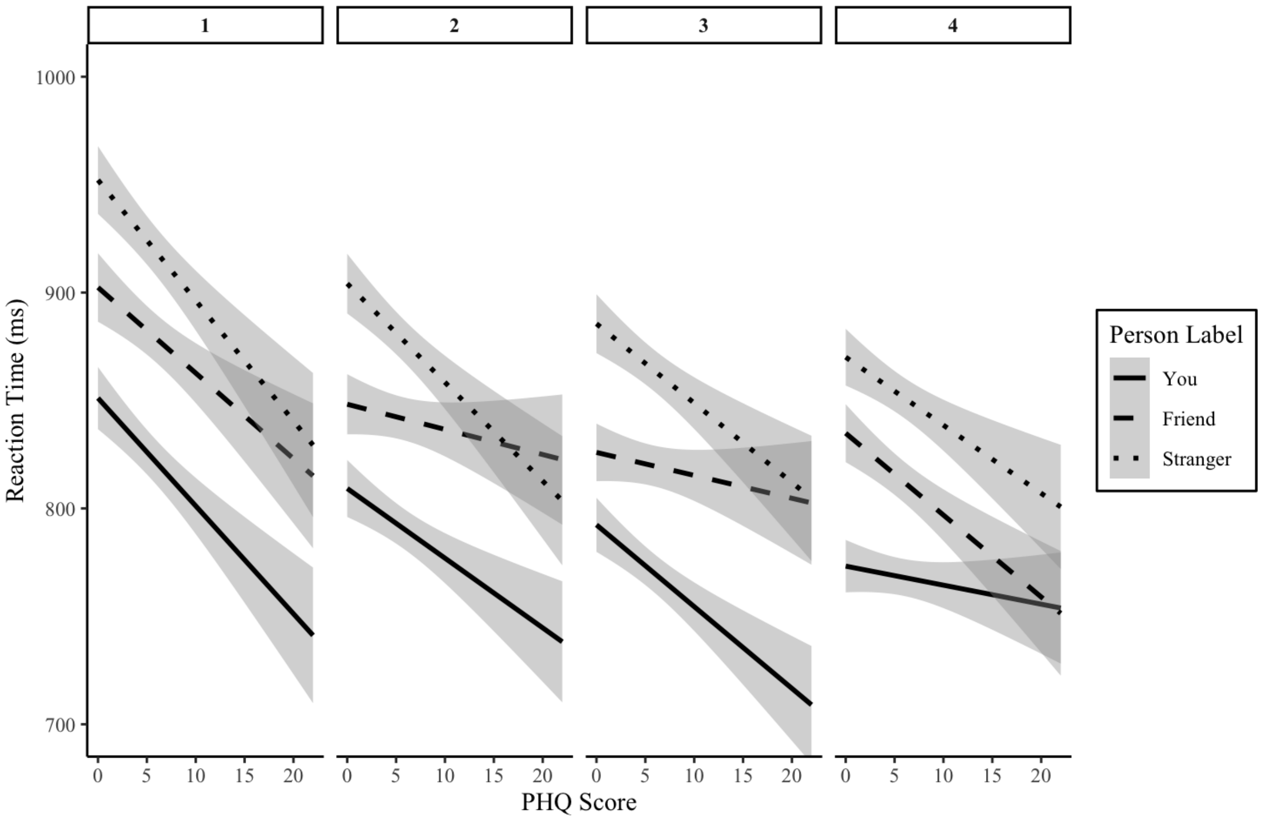
PHQ scores indicated a 'mild' depression on average (M = 5.70, SD = 5.70), ranging from 0 – 22, where 28 was the maximum possible score. As for PHQ, a generalised mixed-effects model was fitted to investigate the effects of person label, PHQ, congruency, and block on accuracy. This model revealed no significant main effect of PHQ (Std. ß = -0.001, p = 0.982) nor interactions between PHQ and Person label (PHQ:WordFriend – Std. ß = -0.015, p = 0.711; PHQ:WordStranger – Std. ß = -0.020, p = 0.588). This indicates that the previously observed significant association between BDDQ and accuracy is specific to BDD and not explained by PHQ, suggesting that depression is unlikely to be a major confound in this interaction.

PHQ-8 and Reaction Time

Figure 10 demonstrates that individuals with higher PHQ scores respond significantly faster to label-shape pairings compared to those with lower PHQ scores, and that individuals with higher PHQ scores respond significantly faster to You-pairings compared to Friend-pairings.

Figure 10.

Participants' Mean RT of Experiment 2, as a function of Person label and PHQ score.



Note. The grey shaded areas show the standard error (SE) of the mean accuracy.

Accordingly, a linear mixed model was fitted investigating whether person label, PHQ, congruency and block could predict RT. This model found a statistically significant main effect of PHQ on RT (ß = -5.96, p = .009, Std. ß = -0.08, 95% CI [-0.16, 0.006]). Additionally, the model revealed a statistically significant and positive interaction between PHQ and Friend (Person label) (ß = 3.70, p = .035, Std. ß = 0.009, 95% CI [-0.03, 0.05]). There was no significant interaction between PHQ and congruency (Std .ß = -0.02, p = 0.914), nor between PHQ and Stranger (Person Label) (Std. ß = -0.03, p = 0.411). In sum, individuals with higher PHQ scores demonstrated an increased self-prioritisation effect, where You-pairings were identified more quickly compared to Friend pairings, but not Stranger pairings, as PHQ scores increased.

Subsequently, a stepwise regression analysis was conducted to identify the most significant predictors of RT by systematically eliminating those that did not significantly contribute to the model's goodness of fit. The stepwise regression used both forward and backward selection (bidirectional) based on the Akaike Information Criterion (AIC) to optimise model performance. The initial model included the potential predictors word, BDDQ, and PHQ (rt ~ (word + bddq + phq) ^3 + (word|partId)). The stepwise regression excluded PHQ due to its non-significant contribution ($p = 0.628$), resulting in a final model with only BDDQ ($p = 0.001$) and word ($p < .001$) as significant predictors of RT (rt ~ word + bddq + (word | partId)).

Exploratory Analyses

As the experiments varied in the proportion of males and females, we investigated whether there was a significant interaction between sex and BDDQ on accuracy. This is because the influence of BDDQ on self-prioritisation was seen exclusively in accuracy, not RT, thus we are interested in whether sex interacts with this effect on accuracy. A logistic mixed model was fitted to the data from all experiments combined to predict accuracy with word, congruency, BDDQ, and sex. No significant main effects nor interactions were observed. This indicates that sex was not a factor influencing the association between BDDQ and accuracy.

Moreover, we investigated whether impulsivity accounted for the faster reaction times demonstrated in individuals with higher BDDQ scores. BIS scores in this sample indicated an average impulsivity ($M = 65.06$; $SD = 5.89$), ranging from 48 to 81, where the lowest possible was 30 and highest was 30. A linear mixed model was fitted to predict RT with person label, BDDQ score, BIS score, congruency, and block. This model found no significant main effect of BIS on RT (Std. ß = 0.0001, $p = 0.131$), nor a significant interaction between BIS and Person label on RT (BIS:WordFriend – Std. ß = -0.05, $p = 0.997$; BIS:WordStranger – Std. ß = -0.05, $p = 0.892$).

As with Experiment 1, we investigated whether the time spent viewing the 'Pairings Screen' varied systematically with BDDQ score using Pearson's product-moment correlations. In Experiment 2, pairing duration was not significantly correlated with BDDQ score, $r(171) = .05$, 95% CI [-0.20, 0.10], $p = .521$. These findings indicate that time spent viewing the pairing screen did not vary as a function of BDDQ.

Finally, as done with Experiment 1, a generalised linear mixed-effects model was conducted to examine whether the type of You-mismatch (You-FriendShape vs You-StrangerShape) influenced RT. There was no significant main effect of mismatch type (Std. ß = -0.03, $p = 0.230$), indicating that RT did not vary as a function of the type of You-mismatch.

The same models were used to investigate whether mismatch type influenced accuracy. There was a significant and positive main effect of mismatch type (ß = 0.25, $p = 0.034$, Std. ß = -.25, 95% CI [0.02, 0.49]), such that accuracy was greater in identifying You mismatched with a Stranger-shape compared to a Friend-shape.

To further explore whether individual differences in BDDQ modulated these accuracy effects, BDDQ score and its interaction with mismatch type were added to the models. There was no significant main effect of BDDQ (Std. ß = -0.14, p = 0.186) nor interaction of mismatch type and BDDQ (Std. ß = 0.11, p = 0.338) was observed. These results suggest that the You-mismatch effect in accuracy was not modulated by BDDQ.

Discussion

Self-prioritisation was observed in all participants, and, again, those with higher BDDQ scores demonstrated an exaggerated self-prioritisation effect. Specifically, early during learning, higher BDDQ scores were significantly associated with a stronger self-prioritisation effect (i.e., a greater gap in accuracy between You- and Friend-pairings or a greater gap in reaction time between You- and Friend- or Stranger- pairings).

Unlike Experiment 1, reaction time analyses of Experiment 2 revealed a significant interaction between person label and BDDQ score for both Friend and Stranger comparisons, indicating that faster responses for You-pairings compared to Friend and Stranger pairings increased as BDDQ score increased. This implies that self-prioritisation is enhanced in individuals with BDD and may manifest not only in accuracy, as shown in Experiment 1 and 2, but also in processing speed.

As observed in Experiment 1, BDDQ score exerted a significant main effect on reaction times, with higher BDDQ scores responding significantly faster than lower BDDQ scores, regardless of the label-shape pairing. The replication of this effect across experiments suggests that individuals with higher BDDQ scores are reliably faster at responding to the label-shape pairings in the self-prioritisation task. Importantly, in an exploratory analysis, an individual's impulsivity, as measured by BIS scores, was not significantly associated with RT. This suggests that impulsivity in BDD is unlikely to account for the observed relationship between BDDQ scores and RT across both studies. Instead, faster RTs among individuals with higher BDDQ scores may reflect heightened attentional engagement with self- and other-related stimuli, consistent with findings that individuals with BDD display increased selective attention to socially and appearance-relevant information. This enhanced attention may then facilitate quicker perceptual processing, even of geometric shapes. Thus, rather than reflecting impulsive responding, the RT pattern may indicate a more general attentional bias or hypervigilance characteristic of BDD.

An individual's PHQ score was not found to be significantly associated with their accuracy in responding to label-shape pairings. These findings align with previous studies that found no association between depression levels and self-referencing (Hobbs et al., 2021; McIvor et al., 2021). However, an individual's PHQ score was significantly associated with their reaction time, similar to BDDQ. This raised the question of whether depression or body dysmorphic disorder (BDD) was more closely related to faster self-referencing in participants. The stepwise regression removed PHQ as a predictor of reaction time, identifying BDDQ as the strongest predictor. These results suggest that BDDQ scores, rather than PHQ scores, are more strongly associated with variation in reaction time.

Finally, there was not a significant main effect of sex, nor a significant interaction between sex and BDDQ, on the self-prioritisation effect, measured either by reaction time or accuracy. This demonstrates that sex is unlikely to influence self-referencing generally, or in BDD.

General Discussion

Summary of Results

Together, Experiments 1 and 2 aimed to investigate self-prioritisation in relation to BDDQ scores. Specifically, whether higher BDDQ scores were associated with differences in the self-prioritisation effect using an associative matching task. Experiment 1 found a relationship between BDDQ scores and performance, through accuracy and reaction time. Experiment 2 replicated this finding, with the addition of the BIS and PHQ to explore impulsivity and depression as potential confounding factors.

Both experiments show a significant association between BDDQ scores and accuracy in identifying self-object matches, indicating that individuals with higher BDDQ scores show more accurate self-processing. Although previous research has identified biased processing of self-related stimuli in BDD (Dent & Martin, 2023), less research has investigated whether the mechanism underlying this enhancement relates to a general focus on self-attention as predicted by the Self-Attention Network (Humphreys & Sui, 2016). Here the biases related to BDD generalise to non-disorder-relevant stimuli and both speak to the generality in the shift in learning and attention and the potential to study how self-bias emerges in the first instance (Byrom & Murphy, 2018).

Using other experimental tasks there has been evidence for perceptual and memory differences, Jefferies et al. (2012) reported that individuals with BDD demonstrated greater recognition accuracy and faster response times to inverted faces compared to healthy controls, indicating superior facial processing in BDD. As individuals with BDD most often perceive ‘defects’ in and around their face (Phillips, 2005), facial stimuli are more disorder-specific than geometric shapes. In contrast, this study used artificial stimuli and *still* identified an exaggerated self-prioritisation effect in high BDDQ scores, indicating that the inflated self-prioritisation bias in BDD reflects a general information processing bias in BDD (i.e., the bias is not exclusively associated with disorder-relevant stimuli). In Experiment 1, BDD had no influence on self-prioritisation effects in reaction time in our experiments. However, in Experiment 2, BDD was significantly associated with faster response times to You-pairings compared to Friend- and Stranger-pairings, aligning with the findings of Jefferies et al. (2012). These findings imply that the increased self-bias in BDD influences both perceptual accuracy and speed of processing. The discrepancy between the two experiments may be due to the smaller sample size in Experiment 1, or perhaps accuracy measures are more sensitive to self-related biases in BDD than reaction times.

The tendency to associate cues can be used as a marker for mental health (Byrom & Murphy, 2014, 2016). People with depression show poor associative learning involving context cues (Msefit et al., 2009), whereas people with schizophrenia show enhanced attention to irrelevant cue (Silverstein et al., 2009). The current evidence emphasizes the role that associative processes during learning may contribute to a disrupted perception of the self and suggest further research to understand the role in learning in the acquisition of BDD. This work could provide a useful insight into how to enhance treatment.

Taken together, the findings suggest a general information processing bias towards self-information, and deficiency of processing information about others, which may be contributing to the distorted views of the self (*i.e.*, self-appearance) observed in BDD. For example, a bias towards processing self-relevant information may explain why individuals with BDD misinterpreted neutral facial expressions as contemptuous exclusively in self-referent situations (Buhlmann et al., 2006). Further, these findings complement the cognitive-behavioural model of BDD (Veale, 2004), which proposes that cognitive biases perpetuate the negative appraisals of self-image seen in BDD. The evidence presented here supports exaggerated self-prioritisation as an additional cognitive bias that contributes to BDD.

Limitations

The sample for Experiment 2 is limited as an equal distribution of males and females was not obtained (n = 41, n = 135). Although our analyses did not find a significant influence of sex on the self-prioritisation effect, nor did sex interact with BDDQ, future research should aim to recruit a more balanced sample to further examine potential sex differences in this information processing. Moreover, the samples used in these experiments were taken from the general population, using the BDDQ to approximate levels of BDD. One must acknowledge that the BDDQ is only a proxy for the likelihood of having BDD and that the clinical implications of these findings cannot be confidently determined without collecting data from a clinical population. Therefore, a future study should administer this associative-matching paradigm to a clinical sample of individuals diagnosed with BDD and compare their self-prioritisation effect to that of the general population.

The absence of a significant relationship between PHQ and accuracy or reaction time in the self-referencing task indicates that depression may not influence this type of information processing. While depression is known to impact learning - such as reducing sensitivity to contextual information (Castiello et al., 2020) – it does not appear to influence performance in simpler associative learning tasks (Hobbs et al., 2023). However, when self-referential and emotional processing are combined, depression is associated with an increased positive bias towards others, meaning depressed individuals form more positive associations with others and fewer positive associations with themselves. There is literature to suggest that there is no correlation between self-bias and emotion-bias (Stolte et al., 2017; McIvor et al., 2021), which is corroborated by neuroimaging evidence that self-relevant stimuli engage the medial prefrontal cortex (mPFC) whereas emotional valence modulates activity in the ventral anterior cingulate cortex (vACC) (Moran et al., 2006).

Taken together, these findings suggest that self-processing is not a unitary construct, but instead comprises multiple mechanisms operating at different cognitive levels. The self-prioritisation effect is thought to reflect attentional self-processing, involving the prioritisation of self-associated stimuli, whereas evaluative self-reference effects reflect elaborative processing, whereby information is integrated with existing self-knowledge (Rogers, Kuiper, & Kirker, 1977). This distinction is important when interpreting clinical findings across self-bias tasks.

Within this framework, depression influences evaluative self-processing, particularly in the context of emotionally valenced information (Derry & Kuiper, 1981; Stolte et al., 2017), but may not be reflected in attentional self-processing as indexed by the self-prioritisation effect. In contrast, the present findings, together with those of Dent and Martin (2023), suggest that body dysmorphic concerns may influence self-biases at levels of cognition that differ from those involved with depression. Self biases related to depression (ie. Self Relevance Effects) seem to reflect developmental changes in line with self knowledge (Maire et al., 2020; Singh & Karnik, 2022) that does not seem relevant for Self priortisation. Depression may be related to self knowledge and elaboration whereas, individuals with higher body image concern appear to show enhanced attentional self-processing for neutral stimuli, as reflected by exaggerated self-prioritisation, alongside enhanced evaluative self-processing for negative self-relevant information. Thus, BDD may affect both attentional and elaborative self-referential mechanisms, whereas depression may primarily affect elaborative self-referential processing.

One explanation for this may be that BDD involves hyperactivation of the mPFC, sef-referral network, as well a negative affective bias in the vAAC, leading to excessive and negatively valenced self-focus. This dual enhancement of both self-focus and negative affect may explain why individuals with BDD demonstrate both an exaggerated self-prioritisation effect with neutral stimuli, as demonstrated in this study, and a tendency to attribute negative information to the self (Dent & Martin, 2023). Given this pattern, future research should investigate a battery of self-bias effects within the same individuals to determine how different components of self-processing contribute to body dysmorphic symptoms..

One way to test a combined self-positivity bias is through a label-shape matching task which distinguishes between "good" and "bad" in addition to "self" and "other" (Hu et al., 2020). Healthy people respond most efficiently to the shape that represents their good self. Similarly, the self-prioritisation effect is boosted in a positive-self connection and dampened in a negative-self connection, suggesting that humans generally seek a positive self-image. With regards to what has been discussed about BDD, one would predict that the self-prioritisation effect may be boosted in a negative-self connection.

While this study uses a single paradigm to assess self-prioritisation, self-referential processing can manifest in various ways. Using a battery of self-prioritisation tasks would provide a more comprehensive understanding of self-referential processing in BDD. For example, Woźniak and colleagues (2023) assessed how individuals processed self-related geometric shapes, names, and avatar faces, finding a difference between high- and low-level depression group only in the avatar faces task. Similarly, future research on BDD should incorporate a wider range of stimuli, such as those varying in spatial frequency, to minimise potential relevance of shape stimuli to body-related perceptual processes. This will allow researchers to capture a broader range of self-prioritisation effects.

Clinical Implications

As self-related processing biases have recently been suggested to be potential clinical 'markers' of psychological disorders, these preliminary findings could be used to facilitate the diagnostic screening of BDD. For example, Liu et al. (2022) demonstrated that non-verbal self- and emotion-processing tendencies, as in the associative-matching task, can successfully be applied to identify and positively predict depression. In the same way, the associative-matching task could be administered to individuals seeking cosmetic surgery, with an exaggerated self-prioritisation effect being indicative of BDD. BDD has a prevalence of approximately 13.2% in a cosmetic surgery population (Veale et al., 2016). Therefore, clinicians can offer those that screen positively for BDD, other psychological treatments (e.g., CBT; NICE, 2005) that may be more effective in improving BDD symptoms, before giving them cosmetic surgery, which is often dissatisfactory for individuals with BDD (Crerand et al., 2005). Similarly, behavioural data from non-verbal self-processing tasks can track treatment progress, through re-administering the associative-matching paradigm at various time-points of the psychological treatment and observing whether the exaggerated self-prioritisation effect has diminished.

Moreover, if one interprets this increased self-prioritisation in BDD as an augmented attentional bias towards self-relevant information, then this could inform potential targets for psychological treatments. For example, this self-referential processing bias can be adapted into a cognitive bias modification (CBM) paradigm. CBM techniques aim to change an individual's selective attention for disorder-salient information, as seen in treatments of anxiety (MacLeod & Mathews, 2012), and so could be applied to diminish the increased selective attention for self-referential information seen in BDD. CBM, therefore, could aid individuals with BDD in reducing their preoccupation with self-appearance, thus minimising the distress this preoccupation causes. Fundamentally, the current findings imply that therapeutic interventions for BDD should encourage BDD individuals to rebalance self-related and other-related processing, thereby reducing the maladaptive self-focus in BDD.

Conclusion

In summary, these findings present a novel interpretation of the learning related cognitions important for developing our self-perceptions. Individuals with higher BDDQ scores displayed an exaggerated self-prioritisation effect on a simple perceptual learning task. Moreover, the findings demonstrate that individuals with higher BDDQ scores display an accelerated self-prioritisation effect, which may reflect an increased focus on the self and others that is characteristic of BDD. This not only enhances our understanding of information processing mechanisms in BDD but can be applied to improve both diagnostic screening and psychological interventions of BDD.

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Appendices

A. Stimuli

B. Body Dysmorphic Disorder Questionnaire (Phillips et al., 1995)

Questionnaire

This questionnaire asks about concerns with physical appearance.

Please read each question carefully and select the answer that is true for you. Also write in answers where indicated.

1a. Are you worried about how you look?

Yes No

1b. If you answered **'Yes'**, do you think about your appearance problems a lot and wish you could think about them less?

Yes No

NOTE: If you answered 'No' to either of the above questions, you have finished this questionnaire. Please scroll to the bottom of the page and click 'Next'. Otherwise, please continue.

If you answered '**Yes'** to 1b, please list the body areas you don't like in the box below. Examples of body areas include: your skin (e.g., acne, scars, wrinkles, paleness, redness); hair; the shape or size of your nose, mouth, jaw, lips, stomach, hips etc.; or defects of your hands, genitals, breasts, or any other body part.

2. Is your main concern with how you look that you aren't thin enough or that you might get too fat?

Yes No

3. How has this problem with how you look affected your life?

- Has it often upset you a lot?

Yes No

- Has it often gotten in the way of doing things with friends, dating, your relationships with people, or your social activities?

Yes No

*If **yes**, please describe how:*

- Has it caused you any problems with school, work or other activities?

Yes No

*If **yes**, what are they?*

- Are there things you avoid because of how you look?

Yes No

*If **yes**, what are they?*

4. On average, how much time do you usually spend thinking about how you look? (Add up all the time you spend in total in a day, then select your response)

Less than 1 hour a day	1-3 hours a day	More than 3 hours a day

C. Instructions for Perceptual Self-Referencing Task

Screen 1:

You will now participate in an online task.

First, you will be asked to give the name of your best friend.

Then, you will be shown 3 statements, which you will be asked to remember.

After this, you will be shown different label-shape pairings, to which you should indicate whether they match the previous statements or are a mismatch, as **quickly**, and as **accurately** as possible.

You will be given feedback before the next label-shape pairing.

Press next when you are ready to move on.

Screen 2:

Enter the **first** name of your best friend below.

Click submit when you have done so.

Screen 3:

Here are 3 statements.

Please remember these.

You are a triangle.

Friend's Name is a circle.

A stranger is a square.

Screen 4:

Now, you will be shown variations of those label-shape pairings, with images of the shape.

You should indicate as **quickly** and **accurately** as possible if the pairing matches what the statements shown previously.

Press 'F' if it is a match.

Press 'J' if it is a mismatch.

You will be shown whether you were correct or not, and then this will be repeated.

Press 'Next' when you are ready to complete 5 practice trials.

Break Screen:

Thank you for completing the 1st/2nd trial.

Give yourself a short break before clicking 'Next' to continue to the next trial.

End Screen:

The experiment is complete!

Your responses have been submitted.

Thank you for completing our experiment!

D. Patient Health Questionnaire (Kroenke et al.,)

Over the last 2 weeks, how often have you been bothered by any of the following:

Little interest or pleasure in doing things?

- Not at all

- Several days
- More than half the days
- Nearly every day

Feeling down, depressed, or hopeless?

- Not at all
- Several days
- More than half the days
- Nearly every day

Trouble falling or staying asleep, or sleeping too much?

- Not at all
- Several days
- More than half the days
- Nearly every day

Feeling tired or having little energy?

- Not at all
- Several days
- More than half the days
- Nearly every day

Poor appetite or overeating?

- Not at all
- Several days

- More than half the days
- Nearly every day

Feeling bad about yourself - or that you are a failure or have let yourself or your family down?

- Not at all
- Several days
- More than half the days
- Nearly every day

Trouble concentrating on things, such as reading the newspaper or watching television?

- Not at all
- Several days
- More than half the days
- Nearly every day

Moving or speaking so slowly that other people could have noticed? Or the opposite - being so fidgety or restless that you have been moving around a lot more than usual?

- Not at all
- Several days
- More than half the days
- Nearly every day

E. Barratt Impulsiveness Scale (BIS-11; Patton, Stanford & Barratt, 1995)

This questionnaire is made up of 30 statements, asking about personality traits.

Please read each statement carefully and select the answer that is most accurate for you.

1- I plan tasks carefully.

- Rarely / never
- Occasionally
- Often
- Almost always / always

2- I do things without thinking.

- Rarely / never
- Occasionally
- Often
- Almost always / always

3- I make up my mind quickly.

- Rarely / never
- Occasionally
- Often
- Almost always / always

4- I am happy-go-lucky.

- Rarely / never
- Occasionally
- Ofte
- Almost always / always

5- I don't 'pay attention'.

- Rarely / never
- Occasionally
- Often
- Almost always / always

6- I have 'racing' thoughts.

- Rarely / never
- Occasionally
- Often
- Almost always / always

7- I plan trips well ahead of time.

- Rarely / never
- Occasionally
- Often
- Almost always / always

8- I am self controlled.

- Rarely / never
- Occasionally
- Often
- Almost always / always

9- I concentrate easily.

- Rarely / never
- Occasionally
- Often
- Almost always / always

10- I save regularly.

- Rarely / never
- Occasionally
- Often
- Almost always / always

11- I 'squirm' at plays or lectures.

- Rarely / never
- Occasionally
- Often
- Almost always / always

12- I am a careful thinker.

- Rarely / never
- Occasionally
- Often
- Almost always / always

13- I plan for job security.

- Rarely / never

- Occasionally
- Often
- Almost always / always

14- I say things without thinking.

- Rarely / never
- Occasionally
- Often
- Almost always / always

15- I like to think about complex problems.

- Rarely / never
- Occasionally
- Often
- Almost always / always

16- I change jobs.

- Rarely / never
- Occasionally
- Often
- Almost always / always

17- I act 'on impulse'.

- Rarely / never
- Occasionally

- Often
- Almost always / always

18- I get easily bored when solving thought problems.

- Rarely / never
- Occasionally
- Often
- Almost always / always

19- I act on the spur of the moment.

- Rarely / never
- Occasionally
- Often
- Almost always / always

20- I am a steady thinker.

- Rarely / never
- Occasionally
- Often
- Almost always / always

21- I change residences.

- Rarely / never
- Occasionally
- Often

- Almost always / always

22- I buy things on impulse.

- Rarely / never
- Occasionally
- Often
- Almost always / always

23- I can only think about one thing at a time.

- Rarely / never
- Occasionally
- Often
- Almost always / always

24- I change hobbies.

- Rarely / never
- Occasionally
- Often
- Almost always / always

25- I spend or charge more than I earn.

- Rarely / never
- Occasionally
- Often
- Almost always / always

26- I often have extraneous thoughts when thinking.

- Rarely / never
- Occasionally
- Often
- Almost always / always

27- I am more interested in the present than the future.

- Rarely / never
- Occasionally
- Often
- Almost always / always

28- I am restless at the cinema or lectures.

- Rarely / never
- Occasionally
- Often
- Almost always / always

29- I like puzzles.

- Rarely / never
- Occasionally
- Often
- Almost always / always

30- I am future oriented.

- Rarely / never
- Occasionally
- Often
- Almost always / always

F. Generalised Anxiety Disorder Assessment (GAD-7; Spitzer et al., 2006)

Over the last 2 weeks, how often have you been bothered by any of the following problems?

Feeling nervous, anxious or on edge?

- Not at all
- Several days
- More than half the days
- Nearly every day

Not being able to stop or control worrying?

- Not at all
- Several days
- More than half the days
- Nearly every day

Worrying too much about different things?

- Not at all
- Several days
- More than half the days
- Nearly every day

Trouble relaxing?

- Not at all
- Several days
- More than half the days
- Nearly every day

Being so restless that it is hard to sit still?

- Not at all
- Several days
- More than half the days
- Nearly every day

Being easily annoyed or irritable?

- Not at all
- Several days
- More than half the days
- Nearly every day

Feeling afraid as if something awful might happen?

- Not at all
- Several day
- More than half the days
- Nearly every day