Do symptoms of body dysmorphic disorder moderate distress reduction in social anxiety: an experimental study?

Emma Thurgood

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Thesis declaration form

I confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Name: Emma Thurgood

Date: 14.06.2024

Overview

This thesis studies the relationship between body dysmorphic disorder (BDD) and social anxiety disorder (SAD) and focuses on two of the mechanisms which may underly them: social prediction error, and self-focused attention (SFA).

Part 1 is a systematic review of the association between SAD and SFA. 16 studies across adult and child populations met inclusion criteria. Significant positive relationships were found between social anxiety symptoms and overall SFA, which supports cognitive behavioural models. In addition, social anxiety symptoms were positively associated with public and private subtypes of SFA. Quality assessment highlighted methodological inadequacies, which need to be addressed in further research.

Part 2 presents an experimental study which used an online social interaction paradigm to manipulate prediction error, with a sample of 202 young adult participants. This study aimed to establish the association between traits of BDD and SAD in a community sample, and determine the influence of BDD symptoms on mood and anxiety in response to a social prediction error. The study found a moderate positive correlation between symptoms of BDD and SAD. However, no significant association was found between BDD symptoms and the effect of prediction error on mood and anxiety. Methodological limitations are discussed, and recommendations for clinical and research development are suggested.

Part 3 is a critical appraisal, which reflects on elements of the research process, including defining search terms, and conducting quality assessment. It also considers the overlap between diagnoses of BDD and SAD and the implications this may have for screening and treatment.

Impact Statement

This thesis comprises an empirical study and a systematic review, both of which have implications to guide future research into the mechanisms underlying BDD and SAD. Understanding the overlap between these persistent and impairing conditions will be crucial in improving screening and treatment methods.

With regards to the academic sphere, the systematic review of this thesis has highlighted several possible directions for further research. Firstly, exploring the association between self-focused attention and social anxiety in young people will be beneficial to expand the current evidence base, which is limited. As SAD has an early age of onset, investigating maintenance factors in children and adolescents will provide valuable insights for early screening and intervention. Secondly, the review utilised a validated quality assessment tool to appraise study methodology, which identified several aspects of research studies which were generally lacking or low in quality. These included the reporting of power analyses and estimates of variance; both of which help the reader to interpret the study's findings, but which may in reality be overlooked when reading and appraising a study. It is hoped that this thorough quality assessment may guide others in academia towards using similar frameworks when both designing and reviewing research.

Although the comorbidity between SAD and BDD has been established in research, little is known about the association between SAD and BDD symptoms in the community. This is important, as both are spectrum disorders, meaning that many people may struggle with symptoms of one or both of these disorders, without

meeting the criteria for diagnosis. Not only has the current study contributed to this gap in research regarding SAD and BDD symptoms in community samples, it also has implications outside of academia, such as in clinical health settings. For example, the finding that BDD and SAD symptoms are highly correlated at sub-clinical levels suggests that assessments for SAD, known to be a highly- prevalent disorder, should also incorporate screening measures for BDD symptoms, which are perhaps less commonly acknowledged in services. Identifying these symptoms, even at sub-clinical levels, may inform treatment protocols as to particular targets for intervention. On a broader scale, the current research has identified a moderate overlap between two disorders currently classified under different spectrums in mental health nosology. This finding may encourage further research to examine the factors that differentiate and correlate these two disorders to inform classification and aid wider understanding. Research investigating the level of overlap of symptoms at different severities of SAD and BDD symptoms will be an important part of this process.

The empirical paper from this thesis used data from a social interaction paradigm which was computerised. The 'partners' in this paradigm were virtual, which allowed for scalability of the study and manipulation of prediction errors. However, through the process of conducting this research, various issues were highlighted regarding some of the potential drawbacks of using virtual, rather than real, social paradigms in research. Given that technology is increasingly being used to mimic social interactions in research, highlighting some of these pitfalls may guide other novice researchers planning to use similar computerised paradigms in studies. As suggested in this thesis, utilising physiological measures such as heart rate

variation, alongside self-report, may provide more in-depth insights into how participants experience these interactions, both in research and in clinical interventions. This thesis will be submitted to UCL Discovery, where it can be accessed and downloaded for use in future research.

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Part One: Systematic Review

What is the association between self-focused attention and social anxiety symptoms?

Abstract

Aims: Social anxiety disorder is a common and highly impairing condition characterised by intense fear of embarrassment and being scrutinised by others. Cognitive behavioural models propose self-focused attention (SFA) as a core maintaining factor for social anxiety disorder. Self-focused attention refers to a perception of internally generated, self-directed information, and can be categorised into different subtypes: focus on the self as a social object (public SFA) and focus on internal aspects of the self (private SFA). Only one previous systematic review has synthesised research findings on SFA and social anxiety, and this was conducted over 20 years ago and did not assess methodological rigour of included studies. The aim of this systematic review was therefore to provide an up-to-date synthesis of the literature on the association between SFA (including its subtypes) and social anxiety, across studies of both adults and children.

Method: Search terms were used to identify studies across three databases (Pubmed, PsychINFO and Medline), which were then screened to determine eligibility based on exclusion and inclusion criteria. Study quality was assessed using an adapted version of the Kmet Quality Assessment Tool.

Results: A total of 16 studies met inclusion criteria, 3 from a child population and 13 from adult populations. Of the 16 studies included, 8 found evidence of a statistically significant association between social anxiety symptoms and overall SFA, with effect sizes ranging medium (Cohen's *d*= 0.47) to large (Cohen's *d*= 1.86). Of the 9 studies that examined public SFA, 7 found evidence of a statistically significant association with social anxiety symptoms, with effect sizes ranging from medium (Cohen's *d*=

0.47) to large (Cohen's *d*= 2.08). Of the 7 studies that examined private SFA, 5 found a statistically significant association with social anxiety symptoms, with effect sizes also ranging small (Cohen's *d*=0.30) to large (Cohen's *d*= 1.16). Quality assessment highlighted a general insufficiency across studies in reporting on certain areas such as sample selection and research question.

Conclusions: Overall, findings demonstrate fairly consistent evidence for an association between SFA and social anxiety, which supports CBT models. Future research would benefit from addressing methodological deficits, as well as measuring data longitudinally to establish causal relationships.

1. Introduction

Social Anxiety Disorder (SAD) is a chronic mental health condition, which according to The Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5; American Psychiatric Association, 2013), causes an individual to experience a marked fear when exposed to social situations. Their fear, that they will act in a way that will be humiliating or receive negative evaluations, is disproportionate to the actual threat posed by the social situation and can lead to high levels of distress or avoidance of social situations (American Psychiatric Association & Association, 2013). SAD is prevalent across the lifespan, with lifetime prevalence estimated as 4% across a wide range of countries (Stein et al., 2017). It is a condition particularly prevalent in younger people, with research suggesting that global prevalence may be as high as 1 in 3 amongst young adults (Jefferies & Ungar, 2020), whilst age of onset is early across the globe (Stein et al., 2017) with the majority of people with lifetime SAD having developed it before the age of 13 (De Vries et al., 2019). This highly prevalent condition is associated with impairments across social, occupational and other important areas of functioning, and hence, understanding the mechanisms that underpin it is crucial, in order to optimise treatments.

Cognitive behavioural models propose that self-focused attention plays a key role in the maintenance of SAD. Self-focused attention (SFA) is a term defined by Ingram (1990) as ‘an awareness of self-referent, internally generated information that stands in contrast to an awareness of externally generated information derived through sensory receptors’. This self-directed information can relate to internal sensory changes, one’s appearance or physical behaviour, and one’s thoughts and emotions. While some level of SFA is a normative process, Clark and Wells’ (1995)

model of social phobia proposed that heightened SFA contributes to the maintenance of the disorder through a variety of means; shifting attentional processes to the self in order to self-preserve; creating a distorted, negative image of the self as a social object; and reducing attention to external factors meaning that negative fears are not disconfirmed. In addition, the model suggests that elevated SFA may impair a person's ability to interpret social feedback, which may lead to reductions in actual social performance, and hence contribute to the maintenance cycle of SAD.

Research has shown that SFA is a multifaceted construct, and has made an important distinction between private and public self-focused attention (Fenigstein et al., 1975). These terms may represent two separate self-regulatory processes, one, a process of focusing on internal aspects of the self (private SFA), and the other, a process of self-awareness which takes into account the social context (public SFA, sometimes termed self-consciousness) (Carver & Scheier, 1987). The emphasis with public SFA is on the reactions of others, and Fenigstein et al. (1975) propose that it is this process of seeing oneself as a social object that can result in apprehensive self-evaluation, and hence can lead to social anxiety. Similarly, the model by Clark and Wells (1995) proposes that when highly socially anxious individuals enter a social situation, their levels of public and private anxiety will both increase, whilst their attention towards the external environment will decrease. An alternative theory, self-discrepancy theory, was posited by Higgins (1987). This suggests that social anxiety will emerge in an individual due to an inconsistency between their 'actual' self and the 'ought' self; the person that they believe other people, and wider society, expect them to be. According to this theory, public SFA will be more strongly

associated with social anxiety than private SFA, because an attention to the 'ought' self requires an awareness to the public-facing aspects of the self.

Two previous narrative reviews have demonstrated a strong evidence base for the association between elevated levels of SFA and social anxiety. Spurr and Stopa (2002) drew the conclusion that amongst non-clinical populations, SFA is associated with increases in social anxiety. This was supported more recently by Norton and Abbott (2016) who identified a wide evidence-base supporting the role of SFA in the anticipatory processes before, during and after a social interaction in an adult population. Regarding the separate facets of public and private SFA and their association with social anxiety, a meta-analysis conducted by Mor and Winquist (2002) found that the relationship between public SFA and social anxiety was significantly stronger than that between private SFA and social anxiety. This finding was in line with Higgin's self-discrepancy theory (1987), as was the same reviews' finding that private SFA showed a stronger association with depression than with social anxiety. A further finding by Mor and Winquist (2002) was that samples from clinically anxious populations were more adversely affected by SFA than were samples from non-clinical populations. This may be linked to the conclusion drawn by Bogels and Mansell (2004), that public SFA will impact negatively on social interaction and performance only when paired with certain vulnerabilities, such as SAD. Again, these authors concluded that public SFA was associated more strongly with social anxiety than private SFA.

The studies included in these reviews used a range of measures to quantify SFA, including validated multi-item measures such as the Self-Consciousness Scale

(Fenigstein et al., 1975) as well as single measures of SFA, such as visual analogue scales. We highlight the distinction between these because research has queried whether single-item measures can adequately, and reliably, capture complex psychological constructs (Allen et al., 2022) such as SFA. In addition, these reviews included studies which controlled for particular variables, and/or induced SFA in order to measure the effects of this on other variables. However, manipulations such as a mirror task, which are used to amplify SFA, can introduce other variables, such as corrective feedback. These variables can confound results (Bogels & Mansell, 2004) and therefore, caution should be used when comparing these types of studies to those measuring closer to a 'pure' relationship between SFA and social anxiety. For this reason, the current review has, unlike the two prior reviews, excluded studies which either manipulate SFA or control for other variables.

The reviews above sampled adult populations; however in a general narrative review about social anxiety in youth, Halldorsson and Creswell (2017) raised the importance of considering the potential differences in maintenance factors across the different developmental stages of pre-adolescence and adolescence. In this review, they highlighted evidence for an association between social anxiety symptoms and SFA amongst both clinical and non-clinical populations. While this supported previous findings in adult populations, the authors identified several limitations, including the important point that some of the questionnaires administered to the children across studies had not been validated for younger populations, and hence were not necessarily measuring the constructs specified. The importance of considering the changes that take place across developmental stages was also raised by Leigh and Clark (2018), who identified a range of factors which change

over the period of adolescence and may impact levels of SAD and SFA, including use of safety behaviours, complexity of mental imagery and the influence of peers. Their review provided promising evidence for the use of the Clark and Wells (1995) model with the younger population but highlighted some gaps in the literature regarding the specific mechanisms by which changes specific to adolescence maintain SAD.

1.1 Aims of this review

In summary, two narrative reviews have highlighted the potential association between SFA and social anxiety symptoms (Norton & Abbott, 2016; Spurr & Stopa, 2002), but to our knowledge only one systematic synthesis of the literature has been undertaken (Mor & Winquist, 2002), and this was over twenty years ago. All of these reviews included studies which i) used a single self-reported rating of self-focused attention, and ii) controlled for particular variables or manipulated self-focused attention. Furthermore, none of these reviews included assessment of methodological quality of included studies, whilst all focused on adult populations.

Thus, there is a need for an up-to-date systematic review on the association between SFA and social anxiety across the lifespan. This paper aimed to review and synthesise the current body of literature on SFA and social anxiety, and appraise the methodological quality of studies to date. Two further aims of this review were to investigate whether SFA differs across age, and whether public and private SFA differ in their relationships with social anxiety.

2. Method

This systematic review was part of a broader review, investigating the role of self-focused attention (SFA) with symptoms of social anxiety, depression and body dysmorphia, which was pre-registered on Prospero (CRD42023358514). This current review focuses on the relationship between SFA and social anxiety only. This systematic review was reported following the guidelines for Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Searches were based upon the primary research question, 'What is the association between self-focused attention and social anxiety symptoms, body dysmorphic disorder symptoms and depression symptoms?'

Searches were carried out jointly by this researcher and a second researcher. The tasks of initial screening, full text screening, data extraction and quality assessment were split jointly between the two researchers, with involvement from members of the wider research team to help to reach consensus if disagreements emerged.

2.1 Search Strategy

Three electronic databases were searched and articles published from database inception to 25th May 2023 were considered.The databases used were Pubmed, PsychINFO and Medline with a filter to select human studies. Search word terms were grouped into two sets and combined (using AND) into a single search which included at least one term from each of the two sets. The first set used the following terms, including wildcards ("self-referen* or self-aware* or *self-focus* or self-

conscious* or ‘self referen*’ or ‘self aware*’ or ‘self focus*’ or ‘self conscious*’ or ‘internal* attent*’ or ‘self-focused cognitive process*’ or ‘self focused cognitive process*’). The second set used the following terms, including wildcards (depress* or MDD or ‘social* phobi*’ or ‘social* anxi*’ or BDD or ‘body dysmorph*’ or dysmorpho*).

After deduplication, 3892 Studies were retrieved using this search strategy across the three databases. The title and abstract of these studies were screened based on inclusion and exclusion criteriaand 70% of these studies (k = 0.68) were double rated by a second reviewer. Full texts were retrieved, and if an article could not be found, authors were contacted requesting a full copy. Articles were then reviewed in full text, identifying those which met eligibility criteria, whilst those articles which did not were excluded. A random 16% (k = 0.57) of these articles were double-rated. Where disagreements emerged, they would be discussed until a consensus was reached. Of the studies meeting eligibility criteria, only studies measuring social anxiety were included in the current paper.

2.2 Inclusion and exclusion criteria

To be included, studies needed to: a) use longitudinal/prospective, cross-sectional or experimental design; b) include 20 or more participants; c) investigate the role of self-focused attention in symptoms of social anxiety, depression or BDD (although only those investigating symptoms of social anxiety were selected for this paper); d) use a multi-item measure of self-focused attention as pre-defined by expert

consensus (see Appendix A); e) use human participants; and f) be written in the English language only. Studies could use participants of any age to be included.

Studies were removed if they met any of the following exclusion criteria: a) is a review, study abstract, single-N case study or case series with sample size <20, incomplete report, book chapter, dissertation or theses which had not been peer reviewed; b) used a non-human sample;, c) used a sample that has been used in another study in the review, in which case, all studies using the sample, besides the oldest published, would be excluded on this basis; d) not available in written English, since digital translation tools available to the researchers were not deemed to be sufficiently accurate; and, e) where full paper was not available following attempts to contact authors. Studies were also excluded if they met the following criteria regarding their measurement of self-focused attention and other variables; f) studies where self-focused attention is measured by a single item, such as a visual analogue scale; g) studies using indirect measure of self-focused attention, such as neuroimaging studies, without the addition of a questionnaire; h) studies which do not measure self-focused attention or social anxiety, depression or BDD; i) studies where the primary predictor being measured is self-awareness, self-perception, self-monitoring, metacognition rather than self-focused attention; j) studies where the primary predictor being measured is rumination, unless it is self-referential attention that is being measured; k) studies which do not measure a direct association between self-focused attention and social anxiety, depression or BDD; l) studies that control for additional variables (moderating/mediating) and do not provide a measure of direct association where variables have not been controlled; m) studies that manipulate or induce self-focused attention, such as through a mirror task. 2.3 Data Extraction and Synthesis

After full text screening, researchers extracted the following data and entered it into a shared Excel spreadsheet; authors, year of publication and country published, study design, sample size, participant ethnicity, participant age, participant sex (% female), measures used to assess SAD and self-focused attention, measuring using subscales (yes/no), outcome variable, mean scores in SAD group, effect size and significance.

The data extraction process lead to the exclusion of three further studies on SAD, which on closer inspect met exclusion criteria (See Figure 1 footnote).

For studies using more than one measure to assess social anxiety, we selected the measure which ranked highest on a hierarchy of measures, pre-specified by the research team. This was based upon the measure's psychometric properties and can be seen in Appendix B.

A narrative synthesis on social anxiety studies was undertaken by this researcher. Studies measuring the association of overall SFA score and social anxiety symptoms were described first, followed by those measuring the association between public SFA and social anxiety symptoms and then the association between private SFA and social anxiety symptoms. For each section, study design and age of population was commented on, and quality assessment findings were provided. A common effect size (Cohen's d) was computed for each study, to aid comparison across studies.

2.4 Quality scoring- assessing the risk of bias

The Standard Quality Assessment Criteria for Evaluating Primary Research Papers (Kmet et al., 2004) was used to appraise the risk of bias and studies' methodological quality. The original version of this tool uses a list of 14 items to score the quality of studies. For the purpose of this review, four items were removed from the checklist. Three of these items (5, 6 and 7 on original tool) related to study factors such as random allocation of participants to groups, and blinding of investigators, which were not relevant to our studies. Item 12 was also removed as it related to whether studies

controlled for confounding, which was one of our exclusion criteria and hence was not applicable.

Two items were added, as decided by both researchers. The first (item 1b: Was the study specifically designed to test the association between SFA and depression/SAD?) was not scored, but was included in the tool as a method of determining focus of the research. The second (item 9b: Did study report power calculation for relevant analysis?) was scored, and was designed to ensure statistical adequacy across included studies. For each item besides question 1b, studies were given a score of 0 if they did not satisfy criteria at all, a score of 1 if it was partially satisfied, and a score of 2 if it was fully satisfied (see Appendix C). Studies were given a score of 0 on questions which were not applicable. To calculate a total score for each study, scores were summed. To calculate the quality score, total score was then divided by (overall number of questions- number of questions marked non-applicable). According to tool guidelines (Kmet et al., 2004), studies could be excluded based upon either a 'liberal' cut-off of <.55 (1.1), or a 'conservative' cut-off of <.75 (1.5). However, for the purpose of this review, all studies, even those with scores under proposed cut-off scores, were included. Scores falling under cut-offs are discussed below.

After reaching consensus, the checklist would be adapted when this was felt necessary to accurately assess the papers (please see Appendix C for adapted cribsheet).

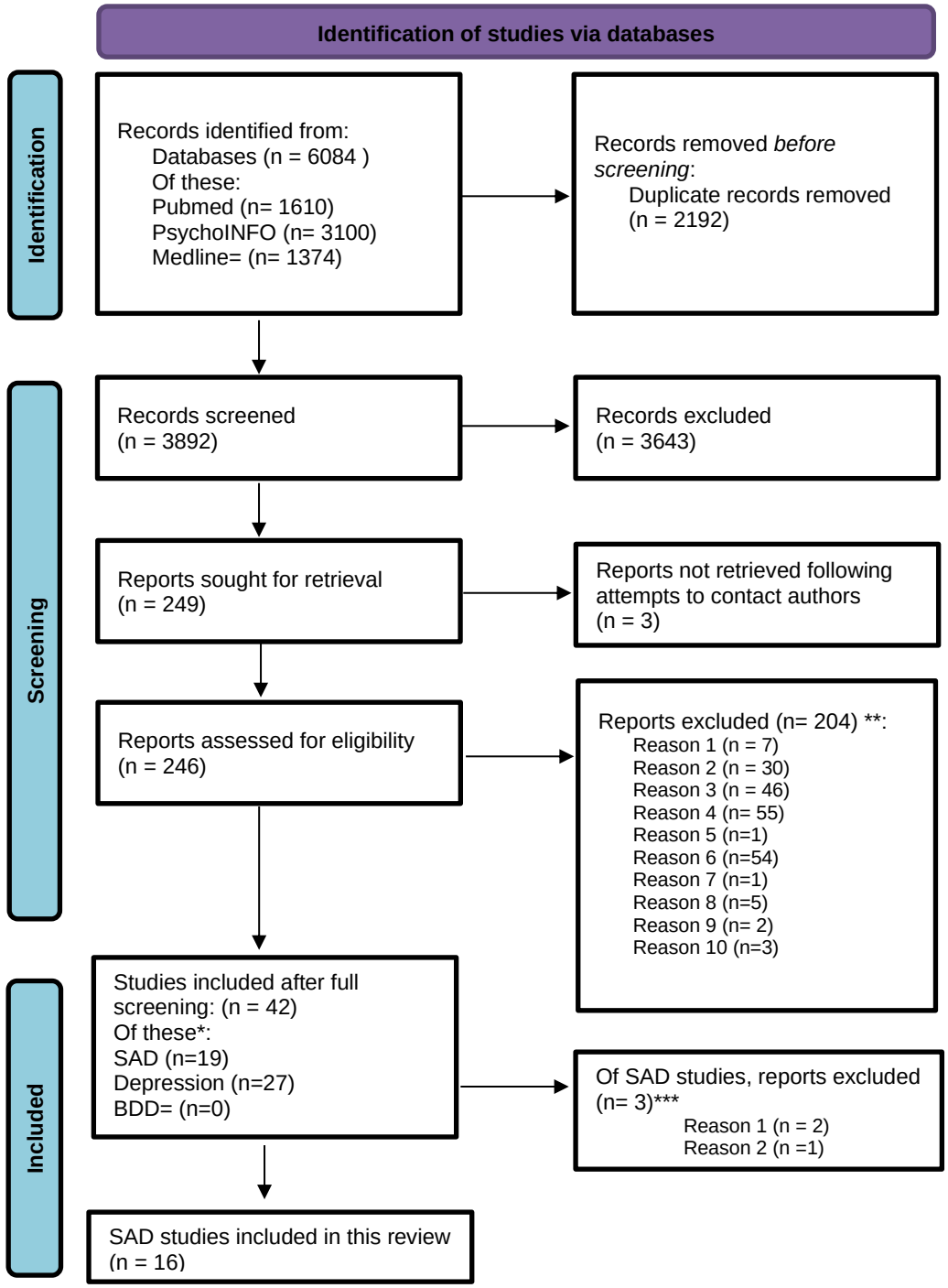
36% of studies were double rated by the other researcher, and agreement was 95%. If there was disagreement between raters, discussion would be had until a consensus was reached.

3. Results

3.1 Study Selection

The study selection process is shown in Figure 1. A total of 6084 Articles were retrieved across the databases: 1610 from Pubmed, 3100 from PsychINFO and 1374 From Medline. Endnote software manually removed 2192 articles which were duplicates (reviewers then manually removed any duplicates that had were not flagged by the software). Of the 3892 non-duplicated studies, 3643 were excluded in the initial screening due to unrelated title and abstract. A total of 246 Studies were retrieved for the full text screening process, and a further 201 were excluded on the basis of not meeting eligibility criteria. Forty-two papers remained, 19 of which measured social anxiety symptoms, and 27 measured depression symptoms. Four of the 45 studies measured both social anxiety symptoms and depression and so were included in both reviews. No studies measuring body dysmorphic disorder met our inclusion criteria. Quality assessment and discussion further lead to the exclusion of three studies on social anxiety, meaning that 16 studies measuring social anxiety were included in this review.

Figure 1. *PRISMA 2020 (Page et al., 2021) flow diagram for new systematic reviews which included searches of databases only*



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

*4 of the studies retrieved measured both social anxiety and depression.

** Reason 1: Study abstract, single-N case study, case series where sample size <20, letter, incomplete report,

book chapter, dissertations/theses that have not been peer-reviewed and reviews. Reason 2: Studies that measure self-focused attention or symptoms of anxiety, depression or body dysmorphic disorder with a single measure, such as VAS. We have chosen to exclude VAS to reduce the heterogeneity between study measures. Studies using multi-item measures will provide more robust evidence. Reason 3: Studies using indirect measures of self-focused attention, such as neuroimaging studies or eye tracking experiments, unless these studies additionally used a questionnaire to measure self-focused attention. Reason 4: Where the primary predictor being measured is self-awareness, self-perception, metacognition, or rumination rather than self-focused attention, unless the component of rumination being measured is self-referential cognitive processing only. Reason 5: Studies which are not available in written English. Reason 6: Studies that do not measure the association between SFA and depression symptoms, SAD symptoms nor BDD symptoms. Reason 7: Must not use the same sample and measures as a previous study included in this review. Reason 8: Studies that do not measure SFA, social anxiety, depression or BDD. Reason 9: Studies measuring depression/SAD symptoms and SFA at different time points. Reason 10 (added when it became apparent that too few studies measured BDD to include in this review): Studies where the association between BDD and SFA is the main focus.

*** Reason 1: On closer inspection, both studies ((Lundh & Ost, 1996; Mellings & Alden, 2000)) used a state measure of SFA after an intervention designed to induce or amplify SFA. Reason 2: On closer inspection, study (Gaydukevych & Kocovski, 2012) used a measure for SFA which was not validated and could not be retrieved to check against inclusion criteria.

3.2 Study Characteristics

Study characteristics are displayed in Table 1. A total of 16 studies fulfilled the inclusion criteria. Of these, 13 studies sampled an adult population, and 3 sampled a child population (age range 8-14 years). The majority of studies used a community-based population (*n*=13), with many recruiting student samples (*n*=10) and some recruiting samples through public advertisements (*n*=3). Of the community-based student samples studied, two of these had a mean age of under 18, while the rest were in university education. Three studies used participants from clinical settings- one of these recruited adult students with a primary diagnosis of SAD, who were seeking treatment; another recruited adult patients with a diagnosis of social phobia from an inpatient treatment centre; the third sampled children with SAD as primary diagnosis, through child health professionals.

Of all the studies included in the review, six used a group comparison design, with five of these grouping participants by social anxiety scores, and one comparing self-focused attention over a range of clinical subgroups including those with a diagnosis of SAD. Ten studies used a correlational design to investigate the association between social anxiety and SFA.

Of the 16 studies in this review, nine measured the specific association between social anxiety and public and/or private self-focused attention, measured using the original Self-Consciousness Scale (Fenigstein et al., 1975) or adapted versions (Filipp & Freudenberg, 1989; Scheier & Carver, 1985).

3.3 Quality Assessment

Table 3 shows the quality scores of included studies as rated by the Kmet Quality Assessment Tool (Kmet et al., 2004). The mean overall quality score (of a total of 2) was 1.29, with two studies falling beneath 'liberal' cut-off of <.55 (1.1), and all but two studies (*n*=14) falling beneath the 'conservative' cut-off of <.75 (1.5), as suggested by Kmet et al. (2004). The majority of these lower-scoring studies were not specifically designed to test the association between SFA and social anxiety, and while points were not lost on this item, many of these same studies lost points for failing to sufficiently describe their research question (*n*=8). Six studies reported results for the association between SFA and social anxiety, but did not comment on these in discussion, or report conclusions related to these findings and hence received a grading of 'not applicable'. Reporting on method of subject selection and sample size appropriateness was generally poor across studies included in this review, with only Ejaz and Muazzam (2021) providing an a priori power analysis. No studies provided an estimate of variance, such as range, distribution or confidence intervals for their main results. However, areas generally reported well across studies, with 75% gaining full marks on these items, were study design, subject characteristics, outcome, method of analysis and reporting of results.

The six studies with quality scores above <.70 included three of the four most recent papers included in this review ((Desnoyers et al., 2017; Ejaz & Muazzam, 2021; Meral & Vriends, 2022)) and two of the three studies using a sample of young people (Hodson et al., 2008; Mallet & Rodriguez-Tome, 1999). These studies showed specific strengths in reporting on research question and method of analysis, and all gained overall scores of >.70 (1.45).

3.4 Summary of findings

3.4.1 Association between overall self-focused attention and social anxiety symptoms

Of the 16 studies included, 8 found evidence of a statistically significant association between social anxiety symptoms and overall SFA, with effect sizes ranging small (Cohen's *d*= 0.47) to large (Cohen's *d*= 1.86) as shown in Table 2.

Three studies investigated the association between overall SFA score and social anxiety symptom score, using a correlational design with participants recruited from the community. Both studies by Desnoyers et al. (2017) and Ejaz and Muazzam (2021) found that baseline levels of SFA were significantly positively correlated with social anxiety symptom scores in adult populations, with large effect sizes (*d*>1); Desnoyers et al. (2017) in a mixed-gender sample, and Ejaz and Muazzam (2021) in a female-only sample. The same positive correlation was found in a population of young people between the ages of 9-14 (Mallet & Rodriguez-Tome, 1999). This was the only study within this review to measure the association separately in boys and girls, with both showing a significant positive correlation, and large effect sizes (*d*> 1). All three of these correlational studies scored highly in quality assessment, losing only several points each for failing to report power calculation and estimates of variance.

Only one study using a clinical sample investigated the correlation between social anxiety and overall SFA, although several more measured the correlation

between social anxiety and public/private types of SFA (see below). Kley et al. (2012) recruited children between the ages of 8 and 12 years, with SAD as a primary diagnosis according to structured clinical interview (SCI). Findings in baseline data showed that overall SFA was positively associated with SAD, with medium effect size (d=0.47), a finding which is homogenous with the adult populations, and community-based child sample above. However, this study scored low in quality assessment, due to inadequate description of research question, sample selection procedure and analytic methods.

Three studies investigated whether adult participants recruited from a community population, and divided into groups scoring 'low' and 'high' in social anxiety symptoms would show significantly different self-focused attention scores (Boehme et al., 2015; Glick & Orsillo, 2011; Meral & Vriends, 2022). In all three studies, participants in the 'high' group met cut-off for clinically significant social anxiety, although they may not have received a formal diagnosis. Meanwhile, those in the 'low' groups did not meet clinical threshold. Findings across these studies were homogenous, in that trait levels of SFA were significantly higher in high social anxiety symptom groups than low symptom groups, with high effect sizes (d>1). However, while the study by Meral and Vriends (2022) scored highly in quality assessment, studies by Boehme et al. (2015) and Glick and Orsillo (2011) scored in the low range, with neither study describing their research question in sufficient detail or providing conclusions which were supported by the above findings.

Only one study included in this review sought to investigate the difference in levels of SFA between social anxiety symptom groups in young people from a

community sample (Hodson et al., 2008). In this study, not only were ‘high’ and ‘low’ symptom groups selected on the basis of the highest and lowest quartile of symptom scores; a ‘middle’ group, made up of those with the middle 50% of scores, was formed, too. Results showed that as with adult populations, SFA scores were significantly different between groups, with SFA in those in the ‘high’ social anxiety symptom group being greater than those in the middle group, who in turn scored higher than those in the low group. This study had a medium effect size (*d*=0.49) and scored highly in quality assessment; however, it is worth noting that SFA scores were determined by the FAQ, which is designed primarily for use with adults and has not yet been validated in children.

3.4.2 Association between public self-focused attention and social anxiety symptoms

Nine of the studies included in this systematic review, all using adult participants, investigated the relationship between public SFA and social anxiety symptoms. Seven of these found evidence of a statistically significant association between the two, with effect sizes ranging medium (Cohen’s *d*= 0.47) to large (Cohen’s *d*= 2.08) as shown in Table 2.

Of the seven studies using a correlational design to investigate the association between baseline levels of public SFA and social anxiety symptoms, five reported a significant positive relationship (Edelmann, 1990; Ejaz & Muazzam, 2021; Bree Gregory & Lorna Peters, 2017; Monfries & Kafer, 1994; Panayiotou et al., 2014) with effect sizes ranging from medium (*d*=0.47) to large (*d*=1.09). These studies measured public SFA with the Self-Consciousness Scale (Fenigstein et al.,

1975) with the exception of Ejaz and Muazzam (2021) who used the revised version of the scale (Scheier & Carver, 1985). It is worth noting that aside from two studies who both used the Social Avoidance and Distress Scale (Watson & Friend, 1969) to screen for symptoms of social anxiety, all of these studies used a different, well-validated tool to measure symptoms, and yet obtained homogenous findings. However, quality ratings of these studies varied, with two falling into the low-scoring bracket (Edelmann, 1990; Panayiotou et al., 2014) based on inadequate reporting of research question and methods of subject selection, alongside other limitations.

In contrast with the findings above, two studies failed to find a significant correlation between public SFA and social anxiety symptoms in samples of adult students. The first of these, which examined only the relationship between social anxiety symptoms and public subscale (rather than both public and private as in most studies in this review) had a small effect size (d=30) (Kocovski & Endler, 2000). The second (Saboonchi & Lundh, 1997) which not find that scores on the Social Phobia Scale (Mattick & Clarke, 1998) were significantly associated with either public or private SFA, found a medium effect size (d=0.65), raising the possibility that the study was underpowered. While the findings of these studies appear to contrast with those in previous research, it should be acknowledged that these were two of the lowest scoring studies in quality assessment, losing marks in areas related to sample size and subject selection, as well as in their descriptions of the research question.

Of the nine studies investigating the relationship between public SFA and social anxiety symptoms, two sampled a clinical population. The first (Hope & Heimberg, 1988) carried out a correlational analysis using a sample of adult students

with a primary diagnosis of SAD, who were seeking treatment at an inpatient clinic. In line with many of the community-based studies in this review, this study found that SAD scores were significantly positively correlated with public SFA, with a large effect size (*d*= 0.77). The second (Jostes et al., 1999), which compared normal controls with patients with a diagnosis of SAD, was the only study to test this association using a group comparison design. As might be expected, findings showed that participants with SAD had significantly higher scores in public SFA than normal controls, with a large effect size (*d*=2.08). Although effect sizes in the research also provided indication that public SFA is more elevated in SAD than in other anxiety disorders, this study scored low in quality assessment, losing some marks around sample size appropriateness. It also used a female-only sample, while most of the studies in this review recruited across genders.

3.4.3 Association between private self-focused attention and social anxiety symptoms

Seven studies in this review investigated the relationship between private SFA and social anxiety symptoms. Of these, five found a statistically significant association between the two, with effect sizes ranging small (Cohen's *d* =0.30) to large (Cohen's *d* = 1.16), as shown in Table 2.

Four studies using a correlational design in a community sample (Edelmann, 1990; Ejaz & Muazzam, 2021; B. Gregory & L. Peters, 2017; Panayiotou et al., 2014) found a larger effect size for the significant association between public SFA and

social anxiety symptoms (ranging from *d*= 0.65 to *d*=1.09) than for the significant association between private SFA and social anxiety symptoms (ranging from *d*= 0.26 to *d*= 0.70). A fifth study (Jostes et al., 1999) using group comparison found a larger effect size for the difference in public SFA scores between patients with SAD and normal controls (*t*= 8.10), than for the difference in private SFA scores between the same groups (*t*= 4.52). This was the only study using clinical subjects demonstrating that public SFA is more strongly associated with social anxiety symptoms than private. The only other study in this review using clinical subjects to investigate both public and private SFA found that while public SFA was significantly correlated with SAD, with a large effect size (*d*= 0.77) the correlation between private SFA and SAD was not significant, with a small effect size (*d*= 0.2) (Hope & Heimberg, 1988). This study scored highly in quality assessment, and was one of the first to show that the Self-Consciousness Questionnaire is a useful and valid tool in a clinical population. Supporting this finding in a community volunteer sample, Monfries and Kafer (1994) found that while public SFA was significantly positively correlated with social anxiety symptoms, with a medium effect size (*d*= 0.47) the relationship between public SFA and social anxiety symptoms was not significant, and effect size was small (*d*= 0.16). This study scored fairly highly in quality assessment, although lost marks in sufficiently describing the characteristics of its sample.

4. Discussion

4.1 Main Findings

This systematic review examined the association between social anxiety symptoms and SFA in both adult, and child populations and across subtypes of SFA, in order to provide an up-to-date synthesis and specify areas for further research. Studies consistently demonstrated a significant positive association between social anxiety symptoms and SFA. Seven of nine studies investigating the relationship between social anxiety and public SFA found a statistically positive correlation, and effect sizes were, in more than half of these studies, larger than for the association between social anxiety and private SFA. No study compared effect size of the association between social anxiety and SFA across adult and child populations, but the three studies sampling a child population found a medium to large effect size for the association between social anxiety and SFA. Quality scores ranged from 10-17 of a maximum total score of 22, with four studies falling below recommended 'liberal' cut-off of <.55 (1.1) and only two studies scoring above the recommended 'conservative' cut-off (Kmet et al., 2004). Quality of reporting was low, with at least 80% of studies scoring either 'partial' or 'no' in regards to the method of sample group selection, appropriateness of sample size, use of a power analysis and estimate of variance. Areas of relative strength were reporting of results, study design and sample characteristics.

In line with previous reviews, studies included in this review have demonstrated that SFA is positively correlated with social anxiety symptoms in adults from both clinical SAD and community-based populations. Of those studies which

investigated the distinct relationships with public and private SFA, most found a significant positive correlation between public SFA and social anxiety symptoms in adults, which is in line with the theory posited by Bogels and Mansell (2004). Also supporting this theory, the relationship between private SFA and social anxiety symptoms tended to be weaker across studies, which as suggested in self-discrepancy theory (Higgins, 1987), may be because it is more closely related to depression (Mor & Winquist, 2002). An interesting finding was that the two studies which failed to find significant relationships between social anxiety and public SFA received some of the lowest marks in quality assessment (Kocovski & Endler, 2000; Saboonchi & Lundh, 1997), both scoring around the <.55 cut off suggested by Kmet et al. (2004). Methodology of these studies was less robust than many others in the field, particularly in the domains of subject selection, sample size appropriateness and reporting on variance. This demonstrates the importance of taking methodological factors into account in research synthesis.

The categorisation of studies into 'clinical' and 'community-based' populations for the purpose of this review allowed us to compare findings between those studies who recruited from clinical settings, such as surgery or inpatient wards, and those who recruited from schools, universities and other community settings. It feels important to highlight that while some group comparison studies referred to their community-based samples as non-clinical, or sub-clinical, the average social anxiety symptom scores of those participants selected for their 'high' SAD group met clinical cut-offs on validated SAD measures. While we cannot directly generalise findings from these studies to populations of people with a clinical diagnosis of SAD, this overlap raises questions as to whether comparisons between clinical and non-clinical

populations made in previous reviews such as that of Mor and Winquist (2002) are truly sampling from discrete groups.

One key aim of this review was to investigate the association in populations of younger people and across different developmental stages, as recommended by Halldorsson and Creswell (2017). In fact, of the 16 studies meeting screening criteria for this review, only three sampled populations of young people, with one of these falling under the most liberal cut-off of <.55 in quality assessment (Kley et al., 2012). In addition, the average ages of the young people recruited for these three studies fell between 10 and 12 years. While this is an important developmental age bracket considering the early onset of SAD (De Vries et al., 2019), these findings are not necessarily generalisable to populations in later adolescence; Leigh and Clark (2018) highlighted the need to include children in the second half of their secondary schooling in self-focused attention research, as this developmental period inevitably brings a new variety of social and academic challenges and changes. Halldorsson and Creswell (2017) also flagged the need for social anxiety research to focus on children as young as 7, the age at which anxiety diagnoses can reliably be diagnosed (Silverman et al., 2001). Hence, more high-quality research investigating the 'pure' association between SFA and social anxiety symptoms in populations of children across developmental stages may help to further deepen our understanding of this relationship throughout the stages of adolescence and pre-adolescence. However, this will require the development and validation of measures which are appropriate and accessible to populations of younger people of different ages.

4.2 Clinical Implications

This current paper has demonstrated that there is a strong significant association between SFA and social anxiety, which supports the cognitive behavioural model posited by Clark and Wells (1995). If, as this model and a broad field of research suggests, SFA is a maintenance factor in SAD, it stands to reason that targeting SFA in treatments for SAD may contribute to a reduction in symptoms of SAD. Researchers in the field have proposed a variety of mechanisms by which this change might occur. For example, learning to redirect attention to the broader aspects of the self and the social environment, may lead to reductions in social anxiety by reducing awareness of bodily symptoms, and reducing fear and negative beliefs around bodily symptoms (Bogels, 2006). Similarly, reduction in SFA may contribute to the reduction of social anxiety symptoms due to a decreased hypervigilance to social threat, reduced avoidance and an increased sense of control over a person's own attentional processes (Bogels & Mansell, 2004).

For the above changes to take place, SFA would need to be a modifiable process, rather than one that is fixed. Indeed, there is a strong evidence base to support the idea that SFA is a process that can be induced or manipulated. Bogels (2006) found that when participants with high levels of social anxiety symptoms underwent a specific attentional training intervention alongside CBT, they showed a statistically significant reduction in their levels of SFA, both at post-treatment and at follow-up. This attentional training also lead to larger reductions in bodily symptoms, dysfunctional beliefs and social phobia scores than applied relaxation with cognitive therapy, which suggested that these superior effects were a direct result of changes in attention. Similarly, studies in which SFA was effectively modified through

intervention or manipulation were identified in a review by B. Gregory and L. Peters (2017). This review went on to demonstrate that across studies, changes in SFA during, or following CBT intervention, were related to positive therapeutic outcomes in people with high levels of social anxiety symptoms. As research continues to guide the development of interventions for SAD, reviews such as the current paper, which provides an updated synthesis on the literature around SFA across the lifespan, will be of great importance.

4.3 Strengths

There were a number of strengths to this systematic review, and which differentiate it from the research currently available. First, we chose to include adult and child samples across a range of recruitment settings, to provide a broader overview of the literature. Second, we included only studies which used a well-validated, multi-item measure of SFA, from a list that we compiled during our investigation into the literature. Determining whether a validated measure focused on the construct of SFA – as opposed to other constructs such as rumination or self-imagery- and hence could be added to this list, was a rigorous and thorough part of the screening process, whereby disagreements were discussed at length until consensus was reached. This process highlighted the discrepancies across the literature regarding the definition of SFA; for example, while some research differentiates SFA and self-awareness as distinct, but related, processes (Silvia & Phillips, 2013), self-awareness is in other literature seen as interchangeable, and defined as ‘self-focused attention or knowledge’ (APA, 2020). Similar discrepancies have been

raised around the definition of self-consciousness and its relation to self-awareness (Nutt Williams, 2008; Yılmaz, 2022). Given the controversy which has long surrounded the terms used in this review, it felt imperative that our search strategy was explicit and detailed, such that it could be replicated. While the previous review by (Mor & Winquist, 2002), commented on these inconsistencies in the literature, they did not account for these in their search strategy or exclusion criteria. This suggests that studies used may have measured different constructs under the blanket term, 'self-focused attention', reducing construct validity and replicability.

A further strength of this systematic review was the detailed quality assessment procedure conducted on all included studies using an established quality assessment tool (Kmet et al., 2004). This tool was selected amongst others as it seemed best suited to our particular study designs, though various adaptations were made to ensure that scoring criteria were clearly specified and some non-applicable questions were removed. The addition of item 1b required researchers to ascertain how many of our included studies, rather than being designed exclusively to examine the association between SFA and social anxiety symptoms, collected baseline data on SFA and social anxiety measures with a primary aim to investigate the effects of an intervention or measure brain activity during a cognitive task. While this distinction did not necessarily impact the robustness of studies, and hence, question 1b was not scored, it helped researchers to establish which parts of the study were relevant to quality assessment, which was hoped to have improved inter-rater reliability. The second additional question highlighted a clear area of weakness across studies, with only one reporting an a priori power calculation, raising questions around the integrity of studies neglecting to report this, and their ability to

detect true effects and draw meaningful conclusions. In addition, with none of our included studies reporting confidence intervals or another form of variance, the spread and variability of study data is unclear, limiting the conclusions that can be drawn. Accounting for quality assessment findings into our study synthesis has allowed for us to more rigorously critique the studies included, and has highlighted some common areas of weakness that previous reviews, without a quality assessment tool, have likely missed.

4.4 Limitations and recommendations for future research

One limitation of this systematic review is that non-English publications were not included, which may have introduced a bias likely contributed to the lack of studies included in our review based upon non-Western cultures. Given that the Western view of the self as an independent, self-contained being differs in many ways to the Eastern view of the self as a being within an interpersonal, connected context (Campbell et al., 1996), it is unlikely that the results of this review would be generalisable to non-Western populations. Further research into the relationship between attention and SAD which considers differences between cultural perspectives on self-concept would help to address these issues around generalisability in the field. Additionally, some papers written in English were not available in full-text, despite attempts to retrieve them (n=3). Thus, the current review may not provide a complete overview of the research to date.

This review excluded studies which induced or manipulated SFA, as the processes by which this is achieved can introduce confounding variables, such as corrective feedback. Instead, only studies using a multi-item self-report measure of SFA were included, which allowed us to synthesise and compare the findings of these studies quantitively. However, it is important to acknowledge that self-report measures can be subject to biases and inaccuracies. Measures which address the concept of the self, such as the Self-Consciousness Scale, have been developed for the Western population, and may not be accessible to those from more collectivist cultures, and hence may elicit different answering styles and create artefactual discrepancies between participants. In addition, although these self-reports are designed to measure a 'trait' level of self-focused attention, a person's responses may be biased by their 'state' self-focused attention, and factors such as mood at the time of measurement, as well as the wish to self-preserve, and the ability to integrate all information relevant and available at the time, to answer the question accurately Paulhus and Vazire (2007). While questionnaires can be an effective way to gather information, we should always interpret the validity of self-report findings with caution for these reasons. Our strict search criteria may have filtered out studies which use a more objective measure of self-focused attention, such as 'eye-gaze' technology, which, by tracking visual attention towards the self, might have provided important data to further enrich our synthesis. Future reviews may establish ways to include such studies without reducing the validity of the constructs under investigation.

Another limitation is that while our review question focused solely on the relationship between SFA and social anxiety, and the separate relationships between SFA and depression/body dysmorphic disorder, it did not make

comparisons across disorders. Research has, for some time, queried the specificity of the role of SFA across different psychopathologies, which we have touched on in this review in terms of the ideas of Mor and Winquist (2002) about subtypes of SFA in anxiety and depression. However, it has been suggested in research that while the process of SFA is common across psychopathologies, in an excessive and rigid form, the content of it will differ depending on the disorder (Ingram, 1990). Only one study included in this review addressed differences in SFA across disorders; Jostes et al. (1999) found that public and private SFA scores were elevated in all patients across a range of clinical groups (social phobia, panic disorder, obsessive-compulsive disorder or bulimia nervosa) compared to normal controls. However, different patterns and levels of intercorrelation were found for public and private SFA across groups. While the current review paper was not designed to explore findings such as this, it has provided an updated synthesis regarding the specific patterns of subtypes of SFA in social phobia. In addition, it has formed part of a broader systematic review of the association of SFA with depression, as well as SAD, which will allow cross-disorder comparisons to be made.

4.5 Conclusions

Overall, the review has added to previous literature, by incorporating research studies undertaken in recent years, and by providing a more comprehensive search strategy which highlights the inconsistencies in the literature regarding the term, ‘self-focused attention’. In addition, by integrating the findings of a rigorous quality assessment procedure into the conclusions it draws, the review has recognised

areas of weakness in the current evidence base, providing new suggestions for future research. The review has identified fairly consistent evidence for an association between SFA and social anxiety symptoms, particularly with public SFA, in line with cognitive behavioural models. However, research to date has shown weaknesses across specific areas of quality assessment – such as reporting on sample and research question – and may not cover all of the development stages of childhood and adolescence. There is therefore a need for further, well-powered and methodologically rigorous studies, particularly in young people. There is an additional need for longitudinal and treatment studies to determine whether SFA is a causal factor, or a consequence, in SAD and other disorders.

Table 1. *Summary of study characteristics including screening tools*

Study ID	Study details	Study Design	Target Population (clinical or community)	Sample size	Sample mean age	% female	Screening Tool for BDD	Screening Tool for SAD	Separates public and private SFA?
1	Boehme et al. (2015), Germany	Group comparison	Community: students, grouped into high and low SAD scores	High SAD - 23.50. Low SAD- 22.94	High SAD - 16, Low SAD - 16.	100	SFAS, (Bogels et al., 1996)	SAS, German version (Stangier & Heidenreich, 2004)	
2	Desnoyers et al. (2017), Canada	Correlational	Community: recruited from advertisements, selected if met criteria for SAD (SCI)	34	137	54	FAQ (Woody, 1996) and SFAS, collapsed into a composite measure	SPIN (Connor et al., 2000)	
3	Edelmann (1990), UK	Correlational	Community: volunteers, self-described 'chronic blushers'	34.5	107	91	SCS (Fenigstein et al., 1975)	SADS (Watson & Friend, 1969)	☑
4	Ejaz and Muazzam (2021), Pakistan	Correlational	Community: students	21.14	300	100	SCS-R (Scheier & Carver, 1985)	Alternative SAS (Ejaz et al., 2020)	☑
5	Glick and Orsillo (2011), USA	Group comparison	Community: students, grouped into high and low SAD scores	Only reported for larger sample	53	Only reported for larger sample	FAQ (self-focus subscale)	SIAS (Mattick & Clarke, 1998)	

6	(Bree Gregory & Lorna Peters, 2017), Australia	Correlational	Community: students	20.06	522	79	SCS	SIAS	☑
7	Hodson et al. (2008), UK	Group comparison	Community: students, grouped into high, medium and low SAD scores	12.24	171	56	FAQ	SPAI-C (Beidel et al., 1995))	
8	Hope and Heimberg (1988), USA	Correlational	Clinical: diagnosis of SAD	30.24	43	45	SCS	SADS	☑
9	Jostes et al. (1999), Germany	Group comparison	Clinical: inpatients with SAD diagnosis Community: healthy controls	Only reported for larger sample	63	100	SAM (Filipp & Freudenberg, 1989) modified German version of SCS	SCI for DSM-III-R (Margraf et al., 1991)	☑
10	Kley et al. (2012), Germany	Correlational	Clinical: SAD primary diagnosis	10.08	75	57	SCQ-C (Bender, Kley and Tuschen-Caffier, 2007)	SPAI-C	
11	Kocovski and Endler (2000), Canada	Correlational	Community: students	Women-20.45, Men-20.65	174	71	SCS (Public only)	EMAS-T-SE (Endler et al., 1991)	☑
12	Mallet & Rodriguez-Tome (1999), France	Correlational	Community: students	12	508	49	SCS-R, French version	SASC-R, French Version (La Greca & Stone, 1993)	
, 13	Meral & Vriends (2022), Switzerland	Group comparison	Community: students, grouped by high and low SAD scores	High SAD: 23.67 Low SAD: 22.56	High SAD - 27, Low SAD- 36	49	SFAS	SPS (Mattick & Clarke, 1998), German version	
14	Monfries & Kafer (1994), Australia	Correlational	Community: volunteers	30.63	385	52	SCS	SADS	☑

15	Panayiotou et al. (2014), Cyprus	Correlational	Community: students	21.11	253	84	SCS	SPAI	☑
16	Saboonchi & Lundh (1997), Sweden	Correlational	Community: students	28.3	70	62.5	SCS, Swedish version (Nystedt & Smari, 1989)	SPS	☑

Note: Full name of measures used for social anxiety. SAS= Liebowitz Social Anxiety Scale; SPIN= Social Phobia Inventory; SADS= Social Avoidance and Distress Scale; SIAS= Social Interaction Anxiety Scale; SPAI-C= Social Phobia and Anxiety Inventory for Children; SCI= Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders (third edition – revised) diagnoses; EMAS-T-S= Endler Multidimensional Anxiety Scales- Trait- Social Evaluation; SASC-R= Social Anxiety Scale for Children-Revised; SPS= Social Phobia Scale.
Full name of measures used for self-focused attention. SFAS= Self-Focused Attention Scale; FAQ= Focus of Attention Questionnaire; SCS= Self Consciousness Scale, SCS-R= Self-Consciousness Scale, Revised; SCQ-C= Self-Consciousness Questionnaire for Children and Adolescents, SAM= Self-Awareness Questionnaire.

Table 2. *Summary of study outcomes including effect size*

Study ID	Study details	Target Population (clinical or community)	Brief outcome	Method of data analysis	Effect size *=p< .05, **=p<.01, ***=p<.001	Common effect size (Cohen's *d*)
1	(Boehme et al., 2015), Germany	Community: students, grouped into high and low SAD scores	Difference between levels of SFA in high and low social anxiety groups is significant	Two-sample t-test	*t*=5.11*	*d*=1.86*
2	(Desnoyers et al., 2017), Canada	Community: recruited from advertisements, selected if met criteria for SAD (SCI)	At baseline, SFA was significantly correlated with social anxiety	Pearson's correlation	*r*=.63***	*d*=1.62***
3	(Edelmann, 1990), UK	Community: volunteers, self-described 'chronic blushers'	Both public and private SFA were significantly correlated with SAD	Pearson's correlation	*r*= 0.31 *** (pub) *r*= 0.17* (priv)	*d*=0.65*** (pub), *d*=0.35* (priv)
4	(Ejaz & Muazzam, 2021), Pakistan	Community: students	Both public and private SFA were significantly correlated with SAD. Overall SFA score was significantly correlated with SAD also.	Pearson's correlation	*r*= 0.31** (pub) *r*= 0.13* (priv) *r*=0.51** (total)	*d*=0.65** (pub), *d*=0.26* (priv), *d*=1.19** (total)
5	(Glick & Orsillo, 2011), USA	Community: students, grouped into high and low SAD scores	High SAD group scored signicantly higher in SFA than the low SAD group	Two-sample t-test	*t*= -4.21***	*d*=1.19***
6	(Bree Gregory & Lorna Peters, 2017), Australia	Community: students	Both public and private SFA were significantly correlated with SAD	Pearson's correlation	r= 0.48** (pub), r=0.33** (priv)	d=1.09** (pub), d= 0.70** (priv)
7	(Hodson et al., 2008), UK	Community: students, grouped into high, medium and low SAD scores	Difference between SFA across high, middle and low SAD group was significant	One-way ANOVA	*f*= 10.69**	*d*=0.49**
8	(Hope & Heimberg, 1988), USA	Clinical: diagnosis of SAD	At baseline, public SFA was significantly correlated with SAD, but private was not	Pearson's correlation	*r*=0.36** (pub) *r*=0.13 (priv)	*d*=0.77** (pub), *d*=0.2 (priv)

9	(Jostes et al., 1999), Germany	Clinical: inpatients with SAD diagnosis Community: healthy controls	Difference between SAD and normal controls is significant for public SFA. Difference between groups is also significant for private SFA.	Two sample t-tests	*t*=8.10*** (pub), *t*=4.52*** (priv)	*d*=2.08*** (pub), *d*=1.16***(priv)
10	(Kley et al., 2012), Germany	Clinical: SAD primary diagnosis	At baseline, SFA was significantly correlated with SAD.	Pearson's correlation	*r*=0.23*	*d*=0.47*
11	(Kocovski & Endler, 2000), Canada	Community: students	At baseline, public SFA was not significantly correlated with SAD	Pearson's correlation	*r*=0.15 (pub)	*d*=0.30 (pub)
12	(Mallet & Rodriguez-Tome, 1999), France	Community: students	At baseline, inward self-consciousness was significantly correlated with SAD for boys and for girls	Pearson's correlation	*r*= 0.48*** (boys), *r*= 0.54*** (girls)	*d*=1.09*** (boys), *d*=1.28*** (girls)
13	(Meral & Vriends, 2022),Switzerland	Community: students, grouped by high and low SAD scores	Difference between baseline levels of SFA in high and low anxiety groups is significant	Two-sample t-test	*t*=5.15*	*d*=1.32*
14	(Monfries & Kafer, 1994), Australia	Community: volunteers	Public SFA was significantly correlated with SAD, whilst private SFA was not	Pearson's correlation	*r*=0.23** (pub), *r*=0.08 (priv)	*d*=0.47** (pub), *d*=0.16 (priv)
15	(Panayiotou et al., 2014), Cyprus	Community: students	At baseline, public SFA and private SFA were both significantly correlated with SAD	Pearson's correlation	*r*= 0.35** (pub), *r*=0.15* (priv)	*d*=0.75** (pub), *d*=0.30* (priv)
16	(Saboonchi & Lundh, 1997), Sweden	Community: students	At baseline, neither public or private SFA were significantly correlated with SAD	Pearson's correlation	*r*= 0.31 (pub), *r*= 0.25 (priv)	*d*=0.65 (pub), *d*=0.52 (priv)

*Note: p values are denoted by *=<.05, **=<.005, ***=<.001.*

Table 3. *Quality appraisal ratings using Kmet Quality Assessment Tool (Kmet et al., 2004)*

Study ID	Study details	Item 1	Item 1b	Item 2	Item 3	Item 4	Item 8	Item 9	Item 9b	Item 10	Item 11	Item 13	Item 14	Total score /22	Quality score
1	(Boehme et al., 2015), Germany		NO											12	1.20
2	(Desnoyers et al., 2017), Canada		YES											17	1.55
3	(Edelmann, 1990), UK		NO											13	1.18
4	(Ejaz & Muazzam, 2021), Pakistan		YES											17	1.70
5	(Glick & Orsillo, 2011), USA		NO											11	1.10
6	(Bree Gregory & Lorna Peters, 2017),		YES											13	1.30
7	(Hodson et al., 2008), UK		YES											16	1.45
8	(Hope & Heimberg, 1988), USA		YES											16	1.45
9	(Jostes et al., 1999), Germany		NO											13	1.18

10	(Kley et al., 2012), Germany		NO											10	1
11	(Kocovski & Endler, 2000), Canada		NO											12	1.09
12	(Mallet & Rodriguez-Tome, 1999),		YES											16	1.45
13	(Meral & Vriends, 2022), Switzerland		YES											16	1.45
14	(Monfries & Kafer, 1994), Australia		YES											14	1.27
15	(Panayiotou et al., 2014), Cyprus		NO											13	1.18
16	(Saboonchi & Lundh, 1997), Sweden		NO											11	1.10
	% YES	50	50	100	6	94	75	6	6	75	6	100	70		
	% PARTIAL	0	0	0	81	6	25	94	0	25	0	0	30		
	% NO	50	50	0	13	0	0	0	94	0	94	0	0		

(KEY: Green=Yes= 2, Amber=Partial=1, Red=No=0, Grey=Not applicable=0) Quality score is calculated by dividing raw score by number of questions minus any questions rated as not applicable (11- N/A))

Item Labels: Item 1- Question/objective sufficiently described? Item 1b (additional question, not scored) - Was the study specifically designed to test the association between SFA and depression/SAD? Item 2- Study design evident and appropriate? Item 3- Method of subject/comparison group selection or source of information/input variables described and appropriate? Item 4- Subject (and comparison group if applicable) characteristics sufficiently described? Item 8- Outcome and (if applicable) exposure

measure(s) well defined and robust to measurement/misclassification bias? Means of assessment reported? Item 9- Sample size appropriate? Item 9b (additional question, scored)- Did study report power calculation for relevant analysis?) Item 10- Analytic methods described/justified and appropriate? Item 11- Some estimate of variance is reported for the main results? Item 13- Results reported in sufficient detail? Item 14- Conclusions supported by the results?

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Part Two: Empirical Paper

Do symptoms of body dysmorphic disorder moderate distress reduction in social anxiety: an experimental study?

Abstract

Aims: While previous literature has established that there is a high comorbidity between diagnoses of social anxiety disorder (SAD) and body dysmorphic disorder (BDD), less is known about the association between symptoms across the continuum in non-clinical populations. Additionally, from a theoretical perspective, BDD could impede outcomes in CBT for SAD, but to date this has not been directly tested. The aims of the current study were to: 1) test the relationship between social anxiety and BDD symptoms in a population of young adults; 2) establish whether symptoms of BDD influence the extent to which distress reduces among individuals with varying levels of social anxiety symptoms when they engage in an online experiment designed to mimic a social interaction; 3) investigate whether incorporating a camera into positive social interactions influences participants' responses to the online social interaction.

Method: The study used data which was collected as part of a larger study on mechanisms of change in cognitive therapy for social anxiety disorder. The core hypothesis of the larger study was that when a social interaction goes better than expected, generating a positive prediction error or 'positive social surprise', it leads to reductions in distress. A sample of 202 participants aged 18-25 were recruited via Prolific, an online testing platform. Validated measures of social anxiety and BDD symptoms were administered to participants, who then completed the online experiment involving speaking to 'virtual players' and receiving feedback over multiple trials. Expectancies and outcomes were manipulated in order to generate prediction errors (i.e. the discrepancy between expectation and outcome). Participants also completed Visual Analogue Scale ratings of mood and anxiety after

each trial. For some participants, the social interaction was via written text with no camera on. For others, the social interaction involved speaking and the video camera on, to create a sense of being observed.

Results: A moderate positive correlation (*r*=.47) was found between symptoms of SAD and BDD in the community. However, BDD symptoms were not associated with the effect of positive social surprises on mood and anxiety (*r*=.01 and *r*=-.07, respectively.) Additionally, incorporating a camera into the online social interaction, to give participants the sense that they were being observed, did not have a significant effect on participants' response to a positive social surprise.

Conclusion: Findings demonstrated that SAD and BDD symptoms often covary at subclinical thresholds, and hence, screening for BDD symptoms in people with social anxiety disorder is recommended in order to identify targets for treatment and inform evidence-based interventions. In this study, BDD levels did not have a significant impact on the effect of positive social surprise on social anxiety symptoms. It is possible that methodological factors such as the virtual social setting or size of our sample may have contributed to this null finding. Further research, using different designs, is needed to test whether BDD symptoms moderate treatment response in social anxiety disorder.

1. Introduction

1.1 Social Anxiety Disorder

Social Anxiety is a disorder with an early age of onset, with 90% of cases occurring before the age of 23 (Kessler et al., 2007). It has an estimated global prevalence of 36% (Jefferies & Ungar, 2020) and, without treatment, symptoms can persist across the lifespan (Stein et al., 2017). The disorder has been associated with high levels of impairment across multiple domains, including social life, work and studies (Aderka et al., 2012), reduced satisfaction in quality of life (Barrera & Norton, 2009), and high prevalence of comorbid mood and other mental disorders (Stein et al., 2017).

Cognitive Behavioural Therapy (CBT) is the first-line intervention for social anxiety disorder (SAD) as recommended by the National Institute for Health and Care Excellence (NICE, 2013). The efficacy of CBT for SAD has been extensively studied, with a recent meta-analysis indicating that compared to control conditions, CBT is associated with better outcomes in adults within 12 months of treatment, with moderate symptom reductions maintained at longer-term follow up (Van Dis et al., 2020). However, not every individual with SAD experiences the same positive benefits. A systematic review of 87 studies of CBT for anxiety disorders found that an approximate 45% of individuals with SAD did not achieve clinically-significant, long-term improvement following intervention (Loerinc et al., 2015). It has been suggested by Leichsenring et al. (2014) that those individuals who do not achieve clinically-significant benefits from CBT may require a treatment of a higher intensity, or that is more specific to particular features of their SAD.

1.2 Social Surprise

In order to continue improving the efficacy of our current treatments for people with SAD, it is vital that we identify and better understand the key mechanisms of change. One mechanism which may drive improvements in SAD is that of “positive social surprise”- that is, experiences in which a social outcome is better than expected. Cognitive models of SAD propose that socially anxious individuals are inherently self- critical (Rapee & Heimberg, 1997) and hold negative expectations of social scenarios, such as poor social performance and social rejection (Cao et al., 2015; Miers, 2021). These expectations will increase anxiety levels in the anticipation of a social interaction, because the person with social anxiety will expect their fears of social failure to be confirmed. Positive social surprises occur when the outcome of the interaction is then, in fact, positive; for example, the other person pays a compliment or gives good feedback.

Research has supported the idea that receiving positive feedback can improve self-appraisal and anxiety levels in SAD. For example, when young people with SAD receive positive feedback from others after a social interaction, they experience increases in self-esteem (Reijntjes et al, 2011) and more positive self-relevant appraisals (Miers, 2021). It has been suggested that these increased positive self-views mediate the effect of CBT on SAD symptom reduction (Goldin et al., 2013). However, positive feedback does not necessarily create the element of “surprise”, which is sometimes termed prediction error. This occurs specifically when an unexpected event is detected; if the gap between expectation and outcome is large enough, it will meet the threshold to be experienced as a surprise (Reisenzein et al., 2019).

Linked to prediction error, the theory of Expectancy Violation proposes that the discrepancy between expectation and outcome is necessary for new learning. This has been supported by Rodebaugh et al. (2010), who found that while positive video feedback after a performance did reduce anxiety levels for people with SAD, it was the discrepancy between how a participant thought they performed and how they actually performed that lead to greatest change in self-perception. It has been proposed that repeated experience of “surprises” enhances learning, and hence maximising the opportunities for this new learning may improve the efficacy of treatments for social anxiety (Craske et al., 2014).

1.3 The association between BDD and SAD

If positive social surprises are a key mechanism of change in SAD, we might hypothesise that one reason that some socially anxious individuals do not respond to CBT interventions is that they are not gaining the same psychological benefits following successful social interactions; in other words, they are not experiencing subjective surprise despite an objectively positive outcome. One factor which may influence the way a person experiences a social surprise is the presence of body dysmorphic disorder (BDD) symptoms. BDD is a mental health condition in which a person becomes preoccupied with their appearance and spends a disproportionate amount of time focusing on perceived flaws, which are objectively minor or completely unobservable. BDD has been associated with poor social functioning, and a predominant feature of BDD is a tendency to avoid social situations, or endure

them with distress (Phillips et al., 1998). Social anxiety and BDD appear closely linked, with a tendency to feel anxious, ashamed and defective and a fear of rejection common features of both (Wilhelm et al., 1997).

Comorbidity rates of SAD and BDD are varied across research, with between 12% and 68% of people with SAD having a comorbid diagnosis of BDD (Fang & Hofmann, 2010). For the majority of people with both diagnoses, the onset of SAD appears to come first (Coles et al., 2006) with some research suggesting that SAD may in fact predispose the development of BDD (Phillips & Stout, 2006). It is worth noting that these comorbidity estimates tend to be derived from clinic samples, which may not be representative of the general population, due to barriers to help-seeking such as lack of perceived need, lack of awareness about services, stigmatising beliefs and having a low socioeconomic background (Eisenberg et al., 2007; Salaheddin & Mason, 2016). For this reason, there is a need to examine concurrence of symptoms in community samples, as well as in clinical groups. While SAD and BDD are currently classified under different spectrums of disorders in the DSM-5 (American Psychiatric Association, 2022), due to their shared attributes, we would expect for social anxiety and BDD symptoms to be associated at subclinical levels. This relationship was demonstrated in a large mixed-gender, student population,12.9% of whom met criteria for comorbid social anxiety disorder and body dysmorphic disorder concerns (Barahmand & Shahbazi, 2015). Another study, using adult participants, randomly sampled from a Brazilian community, found a moderate-high positive correlation between symptoms of SAD and BDD. (Tatiana Soler et al., 2019). However, this paper, which named its sample “unrepresentative of the study population”, commented on the overall lack of research investigating the

association between symptoms of social anxiety and BDD in nonclinical populations. Gaining a more extensive understanding as to how symptom domains occur across the full continuum of SAD and BDD, including in those with subclinical symptoms, will be important for both clinical and research development.

1.4 The Cognitive Model of BDD

The cognitive model of BDD (Veale, 2004), which shows some overlap with the cognitive model of social phobia (Clark & Wells, 1995), can be used to hypothesise how symptoms of BDD may influence the way a person experiences social interactions, and more specifically, positive social surprises. According to this model, a person with BDD will monitor their own appearance through the process of self-focused attention. This attention is captured by both the external image and the internal, felt sense of the self. In BDD, much of the person's attentional capacity is focused on their own self-image and self-appraisal, which by its nature is negative, and hence threatening. Supporting the idea that people with BDD will focus excessively on their own threatening image, research has demonstrated that adults with BDD will fixate more on their perceived facial defect and respond with more distress and anxiety to their own face than adults with social phobia, and healthy controls. This fixation to threat can make it difficult for the person with BDD to disengage with internally-generated information about themselves, and attend to the external environment, which may mean that they fail to process information that could otherwise disconfirm their negative beliefs. Hence, a person with BDD may find it hard to switch their attention from their internal negative self-image to positive

social feedback from others, reducing the impact of the positive social surprise, and potentially reinforcing the person's negative self-perception.

While individuals with BDD may have heightened self-focused attention in non-social settings, self-focused attention is likely to be exacerbated when a person with BDD knows that their appearance is visible to others, such as during an in-person interaction or video call. When a person with BDD is processing their own image, research has indicated that they will experience more vivid, negative images of themselves than controls, and will see these from the observer perspective, meaning that they are imagining themselves as viewed from another person's eyes (Osman et al., 2004). Given that this observer perspective tends to be threatening to the person with BDD, who expects others to reject them or deem them unacceptable (Baldock & Veale, 2017), we might propose that knowing that they are being observed or recorded during a social interaction will increase anxiety levels and sense of threat. This may further exacerbate the process of self-focused attention and make it even more difficult for somebody with SAD to turn their awareness to a positive social surprise.

Another aspect of BDD which may impact on a person's ability to experience a positive social surprise is a process known as negative cognitive bias. This is the tendency for people with BDD to interpret ambiguous social information more negatively than control participants, even when alternative, more positive explanations are available to them (Buhlmann et al., 2002). This tendency to interpret everyday events, such as social interactions, as threatening, is also seen in individuals with SAD (Fang & Hofmann, 2010). We might predict that having

comorbid BDD symptoms, which cause a preoccupation to a negative appraisal of the self, may increase the likelihood that a person with SAD will come away from social interactions with negative ideas about themselves and their appearance, even if the external feedback has been positive. Hence, the ability to benefit from positive social surprises will likely be reduced in those with high traits of BDD.

Given the high rates of BDD in people with SAD, it is crucial that research investigates the impact that this comorbidity may have on treatment outcome. However, intervention studies to date have not examined the effect of comorbid traits of BDD on treatment outcome for people with SAD (Fang & Hofmann, 2010).

1.5 The Current Study

In summary, diagnoses of SAD and BDD commonly co-occur, but research into covariation of their symptoms in community samples is limited. From a theoretical perspective, symptoms of BDD could impede outcomes in CBT for SAD, but to date this has not been directly tested. The current study aims to examine the relationship between social anxiety and BDD in a non-clinical population, and to establish the extent to which BDD symptoms moderate changes in mood and anxiety in a social experiment.

The study utilised data from a large project, The Social Surprise Study, which is aimed at examining mechanisms of change in social anxiety, and the association between social prediction error and the reduction of distress.

1.6 Aims and Hypotheses

Aim 1: To investigate the relationship between social anxiety and BDD symptoms in a non-clinical population.

Hypothesis 1: Social anxiety symptoms, measured with the abbreviated version of the Social Phobia Inventory (Mini-SPIN), will be positively associated with BDD symptoms, measured with the Body Image Questionnaire (BIQ).

Aim 2: To investigate the extent to which BDD symptoms moderate the effect of social surprises (ie. prediction errors) on mood and anxiety in an online experimental paradigm. Participants' responses to social surprises will be quantified as the change in self-reported momentary mood and anxiety from pre-social interaction to post-social interaction.

Hypothesis 2: Higher BDD symptoms will be associated with a smaller change in mood and anxiety levels, in response to a positive social surprise.

Aim 3: To assess the impact that having a camera on (ie. being observable to others) has on participants' response to a social surprise in an online interaction and whether relationships between BDD and mood/anxiety are dependent on camera effects (off vs on)

Hypothesis 3: The association of BDD symptoms with changes in mood and anxiety will be greater in experiments in which the camera is on, compared to when it is off.

2. Methods

2.1 Recruitment and Ethical Approval

This study utilised data collected as part of a larger study, which investigated mechanisms of change in social anxiety. The larger study recruited participants across a series of pilots, and the current study used data from 202 participants, taken from six pilots, which were similar to each other in methodology, with some minor modifications (see Table 1).

Participants were able to sign up to the larger study via Prolific, an online testing platform, and were recruited if they were English speakers, living in either the United States of United Kingdom and aged between 18-25. Participants were excluded if they reported having a neurological condition, taking psychotropic medications, or ever having experienced a psychotic episode. Only Pilot 6 screened participants for social anxiety symptoms, and selected only those scoring at or above cut off (≥6) on the Mini-SPIN.

All participants gave digital informed consent before testing began and received £5 monetary compensation for taking part in the screening and £6 for taking part in the study The UCL research ethics committee have approved this study (REC 24867/001).

2.2 Measures

Demographic information was collected for participants, which included age, birth-assigned sex, gender and self-reported mental health or neurodevelopmental diagnoses. Participants were asked whether they had a diagnosis of depression or anxiety disorder, or a different mental health disorder.

To screen participants for social anxiety, the abbreviated version of the Social Phobia Inventory (Mini-SPIN) (Connor et al., 2001) was administered. This questionnaire is a shorter version of the 17-item Social Phobia Inventory (SPIN) (Connor et al., 2000) and consists of three items, with a range of total scores 0-12 (See Appendix D). The clinical cut-off score of ≥6 is recommended to identify social anxiety disorder. The Mini-SPIN has shown sensitivity of 88.7%, and specificity of 90%, with similar values for men and women. It has shown a 90% accuracy in correctly diagnosing SAD using the recommended cut-off score (Connor et al., 2001).

Body Dysmorphic Disorder (BDD) symptoms were measured using the Body Image Questionnaire (BIQ) (Veale et al., 2012). This is a nine-item questionnaire (see Appendix E), with rating scales from 0-8 and three items reverse-scored. The range of total scores is 0-72, and higher scores indicate higher levels of BDD symptoms, with a recommended clinical cut-off of ≥ 40. Although the BIQ was initially developed to identify individuals who may require further psychological assessment for BDD symptoms following cosmetic procedures, it is now utilised in primary care mental health services as a screening tool for BDD symptoms, and has

been shown to have good internal consistency, test-retest reliability and convergent validity (Veale et al., 2012). Cronbach's alpha (*a*=0.88) indicated a high level of internal consistency for the BIQ with our sample.

To measure participants' mood and anxiety level after each trial, two visual analogue scales were presented to participants after each trial, which asked the following questions and asked participants to answer them using a scale of 0-100:

-How happy do you feel at the moment?

This was rated from 0 (very unhappy) to 100 (very happy). The wording of this question changed, from Pilot 9, based on young person's feedback, to, 'How happy do you feel right now?' with the same rating scale.

-How anxious do you feel right now?

This was rated from 0 (not at all anxious) to 100 (very anxious). The wording of this question changed, from Pilot 9, to 'How nervous/uncomfortable do you feel right now?'

These questions were designed to measure momentary changes in levels of mood and anxiety, and were asked after each of the 48 trials; hence, they needed to be brief, and clear to understand. The second question aims to establish how participants experience the emotion of anxiety, as this is the core emotion in social anxiety, which occurs under particular social conditions.

In addition, these questions were used as they replicate the questions used in previous social anxiety research with a similar social paradigm (Leigh et al., 2021) and previous research using Visual Analogue Scales to measure momentary mood (Jangraw et al., 2023).

2.3 Procedure

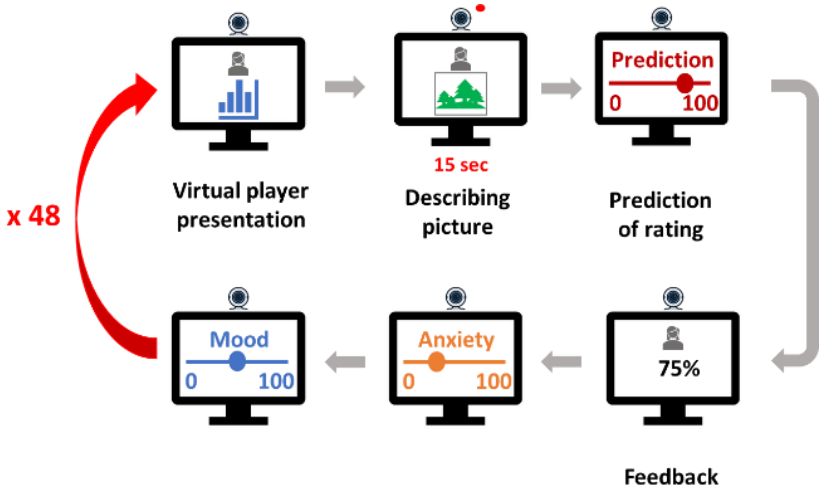
After opting to take part in the research on the Prolific platform, participants were asked to complete a digital consent form (see Appendix G). They were then instructed to fill out the online questionnaires including the Mini-SPIN, BIQ and demographic questionnaires, before beginning the social interaction task with virtual partners (see Table 1 for details). At the end of the task, participants were debriefed and compensated for their time. The study took around 35 minutes to complete from beginning to end.

2.3.1 Virtual social interaction task

Participants took part in a social surprise task, which was designed to emulate a social interaction. This interaction was computerised, and partners were ‘virtual’, in order to make the task scalable. The task was designed in a way such that both expectations and outcomes were manipulated to generate social surprise.

The computerised task consisted of 48 within-subject trials. Before the first trial, participants were presented with an example of the type of feedback given by virtual players in the form of a histogram. Participants were asked to interpret this feedback as a manipulation check.

Figure 1. *An infographic showing the sequence of steps experienced by participants in each trial of the social interaction task*.



Each trial consisted of the following steps:

1) Participants were shown a photograph of a virtual player, introduced as a 'judge', displaying either a neutral expression or smiling. For that virtual judge, they were also presented with a histogram, showing an average of the scores that judge gives other participants. The function of this histogram was to elicit an expectation of the judges as being critical or complimentary, in order to generate prediction error

2) Participants were given a non-emotive image (for example, a person doing yoga) and given fifteen seconds to describe it to the virtual judge, whose image they could see. Depending on the pilot they participated in, participants were either instructed across all trials to describe the image verbally, with their microphone and camera switched on, or by typing.

3) Participants were asked to predict the score the judge had given them for their performance in describing the image, using a visual scale from 0-100.

4) After predicting their score, participants were presented with their actual feedback from the judge

5) Participantswere asked to rate their mood and anxiety levels from 0-100 on a visual analogue scale.

The above process happened over 48 trials. Each participant was ‘paired’ across the trials with eight different judges, meaning that they saw each judge, and received feedback from them, six times.

Feedback received from virtual judges was experimentally manipulated to generate prediction errors. Prediction error in this context was equal to the discrepancy between the rating that participants expected judges to give them for their performance (step 3) and the actual feedback given by the judge (step 4).

Therefore, to generate a negative prediction error, the feedback received from a judge would be worse than the participant predicted. To generate a positive prediction error, the feedback received from a judge would be better than expected. A neutral prediction error would mean that feedback was exactly as predicted.

Each participant saw each judge six times, over which period they would experience two positive prediction errors (with one manipulated to be larger than the other), two negative prediction errors and two neutral prediction errors.. Prediction error through this paper is termed ‘social surprise’, such that positive prediction errors are defined as positive social surprises (see Appendix H for information as to how each prediction error/social surprise was calculated).

Participant data was collected across six pilots on the platform Prolific, each with minor methodological differences based on feedback from the Young Persons' Advisory Group for research (see Table 1 for individual pilot information).

Table 1. *Methodological differences across pilots 1-6*

Pilot number	Participants	Format of communication	Pilot modifications
1	20	Typing only	Exactly as described in methods
2	37	Typing only	One PE per virtual player was increased in size
3	41	Typing only	As above
4	37	Typing only	Feedback taken from young people in previous trials*
5	39	Video and audio	As above but added camera and audio
6	26	Video and audio	As above, but screening for participants scoring ≥6 on Mini-SPIN

* Changes made: added progress bar to show time left in study; varied the time taken to receive feedback from virtual players (1-4 secs; to make it more believable that the virtual players were responding); adapted the

wording on visual analogue scales ('how happy do you feel right now?', as opposed to 'how happy do you feel at the moment?' and 'nervous or uncomfortable' instead of 'anxious')

Note: PE = prediction error

2.4 Statistical analysis

2.4.1 Linear Mixed Effects Models

In the preliminary study, Linear Mixed Effect models were used to investigate the core hypothesis that social prediction error would be associated with a reduction in distress.

The model below shows how mood and anxiety scores (the dependent variables) are equal to the fixed effect (PE) plus the random effect (PE | ID).

$$\text{Mood} \sim \text{PE} + (\text{PE}|\ \text{ID})$$

$$\text{Anxiety} \sim \text{PE} + (\text{PE} \mid \text{ID})$$

In the above model, PE, denotes the fixed effect slope of prediction error, and ID shows individual variability between participants.

Using the model, we can interpret how the effect of social prediction errors on mood and anxiety differs between participants around the fixed slope, which is the estimated average across all participants. A positive value of (PE ID) indicates that a participant's mood increased more than that of the average participant, while a negative value indicates that a participant's mood increased less than that of the average participant. Therefore, random variance components of these effects which are significantly different from 0 indicate significant variability across participants.

In summary, in the model the **fixed effect** of prediction error was equal to the expected change in mood/anxiety to a one-unit increase in social prediction errors across all participants if all other factors are held constant. In the model, random effects (intercept and slope) represent individual variability. The **intercept** is the individual's average mood or anxiety score. The **slope** indicates the extent to which the individual's mood or anxiety changed relative to the average or fixed effect.

2.4.2 Hypothesis-testing

A power analysis was conducted using G*Power 3.1.9.7 (Faul et al., 2007). This analysis indicated that a sample size of 193 would have 80% power to detect a small effect (correlation coefficient of 0.2) at a significant criterion of a=.05. A further analysis indicated that a sample size of 346 would have 80% power to detect a correlation coefficient of r=0.15. Since the dataset available for the current study comprised n= 202, it was likely to be adequately powered to detect small effects of $r \geq 0.2$ but not correlation coefficients of r=0.15 or smaller.

The overall effect of prediction error on mood and anxiety across the whole sample was tested (i.e. the fixed effect of PE on mood and anxiety.) Since the fixed effect determined in the original LME models was not available in the dataset, it was estimated by taking the mean of the slopes (which represent the fixed effect plus individual variability, as shown in the formalism above) and calculating 95% confidence intervals using bootstrapping (1000 resamples).

To investigate Hypothesis 1, that social anxiety symptoms will be positively associated with BDD symptoms, Pearson correlation coefficients were computed to assess the linear relationships between anxiety symptom score on the mini-SPIN questionnaire, and BDD symptoms on the BIQ. Linear relationships with the first rating of mood and anxiety score on the task were also investigated. To test normality assumptions, distribution of data was observed using histograms for all dependent variables.

To investigate Hypothesis 2, that BDD symptoms would be associated with effect of social prediction errors on change in mood and anxiety, Pearson's correlation coefficients were performed between BDD symptoms and anxiety and mood slopes (ie. representing the effects of social prediction errors on mood and anxiety).

To investigate Hypothesis 3, that the association of BDD symptoms with changes in mood and anxiety will be greater in the presence of a video camera and audio-recording, we first wanted to explore the influence of the camera on participant anxiety levels. An independent samples t-test was conducted to determine whether there was a significant difference between levels of anxiety for those participants in pilots without a camera (1-4) , and those in pilots with a camera (5-6).

Box plots were created to show distribution of anxiety scores in pilots without camera (pilots 1-4), and pilots with camera (5-6). Average anxiety score was calculated across all trials and compared between participants with high BDD symptoms (highest quartile) and participants with low BDD symptoms (lowest quartile).

Then, separate Pearson's correlation coefficients for pilots 1-4 and pilots 5-6 were run to measure the association between BDD symptoms and effect of prediction errors on mood and anxiety score. Z-scores were computed to compare associations between the two sets of pilot data.

A moderation regression analysis was conducted to determine whether the presence/absence of a camera moderates the relationship between BDD symptoms and mood/anxiety score.

3. Results

3.1 Participant Characteristics

The characteristics of participants are given in Table 2. Overall, participants had a mean age of approximately 22 years, and 57% were female. The mean symptom score on the Mini-SPIN was 6.08, which is just above the cut off for clinically-significant symptoms of social anxiety (Connor et al., 2001), with 57% of the sample scoring above clinical cut-off on the Mini-SPIN. With respect to BDD symptoms, the mean score was 23.20, which is below the clinical cut-off of 40 (Veale et al., 2012). However, 14% of the sample scored 40 or higher on the BIQ, indicating clinically-significant BDD symptoms.

Table 2. *Participant demographics, and means and standard deviations for participant self-reported measures, across pilots*

	Total Sample	Pilots 1-4	Pilots 5-6	Difference between subsamples
N	202	135	67	
Mean Age (SD)	22.33 (2.0)	22.13 (2.01)	22.73 (1.90)	
Sex % female	57	54	63	χ^2 =3.67, p=.16
Mean Mood score (SD)	56.4 (21.71)	58.10 (21.72)	53.01 (21.47)	*t*= 1.57, p=.12
Mean Anxiety score (SD)	39.22 (26.84)	33.78 (24.39)	50.19 (28.33)	*t*=-4.3, p<.001
Mean Mini-SPIN score(SD)	6.08 (3.33)	6.02 (3.25)	6.21 (3.50)	*t*=-.38, p=.71
N with symptoms on Mini- SPIN ≥6 (%)	115 (57)	79 (59)	36 (54)	χ^2= .42, p=.52

Mean BIQ score (SD)	23.20 (14.02)	21.89 (13.35)	25.85 (15.06)	*t*= -1.9, p=.06
N with BIQ score ≥40 (%)	28 (14)	16 (12)	12 (18)	χ^2= 1.38, p=.24
Mean Mood slope (SD)	.17 (.23)	.16 (.23)	.18 (.24)	*t*=-.54, p=.59
Mean Anxiety slope (SD)	-.07 (.14)	-.06 (.14)	-.09 (.16)	*t*=1.13, p=.26

Note: Mini-SPIN = abbreviated version of the 17-item Social Phobia Inventory (SPIN) (Connor et al., 2000), BIQ= Body Image Questionnaire (BIQ) (Veale et al., 2012)

Mood and anxiety scores were calculated as the first rating on the task ranging from 0-100.

Slope in mood = the effects of social prediction errors on mood. Slope in anxiety= the effects of social prediction errors on anxiety score.

3.2 Association between SAD and BDD symptoms

Data for outcome measures and across pilots was normally distributed (see Appendix I for histograms). Table 3 shows a correlation matrix, including 95% confidence intervals, for all variables. As shown in Figure 2, BIQ symptom score had a moderate, positive correlation with Mini-SPIN symptom score. BIQ symptom score also showed a strong positive correlation with starting anxiety scoreand a moderate inverse correlation with starting mood score.

Figure 2. *Scatterplot showing the relationship between BDD symptoms, measured by the BIQ, and trait anxiety symptoms, measured by the Mini-SPIN.*

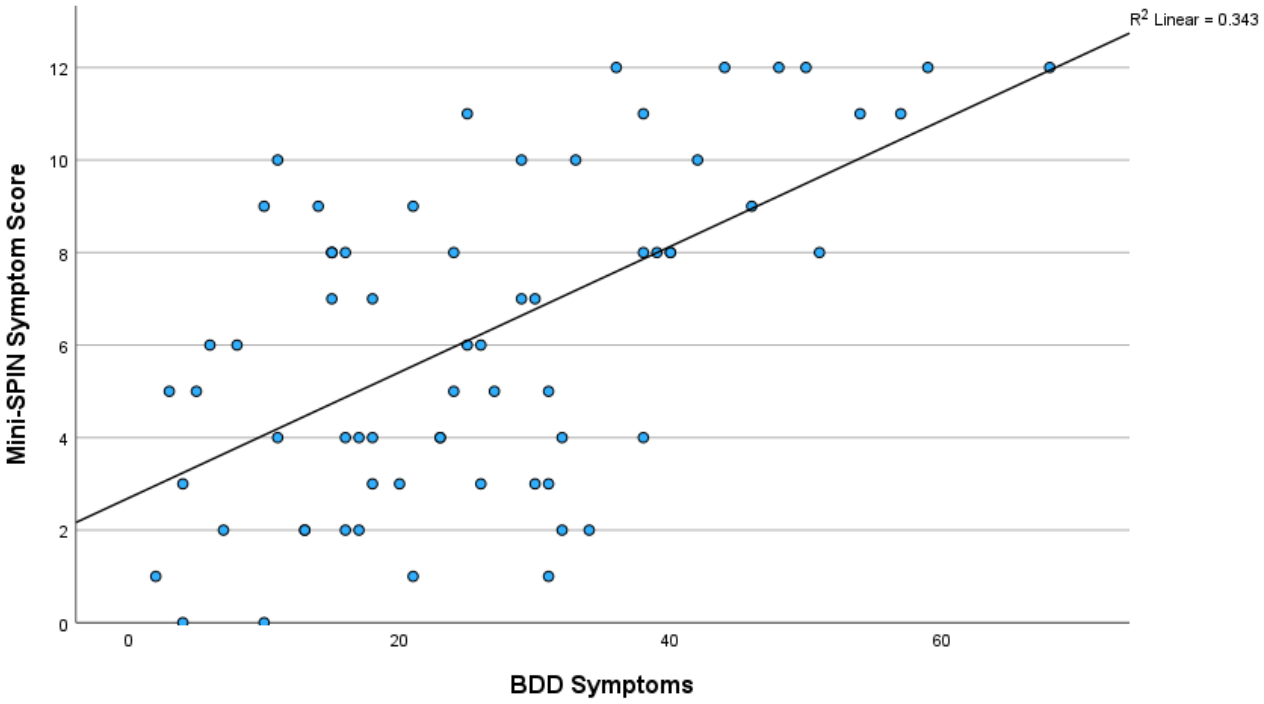


Table 3. *A correlation matrix to show Pearson's correlations between all variables, including 95% confidence intervals*

	BDD score	Mood	Anxiety	Mini-SPIN	Mood Slope	Anxiety Slope
BDD score	1	**-.37**	**.52**	**.47**	.13	-.07
95% CI		[-.48, -.24]	[.41, .61]	[.35, .57]	[.13, .15]	[-.20, .07]
Sig (*p*)		<.001	<.001	<.001	.85	.36
Mood	**-.37**	1	**-.56**	**-.25**	-.06	**.15**
95% CI	[-.48, -.24]		[-.64, -.45]	[-.38, -.12]	[-.20, .08]	[.01, .28]
Sig (*p*)	<.001		<.001	<.001	.39	<.05
Anxiety	**.52**	**-.56**	1	**.44**	**.20**	**-.30**
95% CI		[-.64, -.45]		[.32, .55]	[.07, .33]	[-.42, -.17]
Sig (*p*)	<.001	<.001		<.001	<.05	<.001
Mini-SPIN	**.47**	**-.25**	**.44**	1	.13	**-.16**
95% CI		[-.38, -.12]	[.32, .55]		[.01, .26]	[-.29, -.02]
Sig (*p*)	<.001	<.001	<.001		.08	<.05
Mood slope	.13	-.06	**.20**	.13	1	**-.77**
95% CI		[-.20, .08]	[.07, .33]	[.01, .26]		[-.82, -.70]
Sig (*p*)	.85	.39	<.05	.08		<.001
Anxiety slope	-.07	**.15**	**-.30**	**-.16**	**-.77**	1
95% CI		[.01, .28]	[-.42, -.17]	[-.29, -.02]		
Sig (*p*)	.36	<.05	<.001	<.05	<.001	

Note: Values with significance of <.05 are written in bold.

3.3 Preliminary Analyses

Preliminary analyses found an overall effect of prediction error on mood across the whole sample (fixed effect) of M=0.17, 95% CI: 0.14, 0.19.

The overall effect of prediction error on anxiety across the sample was M= -0.07, 95% CI: -0.09, -0.06. See Appendix K for histograms of bootstrapped means for mood and anxiety.

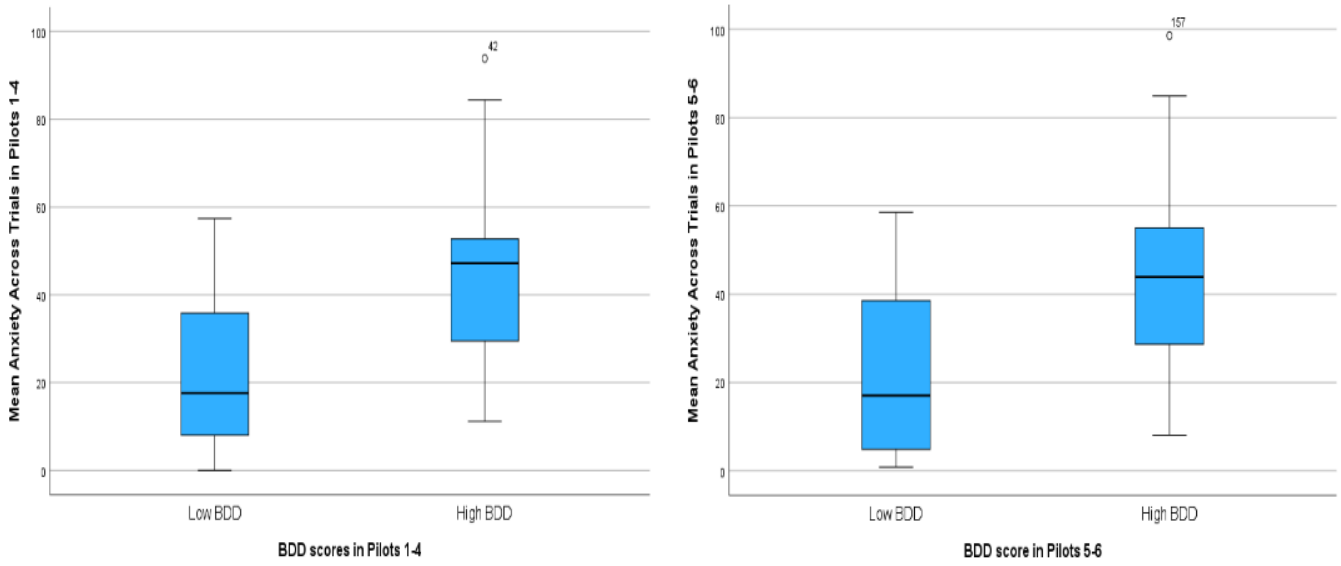
3.4 Effect of BDD symptoms on distress reduction to positive social surprise

As shown in Table 3, Pearson's correlations coefficients indicated that the relationship between BDD symptoms and effect of prediction error on mood was negligible and non-significant. Similarly, there was no association between BDD symptoms and effect of prediction error on anxiety.

3.5 Effect of the presence of a camera

An independent samples t-test determined that anxiety scores were significantly higher in Pilots 5-6, which incorporated video and audio recording (M=50.19, SD=28.33), compared to Pilots 1-4, which involved written text and no camera (M =33.78, SD= 24.39) [t(200) =-4.27, p<.001]. Box plots did not indicate that anxiety levels differed across trials for those with 'high' or 'low' BDD symptoms (see .

Figure 3. *Boxplots showing distribution of anxiety scores between participants in the highest and lowest quartile of BDD scores, in Pilots 1-4 and Pilots 5-6. Two outliers are shown, one in Pilots 1-4 and one in Pilots 5-6.*



As shown in Table 4, the association between effect of social prediction error on mood and anxiety was not significantly different between Pilot 1-4 (without camera) and Pilot 5-6 (with camera). Results remained consistent when outliers were removed (see Appendix J).

Moderation analysis was conducted to determine whether the relationship between BDD symptoms and mood, and BDD and anxiety, depends upon whether a camera is present or absent. For mood, the interaction between BDD and camera effects was not significant, (b=-.11, SE= .21, t=-.50, p=.62). Similarly, for anxiety, the interaction between BDD and camera effects was not significant (b=.32, SE= .23, t=

1.36, *p*= .18). Table 5 and 6 demonstrate that while both mood and anxiety were associated with BDD symptoms during the task, camera effects did not influence the magnitude of the association between mood/anxiety and BDD symptoms.

Table 4. *Pearson's correlation coefficients for the effect of social prediction errors on mood and anxiety, in Pilots 1-4 and Pilot 5-6.*

	Pilot 1-4 (n= 135)	Pilot 5-6 (n=67)	Comparison
Effect on mood	*r*=.01, *p*=.9, 95% CI [-.21, .13]	*r*=.004, *p*=.98, 95% CI [-.24, .24]	*z*= 0.06, *p*=.96
Effect on anxiety	*r*=-.04, *p*=.62, 95% CI [-.16, .18]	*r*=-.07, *p*=.55, 95% CI [-.31, .17]	*z*= 0.72, *p*=.47

Table 5. *A moderation analysis investigating whether the relationship between mood and BDD symptoms is dependent on camera effects (off vs on)*

Dependent variable: Mood				
Variable	Coefficient	Standard Error	*t*	*p*-value
Intercept	69.41	3.36	20.64	<.001
BDD symptoms	-.52	.13	-3.93	<.001
Camera effects (Off vs on)	-.33	5.99	-.06	.96
BDD * Camera effects	-.11	.21	-.50	.62

Table 6. *A moderation analysis investigating whether the relationship between anxiety and BDD symptoms is dependent on camera effects (off vs on)*

Dependent variable: Anxiety				
Variable	Coefficient	Standard Error	*t*	*p*-value
Intercept	16.11	3.69	4.36	<.001
BDD symptoms	.81	.14	5.6	<.001
Camera effects (Off vs on)	5.06	6.57	.77	.44
BDD * Camera effects	.32	.23	1.36	.18

4. Discussion

4.1 Main Findings

4.1.1 Hypothesis 1

The intent of this study was firstly to determine the association between symptoms of BDD and social anxiety, and secondly, to establish the extent to which BDD symptoms would influence the effects of social prediction errors in participants with differing levels of social anxiety, following a brief social interaction. While it is well-documented that social anxiety and BDD have high comorbidity in clinical settings, less is known about the relationship between the two in community populations, in which symptoms may be present without necessarily meeting clinical threshold for diagnoses. In line with our hypothesis, this study found a significant positive correlation between social anxiety symptoms and BDD symptoms. Given that SAD and BDD share a range of common features, including social avoidance, a heightened sensitivity to rejection and hostility, and a fear of negative evaluation by others (Kelly & Kent, 2017), it is not surprising that the two are frequently co-occurring at sub-clinical levels. However, the moderate effect size of r= 0.47 is consistent with these being separable constructs, and suggests that not all people with high levels of social anxiety had high levels of body dysmorphic symptoms and vice versa.

Although it is quite feasible that levels of overlap in SAD and BDD symptoms will differ across individuals, it may also be the case that the Mini-SPIN questionnaire has identified those with high levels of social anxiety without differentiating between the types of social situations feared. According to Kessler et al. (1998), social anxiety can be categorised into subtypes; the generalised type, which is characterised by a broad range of social fears, and the non-generalised type, relating exclusively to fears around public performance. A similar view is maintained in the DSM-5 (American Psychiatric Association [APA], 2022), which identifies a ‘performance-

only' subtype, categorising individuals who fear only performing and/or speaking in public. The generalised type is associated with higher levels of social anxiety symptomatology and clinical severity, and higher rates of comorbidity than the performance-related subtype in isolation (Fuentes-Rodriguez et al., 2018; Knappe et al., 2011). Hence, we might expect BDD and social anxiety symptoms to be more closely associated in people with the generalised subtype than the performance-only. While the Mini-SPIN was developed to screen for the generalised subtype of SAD (Connor et al., 2001), items such as *'Fear of embarrassment causes me to avoid doing things or speaking to people'* may have also captured individuals with the performance-related subtype. Therefore, we might have expected to see a higher correlation between SAD and BDD symptoms if we used a social anxiety measure which could differentiate subtypes and identify those with the generalised subtype only.

4.1.2 Hypothesis 2

The second aim of this study was to investigate the potential influence of BDD symptoms on the effects of social prediction errors on mood and anxiety. Contrary to our hypothesis, we found that BDD symptoms were not significantly associated with the effects of prediction errors on mood or anxiety. This null finding could indicate that BDD symptoms genuinely do not moderate the effect of a positive social surprise on mood or anxiety. An alternative possibility for these null findings is that participants may not have believed strongly enough that they were taking part in a real social interaction. Although efforts were made to increase the sense for participants that their 'virtual partners' were real people, the social interactions were

very brief, with only a single image of the virtual partner for the participant to familiarise themselves with. If participants did not feel that their virtual partner was real, this may not have induced a ‘sense of presence’ or immersion in the task, which according to virtual reality studies is necessary for the experience of anxiety in a virtual environment (Ling et al., 2014). On the other hand, some studies have found that social anxiety and its behavioural markers can be elicited in computer games, suggesting that social interactions can provoke anxiety even when participants know that they are not, objectively, ‘real’ (Dechant et al., 2021). Nevertheless, in the current study, being immersed in the task may have been particularly important for those participants with high BDD symptoms, who tend to experience high levels of threat in social situations based on the expectation that others will reject or disapprove of them (Baldock & Veale, 2017). It is therefore possible that participants who did not believe that they were receiving feedback from a real virtual partner may have placed less value on the importance of this feedback, and therefore, their response to the social surprise may have been less representative of how they would ordinarily behave and feel in a real social interaction.

An additional factor for consideration regarding the null findings of Hypothesis 2, is whether in our sample, the effects of positive prediction error on mood and anxiety were large enough in magnitude to allow for the measurement of moderators. Inspection of slope data showed good levels of variability for mood slopes (M= 0.17, SD= 0.23) and anxiety slopes (M= -.07, SD= .14)) (See Appendix I for histogram data). Thus, it is unlikely that low variance in our data was a factor contributing to the negligible and non-significant relationship found between BIQ

symptoms and effect on mood and anxiety. One possibility is that moderating effects of BDD did exist, but they were smaller than our study was powered to detect. Indeed, research has demonstrated that moderation effect sizes are often very limited (Aguinis et al., 2005) and hence, using a larger sample size would have increased this study's power to detect small, but meaningful moderating effects.

Although mood and anxiety slopes showed good variability, it is possible that Linear Mixed Effects model outputs could have been improved, had the prediction error variable been set up differently. In the pilots used in this study, participants were asked for their prediction *after* the social interaction, allowing them to take their own performance and experience into account in their self-rating. However, previous research (Heinig et al., 2023) has asked for participant's predictions of their performance *before* the social interaction takes place, using questions such as, 'How do you think you will perform?' In fact, this prospective approach is more in line with the practices of cognitive behavioural therapy for CBT, in which an individual will generally be asked to predict what will happen in a feared social interaction before they engage in it (Dunkley & Robichaud, 2022). Although the effect of this modification was not explored at the time the current pilots were conducted, it was investigated in later pilots, with findings suggesting that asking participants for their prediction before they engaged in the social interaction, rather than after, lead to improvements in model outputs to predict anxiety and mood. It is possible that making this temporal change in the prediction error variable in our pilots would have increased its effects on mood and anxiety, and allowed us to more clearly see the effects of any moderating variables.

4.1.3 Hypothesis 3

Our third study aim was to investigate the effect of performing in front of a camera on anxiety and mood changes to a positive social surprise, particularly for those participants with high levels of BDD symptoms. Although participants reported higher levels of anxiety with the camera on, there was no significant effect of camera on the extent to which BDD symptoms influenced the impact of social prediction errors on mood/anxiety. Of note, even with the camera on, the correlation coefficient for both mood and anxiety was close to zero, indicating that the null finding is unlikely to be explained by lack of statistical power. In moderation analysis, camera effects (off vs on) did not show a unique association with mood or anxiety when BDD symptoms were held constant, suggesting that the effect of BDD symptoms on momentary mood and anxiety overrides any effect of a camera being on or off.

This result is contradictory to findings by Orr and Moscovitch (2014) who examined the impact of video feedback on symptoms of social anxiety, and found that having high levels of appearance-related concerns reduced the effects on mood and anxiety of positive video feedback. It is possible that it is by the process of self-focused attention that traits of BDD increase social anxiety in a social interaction. Therefore, in our study, merely knowing that the camera was switched on without the visual reminder of the digital self-image may have failed to activate appearance-related anxieties in people with high BDD symptoms. In line with the theory of self-focused attention posited by the cognitive behavioural model of BDD (Veale, 2004), we would expect that the addition of an image of participants' own face would lead to increased fixation to the image, which has been associated with increased anxiety

and distress (Grocholewski et al., 2012). In addition, seeing their own image, rather than just imagining how they appear, in the observer perspective is likely to exacerbate the threat response in those with high BDD symptoms, as suggested by Baldock and Veale (2017). Future research would benefit from incorporating a video image and monitoring attention to the self-image using eye-tracking technology, in order to establish the impact of self-focused attention in digital social interactions for people with high levels of BDD symptoms.

4.2 Clinical Implications

The finding that BDD and SAD symptoms frequently co-occur in community samples has implications for clinical screening and interventions, as people with a diagnosis of one may experience symptoms of the other, even if they do not have comorbid diagnoses. While the CBT protocol for BDD shares some features with the protocol for SAD, such as cognitive restructuring and psychoeducation, treatments specific to BDD diagnoses incorporate additional appearance-related elements such as mirror retraining and other visual training techniques (Fang & Hofmann, 2010). Research on the use of mirrors in BDD has highlighted the way that maladaptive self-focus and beliefs around the importance of gazing at perceived defects contribute to lower mood in BDD patients than healthy controls (Veale & Riley, 2001), which supports the addition of visual retraining elements to BDD treatments. However, while this is not routinely delivered as part of CBT for social phobia, it may prove a helpful addition for those participants who have additional, specific concerns around their body image and/or facial appearance. It will be important that future screening tools

for SAD acknowledge the common overlap with BDD symptoms; screening for these could help to identify for whom additional appearance-related modules would benefit.

4.3 Strengths and Limitations

This study used a novel paradigm to elicit the sense in participants that they were participating in a social scenario and receiving feedback for their performance, without requiring the addition of real interactional partners. In addition to the fact that this reduced the resources required to conduct the experiment, it also allowed for the prediction errors to be experimentally manipulated. This allowed for each participant to experience an identical combination of prediction errors irrespective of the magnitude of their predictions, which were generated by computer, and hence replicable across trials and pilots. With an increasing focus in recent years on reproducibility in psychological research (Collaboration, 2015), this standardised method of feedback from virtual partners is a strength that would be difficult to implement in an experiment using real conversational partners. In addition, whilst the ecological validity of the study was reduced due to the computerised nature of the paradigm, feedback from the Young Person's Advisory Panel was collected and utilised to increase the accessibility and sense of realness of the paradigm to young people. For example, varying the time interval that it took for virtual partners to provide feedback was a minor change implemented after it was suggested that this might increase the feeling that participants were talking to real people.

The present sample had several limitations, specifically in the domain of the sample of participants used. Firstly, only participants between the ages of 18-25 were recruited to participate in the study, an age group selected because it surpasses the approximate mean age of onset of both BDD and SAD (Kelly et al., 2013). Although adults over the age of 25 were not considered for this particularly study, research has suggested that adults and adolescents do not differ significantly on most characteristics of BDD, and show similar rates of comorbidity between BDD and SAD (Phillips et al., 2006), suggesting that our findings may extend to adults over the age of 25. However, given that the median age of onset for SAD has been estimated as 13 years (Kessler et al., 2007) and that BDD symptoms of varying severity can be identified in children as young as 10 (Rautio et al., 2022), we would suggest that future research investigate the effects of a paradigm similar to that used in this study on a sample of adolescents. This might also provide possible insights into how current interventions for childhood SAD may be adapted to incorporate appearance-related anxieties, even amongst children who have not been clinically diagnosed with BDD.

Another limitation of the current study is that ethnicity data was not collected during screening. Research has identified ethnic differences in self-reported social anxiety, which are mediated by differences in Eastern/Western views of the self (Hong & Woody, 2007), and valuable insights may have been gained from considering the impact of such cultural differences on the current study's findings. Without the ability to establish whether there was an association between participant ethnicity and dependent variables, it is difficult to make claims regarding the generalisability of findings to the general population. A further factor which may

reduce the generalisability of findings is our use of an unselected community population; with the exception of pilot 6, which screened participants for Mini-SPIN symptom scores ≥6, we did not select specifically for high levels of SAD or BDD. Although this was crucial to test Hypothesis 1, it is possible that recruiting participants with subclinical levels of BDD may have contributed to the null findings to Hypotheses 2 and 3, as symptom levels may not have been high enough to see significant changes to positive social surprises. However, BDD is conceptualised as a dimensional construct (Bala et al., 2021), suggesting that the same mechanisms underly sub- and supra-threshold symptoms. Of note, in the current study, the full continuum of BDD symptoms were represented, with BIQ symptom scores ranging from 0-68, and 'high scorers' were well represented. In fact, 13.7% of participants scored above clinical threshold on the BIQ (≥40), which is vastly higher than the estimated prevalence of BDD in adults in student populations (2.2% (Veale et al., 2016)) and in adolescents (1.9%; (Krebs et al., 2024)). Selection bias may have accounted for these findings, as research has demonstrated higher rates of psychological symptomatology in those that volunteer for research studies than in non-volunteers (Kaźmierczak et al., 2023). Again, this suggests that caution should be applied when generalising the results from this study to the target population.

4.4 Conclusions

In conclusion, this study has examined the association between symptoms of SAD and symptoms of BDD in a community population, and explored how BDD symptoms may influence distress reduction to positive social surprises. While BDD symptoms did not moderate levels of anxiety and mood to social surprises in this particular

social paradigm, a moderate correlation was identified between BDD and social anxiety symptoms. Screening for BDD traits when assessing for social anxiety, and other mental health disorders, will help to identify the presence of comorbid symptoms, and hence inform treatment protocols as to additional targets for intervention.

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Part Three: Critical Appraisal

1. Overview

During my time on the Doctorate, I have had the experience of working, across a variety of settings, with people struggling with symptoms of BDD. Often, these symptoms will go unacknowledged by screening tools during the assessment process, and only come up later over the course of therapy work. For example, a young person with a diagnosis of social anxiety disorder might in therapy disclose a specific anxiety related to a part of their appearance, which they feel is defected or ugly, and which they find themselves attending very strongly to throughout social interactions. I have witnessed the detrimental impacts that the perception of these appearance-related faults can have on the person's ability to approach social situations and interact with others, as well as on their sense of identity. They can contribute to increased rumination about appearance, severe anxiety and feelings of low mood, and ultimately can lead to avoidance of contact with others and impairments across many areas of functioning. Although there is an evidence base to support these observations, I have often felt that the empirical literature on BDD symptoms, and particularly their interactions with other diagnoses such as social anxiety disorder, is limited. It is for this reason that I chose to pursue this piece of research for my thesis project, in the hopes that expanding knowledge in this area would aid the development of screening and treatments for people with BDD symptoms.

In this paper, I will reflect firstly on some of the barriers that arose in the process of planning and carrying out my systematic review, and the ways that they will impact my approach to conducting research in future. I will then appraise some of the methodological choices made in my empirical study, and address the

implications that this study might have for our understanding of BDD in screening and treatment.

2. Challenges in defining the term ‘self-focused attention’

In the process of conducting my systematic review, I adhered to Open Science Principles for the first time, and was taken aback by the rigour and scrutiny required in each stage of the research process. Having identified search terms, and inclusion and exclusion criteria, I approached the search and screening process with the expectation that selecting research articles for use in my review would be straight-forward. A hurdle, which I realised as I became slowly acquainted with the literature, came in the use of the search term ‘self-focused attention’. Self-focused attention is a multifaceted construct, which in research has been used very closely alongside the term self-awareness, and this raised questions for me. Namely, does self-focused attention require for a person to be self-aware? Cognitive research has suggested that these are in fact, separate constructs, and that attending to objects can take place even if a person is not consciously aware of them (Norman et al., 2013). Supporting this in regards to the self, Silvia and Phillips (2013) propose that self-focused attention can be elicited, and even used to evaluate the self, outside of conscious awareness.

Having established that the constructs of self-focused attention and self-awareness are distinct enough to include one and exclude the latter, I began screening, only to find that the two were regularly used interchangeably. For example, several studies used measurement scales to assess ‘self-awareness’,

made up solely, or mostly of questions pertaining to attention to the self (Chen et al., 1998; George & Stopa, 2008). Ultimately, over a fifth of studies (n=55) during full text screening were excluded on the basis of the primary construct measured being different to self-focused attention (these included self-awareness, self-perception, metacognition and rumination), despite some of these appearing very suitable for inclusion criteria when assessing just title and abstract. The invaluable support of other researchers in the screening process allowed for us to narrow down screening criteria based on new terms or questions emerging from the literature, in order to standardise the procedure as much as was possible. I have come out of the process with a newfound appreciation for the considerable hours and careful examination needed to design and carry out a systematic review protocol.

3. Identifying areas for improvement in the current literature base

To assess the methodological quality of studies in my systematic review, I used the Kmet Quality Assessment Tool (Kmet et al., 2004), and this part of the process opened my eyes to areas which may often be overlooked in the reporting and analysis of research. For example, it quickly came to my notice that the vast majority of studies (94%) in my review failed to report an a-priori power calculation to determine the statistical power of their hypothesis test. This was higher even than the finding in a review conducted in 2005, that of 519 studies, around three quarters failed to mention a power calculation (Chan & Altman, 2005). Although a power calculation is not always appropriate – for example, in a prevalence or pilot study, which does not have a simple hypothesis- and parameters used to calculate study power are rarely very precise, power calculations still provide an indication that a

study has been adequately planned, with consideration given to the appropriateness of sample size for the study's specific research question. On a larger scale, attending to statistical power in research is an important part of developing consistent psychological science, as underpowered studies have frequently been contradicted or shown to overestimate effects by studies that have been adequately powered (Ioannidis & Siegling, 2015). When appraising my overall study findings in the context of their quality ratings, I noticed something similar; that those studies with contradictory findings to the overarching research tended to be studies with lower quality ratings. Although evidently, it is a well-documented finding that psychological research can fail to report aspects such as a power analysis, it was only through the process of quality appraisal that I was able to fully consider the robustness of included studies in this way. I certainly believe that this experience will help me to adopt a more critical stance when considering research findings in future.

A finding that I was surprised by, and which elicited a level of disappointment, when carrying out the searches for my systematic review, was the low number of studies obtained on the relationship between BDD and self-focused attention (SFA). The cognitive model of BDD (Veale, 2004) has suggested that self-focused attention is a core process in the disorder, and there has been some evidence to support this association in both clinical, and non-clinical adult populations (Barnier & Collison, 2019; Grocholewski et al., 2012). Despite this, to our knowledge, a review into studies measuring the relationship between BDD and SFA had not been conducted in the last 15 years. In fact, when we ran preliminary searches and began screening studies, it became quickly apparent that robust research into the role of SFA in BDD

is in short supply, with only 9 of the 250 studies deemed eligible for full-text screening measuring this association. The majority of these studies were later excluded due to not meeting methodological criteria for the review, such as not using a multi-item measure to screen for SFA, which overall, meant that not enough studies remained to systematically review the relationship between these two variables. This has identified a gap in the research base, which feels important to address. Literature investigating mechanisms of BDD in younger populations may be particularly limited, although I am pleased to see that it is gaining increased research attention. For example, a recent study highlighted the high prevalence of appearance preoccupation in young people, which is linked to similar impairments to those seen in BDD (Krebs et al., 2024). Further research into the role of self-focused attention in adolescents may provide insights into the mechanisms behind this link, which ultimately will improve our ability to detect BDD symptoms in young people.

4. The use of visual analogue scales (VAS) to measure psychological constructs

In the process of reflecting on the possible reasons behind the null findings to Hypotheses 2 and 3 (ref) in my empirical study, I considered the use of single visual analogue scales to measure mood and anxiety, and whether these would have provided a valid and reliable measure. The benefits of using VAS in this experimental paradigm was that they improved scalability of the study, as they allowed for data on mood and anxiety to be collected for each participant in the same standardised way across all 48 trials, using a quick and simple sliding scale similar to those which participants may have encountered before in online forms. At the same time, I wondered how reliable a single-item measure could be to quantify a construct

such as mood, which is subjective and multidimensional. This consideration was the very reason that studies using solely VAS scales to measure self-focused attention and/or anxiety were screened out of my systematic review, as it was felt that these were not as robust as multi-item measures.

There is, in fact, a strong evidence base supporting the use of VAS scales as a quick, effective and easily-administered way to measure psychological constructs. For example, VAS scales have shown reliability and validity in measuring state anxiety (Abend et al., 2014) and stress levels, (Barré et al., 2017) and a high correlation has been demonstrated between VAS scales and established multi-item measures for anxiety (Williams et al., 2010). On the other hand, technological advancements can offer us innovative ways to detect minute-to-minute changes in constructs such as mood and anxiety, without having to rely fully on self-report data. One example of this is wearable biosensors, which allow for the instantaneous collection of data related to physiological data such as heart rate variability (HRV) in response to cognitive and affective states. The ease with which HRV allows for data to be collected, and the fact that it is painless and non-invasive, makes it an accessible method of measurement in research (Laborde et al., 2017). In addition, a recent review has indicated that it is a valid and reliable way to detect physiological responses to stress, and correlates highly with validated anxiety measures (Peabody et al., 2023). On the basis of these reflections, I feel that future research investigating changes in mood and anxiety during social situations, would benefit from incorporating physiological measures of data alongside visual analogue scales. In the current study, this may have added to our understanding on the effectiveness of the virtual paradigm in creating changes in mood and anxiety states.

5. The association between BDD and SAD -further reflections

Whilst reviewing the literature on the association between BDD and SAD, I came across one study which suggested that BDD could be classified as both an anxiety spectrum disorder, and an obsessive-compulsive disorder, as it is currently (American Psychiatric Association, 2022). This was proposed by Barahmand and Shahbazi (2015), based upon their finding that BDD showed high comorbidity with both social anxiety and obsessive compulsive disorder (OCD) in the community. They raised the possibility that the three could lie on one continuum of distress severity, and I have considered this idea in relation to my own findings. Indeed, my data showed that in a non-selected community sample, BDD and SAD symptoms were moderately correlated, which made sense to me in the context of their overlapping features, such as fear of negative evaluation, negative interpretation biases and interpersonal sensitivity. Another feature of all three conditions, BDD, SAD and OCD, is the cognitive pattern of ruminative thinking, although the specific types of ruminative thoughts may differ across conditions (Carpita et al., 2020). Preliminary research has suggested that as the symptoms of OCD and anxiety disorders become more severe, they may become more distanced from each other, while at lower levels, they map more closely onto a shared pathway (Vigne et al., 2019). I do, to an extent, agree that the shared features and the current comorbidity data on BDD and SAD symptoms challenge the notion that these disorders lie in discrete diagnostic categories. However, I believe more research will be required to further establish a shared way to conceptualise them. This will require a broader exploration into how transdiagnostic features of the disorders manifest at differing

levels of severity, which I would argue could be testable using community samples, given that the number of participants scoring above clinical cut off for BDD and/or SAD in the current study was high.

One of the benefits of the development of a shared pathway for those with mild anxiety and/or obsessive-compulsive symptoms is that it may increase the accessibility of treatments for those who may not currently meet criteria for a clinical diagnosis. It may also support the development of therapies which are formulation-based and tailored to an individual's specific symptoms rather than driven solely by their diagnostic label. Based on the finding that BDD and SAD symptoms co-occur frequently in a community population, I hope that the development of assessment screening tools for social anxiety which also screen for BDD symptoms, and vice versa, will aid this process of tailoring social anxiety therapies to the individual. In practice, for a person with social anxiety disorder who also has a high level of BDD symptoms, this might involve incorporating modules to target specific BDD symptoms, such as perceptual mirror retraining for perceptual biases, into their treatment plan. However, while many studies have suggested the implementation of this type of visual intervention for people with symptoms of BDD, I came across very few in the literature which studied their effectiveness. Further research will be needed to assess the effectiveness of interventions specific to BDD to provide more direction regarding the implementation of these into treatment protocols.

It is my great hope that as the robust evidence base on the mechanisms underlying BDD, the screening tools used to assess its symptoms and the treatments designed to alleviate these symptoms continues to expand and enhance,

this will be reflected in clinical health settings, and lead to more positive outcomes for people experiencing the highly impairing symptoms of BDD.

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Appendices

Appendix A: A list of multi-item questionnaires measuring self-focused attention which met criteria for inclusion

The following measures which met criteria for inclusion were selected initially:

- The **Self-Consciousness Scale** (Fenigstein et al., 1975)
- The **Self-Consciousness Scale- Revised** (Scheier & Carver, 1985)
- The **Self-focused Attention Scale** (Bogels et al., 1996)
- The **Focus of Attention Questionnaire** by (Woody, 1996)

Several additional measures were found during the review process and deemed relevant by expert consensus, so were added to the list of included self-focused attention measures:

- The **SAM questionnaire** (Filipp & Freudenberg, 1989) A modified German version of the Self-Consciousness scale (Fenigstein et al., 1975)
- The **Self Consciousness Questionnaire for Children and Adolescents** (Kley et al., 2012)

Appendix B: Pre-defined hierarchy of SAD measures

We have chosen the study's appointed primary outcome measure for social phobia, however, when more than one primary outcome measure was specified, we weighted them in the following order;

1. Liebowitz Social Anxiety Scale (LSAS; adult/youth versions; Masia-Warner, Klein & Liebowitz (1999); Liebowitz (1987))
2. Social Phobia Anxiety Inventory (SPAI; adult/youth versions; Beidel, Turner, and Morris (1995); Turner, Beidel, Dancu, and Stanley (1989)).
3. Social Interaction Anxiety Scale (SIAS; Mattick & Clarke., 1998)
4. Social Phobia Inventory (SPIN; Conner et al., 2000).
5. Social Avoidance and Distress Scale (SADS; Watson & Friend, 1969)
6. Fear of Negative Evaluation Scale (FNE; Watson & Ronald, 1969)

Appendix C: Adapted Crib Sheet for Quality Assessment

Standard Quality Assessment Criteria for Evaluating Primary Research Papers. Used alongside Manual for Quality Scoring of Quantitative Studies (Kmet et al., 2004)

The Criteria		Crib notes to be used with Kmet et al. (2004)	Yes (2)	Partial (1)	No (0)	N/A
1	Question/objective sufficiently described?	Use Kmet et al. (2004) criteria.				
2	Study design evident and appropriate?	Use Kmet et al. (2004) criteria. Yes: if the design answers the question relevant to our inclusion criteria, even if the question reported in the study does not exactly align with our review research question.				
3	Method of subject/comparison group selection or source of information/input variables described and appropriate?	Use Kmet et al. (2004) criteria. To define 'acceptable' in the 'yes' category: acceptable includes evidence of an unbiased selection process.				
4	Subject (and comparison group**, if applicable**) characteristics sufficiently described?	Use Kmet et al. (2004) criteria.				
5	If interventional and random allocation was possible, was it reported?	N/A				

6	If interventional and blinding of investigators was possible, was it reported?	N/A				
7	If interventional and blinding of subjects was possible, was it reported?	N/A				
8	Outcome and (if applicable) exposure measure(s) well defined and robust to measurement / misclassification bias? Means of assessment reported?	Use Kmet et al. (2004) criteria. Follow the criteria applicable to survey's only for this area.				
9	Sample size appropriate?	Use Kmet et al. (2004) criteria. Yes: exclude 'seems reasonable'. Instead, only select 'yes' if studies have reported a power calculation to justify the sample size for the analysis relevant to our review. Alternatively, when results are achieved for major outcomes, appropriate sample size can usually be assumed when standard errors/variance estimates are reported, unless large standard errors (SE > ½ effect size) and/or problems with multiple testing are evident. Decision analyses: size of modelled cohort / number of iterations specified and justified. Partial: exclude this criteria - 'Or some statistically significant results in the absence of variance estimates'				
10	Analytic methods described/justified and appropriate?	Use Kmet et al. (2004) criteria. Partial: if the statistical test isn't explicitly stated, then mark as partial. If normality checks have not been reported, mark as partial. Yes: in addition to existing criteria, where applicable, assumptions have been reportedly met.				

11	Some estimate of variance is reported for the main results?	Use Kmet et al. (2004) criteria. Only applicable to areas of the study that are relevant for our review. If the study research question does not match our review question, this area should be answered based on analysis extracted for our review (even if question not explicitly stated in the study).				
12	Controlled for confounding?	N/A				
13	Results reported in sufficient detail?	Use Kmet et al. (2004) criteria.				
14	Conclusions supported by the results?	Use Kmet et al. (2004) criteria. N/A: if conclusions are stated for the main research question but not for questions relevant for our study. Where study objectives align with our review objectives but conclusions are based on alternative analysis that wasn't extracted for purpose of this review.				

*Across all criteria, mark as the lowest standard if there is uncertainty.

Appendix D: Mini-SPIN questionnaire

The below questionnaire, designed to test participants' symptoms of social anxiety, was administered digitally.

For each question, please circle the number which best describes how you have been feeling the past week.

	Not at all	A little bit	Somewhat	Very much	Extremely
Fear of embarrassment causes me to avoid doing things or speaking to people	0	1	2	3	4
I avoid activities in which I am the center of attention	0	1	2	3	4
Being embarrassed or looking stupid are among my worst fears	0	1	2	3	4

Appendix E: Body Image Questionnaire (BIQ)

The below questionnaire, designed to test participants' symptoms of body dysmorphic disorder, was administered digitally.

These questions aim to understand how you feel about your appearance. Please answer them in relation to any features of your appearance that concern you but please do not include overall body weight.

Please answer the following for how you have felt over the past week.

1. How often do you **deliberately** check your feature(s)? **Not accidentally catch sight of it.** Please include looking at your feature in a mirror or other reflective surfaces like a shop window or looking at it directly or feeling it with your fingers.

0	1	2	3	4	5	6	7	8
About 40 times or more a day		About 20 times a day		About 10 times a day		About 5 times a day		Never check

2. To what extent do you feel your feature(s) are **currently** ugly, unattractive or 'not right'?

0	1	2	3	4	5	6	7	8
Very ugly or 'not right'		Markedly unattractive		Moderately unattractive		Slightly unattractive		Not at all unattractive

3. To what extent does your feature(s) **currently** cause you a lot of distress?

0	1	2	3	4	5	6	7	8
Not at all distressing		Slightly distressing		Moderately distressing		Markedly distressing		Extremely distressing

Next

4. How often does your feature(s) **currently** lead you to avoid situations or activities?

0	1	2	3	4	5	6	7	8
Always avoid		Avoid about three quarters of the time		Avoid about half of the time		Avoid about a quarter of the time		Never avoid

5. To what extent does your feature(s) **currently** preoccupy you? That is, you think about it a lot and it is hard to stop thinking about it?

0	1	2	3	4	5	6	7	8
Not at all preoccupied		Slightly preoccupied		Moderately preoccupied		Very preoccupied		Extremely preoccupied

6. If you have a partner, to what extent does your feature(s) **currently** have an effect on your relationship with an existing partner? (e.g. affectionate feelings, number of arguments, enjoying activities together). If you do **not** have a partner, to what extent does your feature(s) **currently** have an effect on dating or developing a relationship?

0	1	2	3	4	5	6	7	8

7. To what extent does your feature(s) **currently** interfere with your ability to work or study, or your role as a homemaker? (Please rate this even if you are not working or studying: we are interested in your ability to work or study.)

0	1	2	3	4	5	6	7	8
Not at all		Slightly		Moderately		Markedly		Very severely I can't work

8. To what extent does your feature(s) **currently** interfere with your social life? (with other people, e.g. parties, pubs, clubs, outings, visits, home entertainment)

0	1	2	3	4	5	6	7	8
Not at all		Slightly		Moderately		Markedly		Very severely

9. To what extent do you feel your appearance is the most important aspect of who you are?

0	1	2	3	4	5	6	7	8
Not at all		Slightly		Moderately		Mostly		Totally

Next

Appendix F: Ethical Approval for Study

UCL RESEARCH ETHICS COMMITTEE
OFFICE OF THE VICE-PROVOST (RESEARCH, INNOVATION & GLOBAL ENGAGEMENT)

UCL

24th April 2023

Prof Argyris Stringaris
Department of Psychiatry
UCL

Cc: Marjan Biria & Isobel Ridler, UCL Department of Psychiatry

Dear Professor Stringaris

Notification of Ethics Approval with Provisos
Project ID/Title: 24867/001: Emotion fluctuations with experimental paradigms in young adults and adolescents

Further to your satisfactory responses to the Committee's feedback, I am pleased to confirm in my capacity as Chair of the UCL Research Ethics Committee (REC) that your study has been ethically approved by the UCL REC until **31st May 2028.**

Please provide evidence in due course of the schools' agreement to collaborate with you and assist with recruitment for our records.

Ethical approval is subject to the following conditions:

Notification of Amendments to the Research
You must seek Chair's approval for proposed amendments (to include extensions to the duration of the project) to the research for which this approval has been given. Each research project is reviewed separately and if there are significant changes to the research protocol you should seek confirmation of continued ethical approval by completing an 'Amendment Approval Request Form'https://www.ucl.ac.uk/research-ethics/responsibilities-after-approval

Adverse Event Reporting – Serious and Non-Serious
It is your responsibility to report to the Committee any unanticipated problems or adverse events involving risks to participants or others. The Ethics Committee should be notified of all serious adverse events via the Ethics Committee Administrator (ethics@ucl.ac.uk) immediately the incident occurs. Where the adverse incident is unexpected and serious, the Joint Chairs will decide whether the study should be terminated pending the opinion of an independent expert. For non-serious adverse events the Joint Chairs of the Ethics Committee should again be notified via the Ethics Committee Administrator within ten days of the incident occurring and provide a full written report that should include any amendments to the participant information sheet and study protocol. The Joint Chairs will confirm that the incident is non-serious and report to the Committee at the next meeting. The final view of the Committee will be communicated to you.

Research Ethics Service
Office of the Vice-Provost (Research, Innovation & Global Engagement)
University College London
Email: ethics@ucl.ac.uk
www.ucl.ac.uk/research-ethics/

Final Report

At the end of the data collection element of your research we ask that you submit a very brief report (1-2 paragraphs will suffice) which includes in particular issues relating to the ethical implications of the research i.e. issues obtaining consent, participants withdrawing from the research, confidentiality, protection of participants from physical and mental harm etc.

In addition, please:

- ensure that you follow all relevant guidance as laid out in UCL's Code of Conduct for Research;
- note that you are required to adhere to all research data/records management and storage procedures agreed as part of your application. This will be expected even after completion of the study.

With best wishes for the research.

Yours sincerely

Professor Michael Heinrich
Joint Chair, UCL Research Ethics Committee

Department of Psychiatry, 149 Tottenham Ct Rd, London W1T 7BN
Department of Psychology and Language Sciences, Research Department of Clinical, Educational & Health Psychology, 26 Bedford Way, London, WC1H 0AP

Name and Contact Details of the UCL Data Protection Officer:
Alexandra Potts: data-protection@ucl.ac.uk

Social Emotions

Participant Information Sheet

This research has been approved by UCL Research Ethics Committee
(Approval ID Number: 24867/001)

You are being invited to take part in a research study. Before you make a decision, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Deciding not to participate will not affect you now or in the future in any way. Thank you for reading this.

What is the purpose of this study?
The purpose of this study is to improve our understanding of mood and emotion fluctuations and investigate what causes them in adolescents and young adults.

Why have I been invited to take part?
You have been chosen because you were interested in participating in a study investigating mood and emotions. The inclusion criteria for this study are that you must be between 18-25 years old, must **not** have any neurological conditions, past or current psychotic episodes, must **not** take any psychotropic medications, and lastly, must have good internet connection.

Do I have to take part?
It is completely up to you to decide whether or not to take part in this study. We will describe what will happen during this study in this information sheet. If you demonstrate interest in collaborating with us, you can then sign a consent form after reading this information sheet and after making sure all your questions are answered by the researchers using the email addresses provided. You are free to withdraw at any time, without giving a reason and without it affecting any benefits that you are entitled to. If you decide to withdraw you will be asked what you wish to happen to the data you have provided up that point.

What will happen if I take part?
You will first start by an initial screening which takes about 15 minutes to complete and if the study was suitable for you, you will carry on with the actual study entailing some questionnaires and computer tasks. During the screening, you will be asked to answer some questions with regard to the inclusion/exclusion criteria mentioned above to decide whether this study would be suitable for you.

Study summary: This is a study about how people think and feel while they have to play a game, simply wait, or are in social situations. If you decide to take part and if after screening the study would be suitable for you, you will answer some questionnaires and perform some computer tasks outlines below. The total duration of the study is up to 90 minutes. We may contact you again in the future to repeat some experiments in a second study session.

Who can take part *(eligibility assessment)*: After reading this information sheet, for which you can take as much time as needed to make sure you understand everything, you will have an opportunity to ask us any questions. Once you have decided that this study is of interest to you, you will need to answer some additional questions to make sure the study is suitable for you. These questions pertain to the inclusion and exclusion criteria mentioned above. You will also be asked to provide personal information including your age in years, gender and sex. Once you have been selected to participate in the study, you must note that you can still withdraw from the study at any time during, before or at the end of the study, you can request the deletion of any data you have provided. You do not need to give us any reason. However, if you choose to withdraw after the study finishes it will not be possible to delete your data, as your personal information will be deleted and it will no longer be possible to identify your study record.

Mental health questionnaires: As part of this study, you will complete questionnaires relating to your mental health before and during the study session. The questionnaire data will be saved on a secured online platform and will take approximately 15 minutes to complete.

Computerised tasks: You will also complete a few computer tasks studying how people think and feel under certain circumstances. These circumstances may vary from simply waiting whilst looking at something on the screen (e.g. a cross) to having a conversation with a virtual or real conversation partner where you tell them about your day. There will be no correct or wrong answers on these tasks. This part of the study will take approximately 75 mins with as many breaks in between as you need.

What are the possible disadvantages and risks of taking part?
We do not expect any risks or side effects associated to the computerised tasks and questionnaires we use in this study. However, if you are not comfortable answering any of the mental health questions, then you will not be compelled to do so. For computer tasks, we have explicitly chosen our stimuli to be either neutral or positive, and not to include any negative stimuli. If you are currently experiencing any mental health problems you can contact your healthcare provider or charities such as Mind (https://www.mind.org.uk) or Samaritans (https://www.samaritans.org). However, if you provide us with specific issues we could guide you better according to your specific needs—even if you decide not to take part in this study.

What are the possible benefits of taking part?

You will be compensated for the time you spend participating in the study at a rate of £5 for the screening section and £12 for the study participation. Apart from the monetary compensation, there will be no direct benefits of taking part in this study. However, you will have the pleasure of knowing that you have made a great contribution to our understanding how mood and emotions fluctuate in social situations. Findings of this research will help us to improve psychological treatments for emotional problems in young people.

What if there is a problem?
If you have a concern about any aspects of this study, in the first instance you should contact the researchers in this study who will do their best to answer your questions. You can contact them using the email address aim.lab@ucl.ac.uk. However, if you feel your complaint has not been handled in a satisfactory manner you may contact the Chair of the UCL Research Ethics Committee, ethics@ucl.ac.uk. Please note that all researchers working with individuals below the age of 18 have undergone a satisfactory criminal records check.

Will my taking part in this project be kept confidential?
All the information that we collect about you during the course of the research will be kept strictly confidential. You will not be able to be identified in any ensuing reports or publications. We will take every precaution to ensure that confidentiality is not breached, including only storing your anonymised data. We will take every precaution to ensure that confidentiality is not breached, including only storing video and audio recording data on a secure university computer system to which access is highly restricted (only by the study team), and by issuing you with a specific code to use instead of your name when completing the online questionnaires and cognitive tests. Information such as name, email, address or IP will NOT be collected as part of this study.

Limits to confidentiality
Confidentiality will be respected unless there are compelling and legitimate reasons for this to be breached (for example in the unlikely event of a threat to your safety or the safety of others, or if we are legally obliged to). If this was the case we would inform you of any decisions that might limit your confidentiality.

What will happen to the results of the research project?
The results of the study will be presented at conferences, published in scientific articles, and may be used as part of Master's or PhD degree dissertations. You will not be identified in any report or publication. After publication the anonymised study data will be made available as "open data" on a public archive, meaning anyone with an internet connection can download them, in perpetuity. This is so that other researchers can easily access the data if they wish to perform extra analyses or ask different scientific questions. It will not be possible to identify you based on the data placed in the archive.

Local Data Protection Privacy Notice

***Notice*:** The controller for this project will be University College London (UCL). The UCL Data Protection Officer provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk.

This 'local' privacy notice sets out the information that applies to this particular study. Further information on how UCL uses participant information is provided in our 'general' privacy notice for participants in health and social care studies, which can be viewed here.

The information that is required to be provided to participants under data protection legislation (GDPR and DPA 2018) is provided across both the 'local' and 'general' privacy notices.

- The categories of personal data collected in this study will be: *date of birth, health, sex, gender, video/audio*.
- The lawful basis that will be used to process your personal data is *performance of tasks in the public interest*.
- The lawful basis that will be used to process your *special category personal data* (which includes health data) is *research purposes*.
- *Your personal data will be processed so long as it is required for the research project*. If we are able to anonymise or pseudonymise the personal data you provide we will undertake this, and we will endeavour to minimise the processing of personal data wherever possible.
- Your personal data will not be transferred to any other institution.

If you are concerned about how your personal data is being processed, or if you would like to contact us about your rights, please contact UCL in the first instance at data-protection@ucl.ac.uk.

Who is organising and funding the research?
This research is being organised by researchers at the UCL departments of Psychiatry, Psychology and Language Sciences, and the faulty of Brain sciences. This research is being funded by the Wellcome Trust.

Contact for further information
If you have any questions about the study you should contact the research team using the email aim.lab@ucl.ac.uk.

Thank you for reading this information sheet

☐ I wish to proceed with the study

☐ I do not wish to proceed with the study

If Yes:

Thank you for reading this information sheet and deciding to participate in this study. Our research depends entirely on the goodwill of potential volunteers such as you.

*

I confirm that I understand that by ticking each box below I am consenting to this part of the study. **I understand that it will be assumed that unticked boxes mean that I do NOT consent to that part of the study and, by not giving consent for any one element, I may be deemed ineligible for the study.**

☐ 1. I have read the information above and understand I can email the researchers with any questions.

☐ 2. I consent to the collection of the following types of research data: Mental health questionnaires and performance on computerised tasks.

☐ 3. I understand that no identifiable personal information will be collected and that my data will be stored securely and anonymously.

☐ 4. I consent to video and audio recordings of the testing session to take place.

☐ 5. I understand that the video and audio recording data will be kept safe on a secure university computer and storing system to which access is highly restricted (only by the study team) and will be de-identified and destroyed after the data analysis.

☐ 6. I understand that participation is completely voluntary and that I can withdraw at any point without giving any reason and without any penalty, simply by closing my browser.

☐ 7. I understand that confidentiality will be strictly adhered to and it will not be possible to identify me in any publications or presentations. I understand that such confidentiality is limited if evidence of wrongdoing or potential harm is uncovered. In such cases the researcher may be obliged to contact relevant statutory bodies/agencies.

☐ 8. I understand the benefits of participating as stated in the Information Sheet, including the receipt of financial compensation of £12.

☐ 9. I understand that only fully anonymised research data from the study will be presented, published or archived in an open access repository, which might be used for future analysis by other researchers not connected with UCL.

☐ 10. I hereby confirm that:

a) I understand the inclusion criteria as detailed in the Information Sheet
b) I meet these criteria, and do not meet any of the exclusion criteria

c) I do not have current or past experiences of psychosis or neurological conditions
d) I do not currently take or have a history of taking any psychotropic medications

By pressing “**Continue**” I consent to take part in this study

Appendix H: Manipulations of feedback and prediction error

• Feedback manipulation: We manipulated feedback with the aim of generating two positive (one positive and one bigger positive feedback, see below how these were calculated), two negative, and two neutral prediction errors (PEs) per judge. For pilot 3, instead of one bigger positive, we had one biggest positive feedback per judge which was a number between 90-100 selected randomly.

o Positive PE feedback: This was generated by 1) randomly sampling from a normal distribution of numbers with a mean of 12, a standard deviation of 3, a minimum value of 12 and a maximum value of 20; 2) adding this sampled number to the judge's histogram mean value.

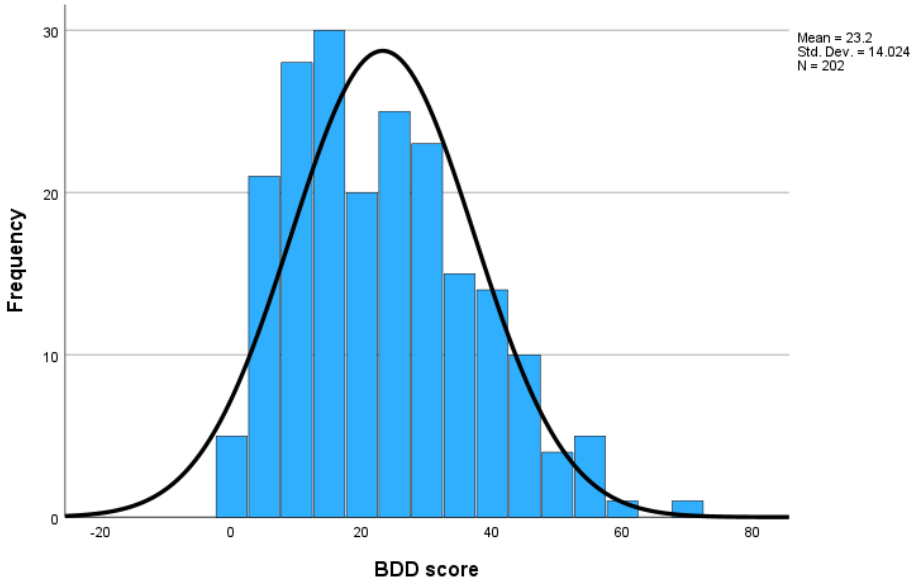
o Bigger Positive PE feedback: This was generated by 1) randomly sampling from a normal distribution of numbers with a mean of 12, a standard deviation of 3, a minimum value of 12 and a maximum value of 20; 2) adding this sampled number to the judge's histogram mean value; 3) Adding 10 ±1 to the summed value.

o Negative PE feedback: This was generated by 1) randomly sampling from a normal distribution of numbers with a mean of 12, a standard deviation of 3, a minimum value of 12 and a maximum value of 20; 2) subtracting this sampled number to the judge's histogram mean value.

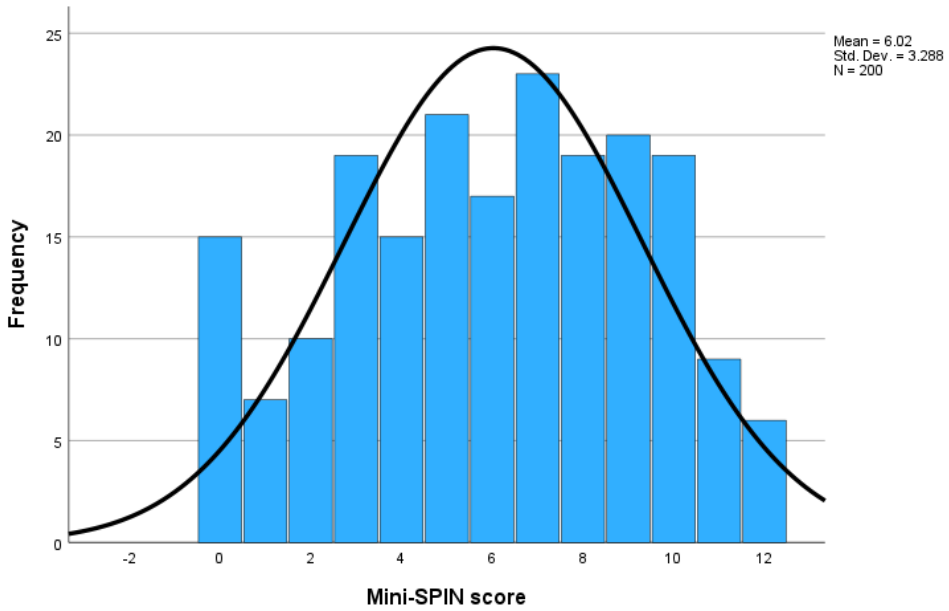
o Neutral feedback: Neutral feedback was either the exact value or ±1 of the judge's histogram mean value.

Appendix I: Histograms to show distribution of variables

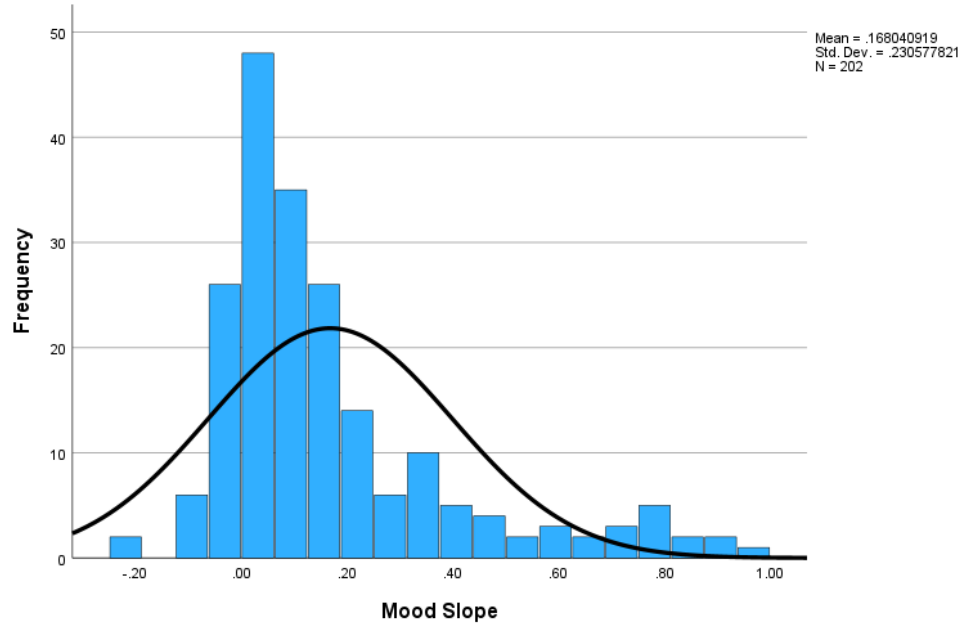
A histogram to show distribution of BDD symptoms on the BIQ questionnaire



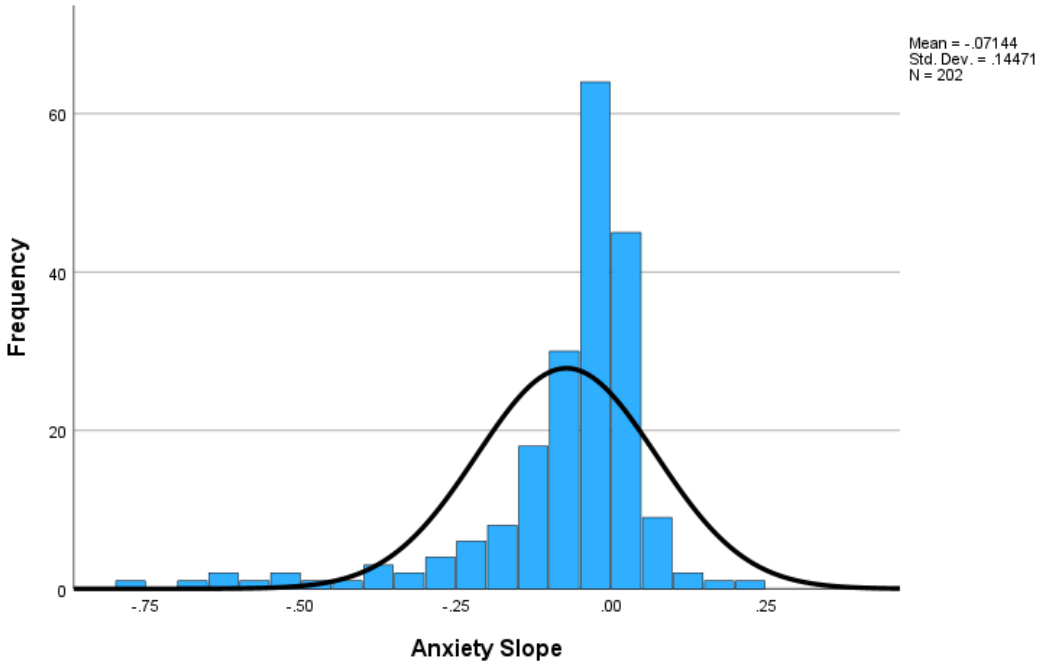
A histogram to show distribution of symptoms on the Mini-SPIN questionnaire



A histogram to show distribution of mood slopes across participants.



A histogram to show distribution of anxiety slopes across participants



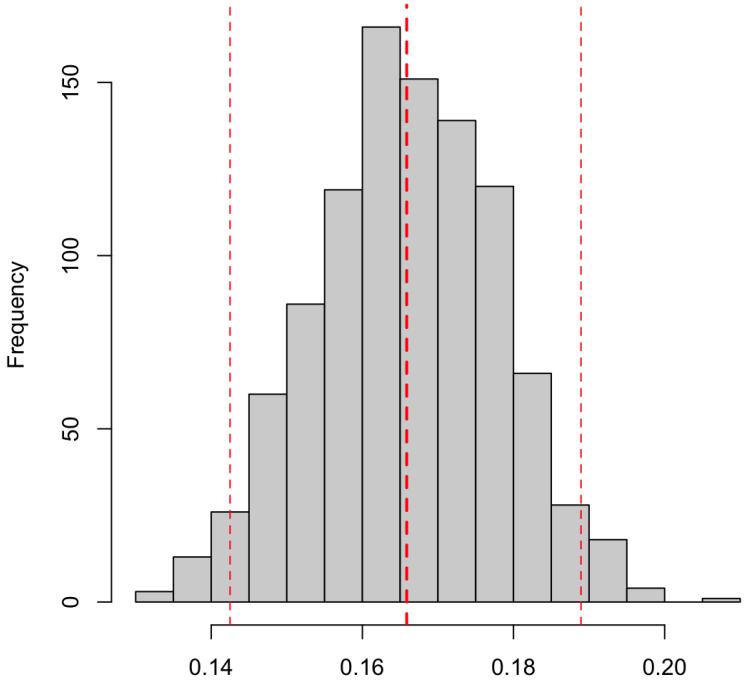
Appendix J: Sensitivity analyses

A sensitivity test to check for effect of excluding or including two outliers in data.

Correlation	With outliers	Without outliers	Comparison
BDD and mood	r=-.37, p<.001	r= -.34, p<.001	z=-0.34, p=0.73
BDD and anxiety	r=.51, p<.001	r= .5, p<.001	z= -0.13, p=0.89
BDD and mini-SPIN	r=.47, p<.001	r= .45, p<.001	z= 0.25, p=0.8
BDD and anxiety slope	r=-.07, p=.36	r=-.07, p=.34	z= 1
BDD and mood slope	r=.01, p=.85	r=.03, p=.67	z= -0.2, p=0.84
BDD and mood slope pilot 1-4	r=.01, p=.9	r=.02, p=.84	z=-0.1, p=0.92
BDD and mood slope pilot 5-6	r=.004, p=.98	r=.04, p=.75	z=-0.36, p=0.72
BDD and anxiety slope pilot 1-4	r=-.04, p=.62	r=-.05, p=.58	z=.01, p=.92
BDD and anxiety slope, pilot 5-6	r=-.07, p=.55	r=-.08, p=.53	z=.01, p=.92

Appendix K: Histograms to show bootstrapped means

A histogram showing bootstrapped means for mood



A histogram showing bootstrapped means for anxiety