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The role of dispositional reinforcement sensitivity and self-esteem in social interaction anxiety and social phobia

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Social anxiety is related to normal variation in personality and manifests as anxiety concerning interactions with others (social interaction anxiety), and/or as a fear of social scrutiny whilst performing tasks when under observation from others (social phobia). In revised Reinforcement Sensitivity Theory (rRST) a behavioral inhibition system (BIS) facilitates defensive approach behaviors and anxiety in situations of uncertainty. A fight-flight-freeze system (FFFS) facilitates fear and avoidance behaviors, and a behavioral approach system (BAS) facilitates anticipated reward and/or approach-based behaviors. rRST suggests that a socially anxious phenotype would experience elevated BIS sensitivity, elevated FFFS sensitivity, and dampened BAS sensitivity. We used self-report measures to test if the effects of social interaction anxiety and social phobia (which reflects the fear of social scrutiny) are separable within rRST, as in rRST anxiety and fear are separate constructs. Low levels of self-esteem are a risk factor for social anxiety, thus we tested how two sub-components of self-esteem referred to as self-acceptance and self-assessment predict social interaction anxiety and social phobia. 405 participants (mean age = 30.6; 86% female) completed the online study. Social interaction anxiety and social phobia were positively correlated with BIS and FFFS-flight sensitivity, and were negatively correlated with BAS, and FFFS-fight sensitivity in males and females. Social interaction anxiety and social phobia were negatively correlated with self-acceptance in males and females. Multiple regression showed that for females BIS and FFFS-flight scores were prominent positive predictors of social interaction anxiety whereas BIS was a prominent positive predictor of social phobia. For males the FFFS-fight subscale was a prominent negative predictor of social interaction anxiety. Overall, a synthesis of the present study and previous studies suggests that there may be subtle differences in how trait social interaction anxiety and trait social phobia relate to reinforcement sensitivity.

Keywords: personality, social anxiety, reinforcement sensitivity, self-esteem

The social anxiety spectrum ranges from undiagnosed trait levels of social anxiety through to a clinically diagnosed social phobia / social anxiety disorder (Rapee & Heimberg, 1997). Trait social anxiety can manifest as anxiety concerning interactions with others (trait social interaction anxiety), and as a fear of social scrutiny whilst performing tasks when under observation from others (trait social phobia). These two constructs can be assessed with self-report measures, and are strongly positively correlated (Mattick & Clarke, 1998). People with elevated social anxiety can be fearful of social situations, due to the possibility of negative evaluation from other people (Morrison & Heimberg, 2013), or positive evaluation from other people (Weeks, Heimberg, Rodebaugh, & Norton, 2008). It has been proposed that social anxiety is related to variability in the sensitivity of affective brain-behavioral systems that mediate personality (Kimbrel, 2008). Indicators of personality, self-esteem, and mental health share a substantial proportion of genetic variation (Silventoinen et al., 2022). The present study examines the strength of the relationships between biologically defined personality constructs, self-esteem, and social anxiety.

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Social anxiety

The DSM-5 (Diagnostic and Statistical Manual of Mental Disorders, fifth edition) describes clinical social phobia (which is also known as social anxiety disorder) as a type of fear and anxiety that is specific to social situations where people feel that they are being observed, noticed, and/or scrutinized. According to the DSM-5, people with clinical social phobia may experience fear that their anxiety symptoms will be noticed by others, and they may fear social rejection. As social interaction will routinely elicit psychological distress, these social interactions may be either avoided altogether, or uncomfortably and unwillingly endured. A diagnosis of this disorder requires that the fear and anxiety experienced by a person is obviously out of proportion to the actual threat present in the social situation. Moreover, the fear and anxiety concerning social situations will continue for at least six months and will elevate psychological distress and manifest an impairment in social functioning (American Psychiatric Association, 2013). When cases of clinical social phobia (social anxiety disorder) occur other anxiety disorders, major depression, substance use disorder, and/or avoidant personality disorder may also be present (National Collaborating Centre for Mental Health, UK, 2013).

Social anxiety is often argued to be separable into two experientially different phenomena that manifest as social

interaction anxiety (fearfulness and avoidance concerning social situations requiring interpersonal communication with other people) and social observation anxiety (fearfulness and avoidance concerning social situations involving observation or scrutiny from other people; Habke, Hewitt, Norton, & Asmundson, 1997; Hughes et al., 2006; Kashdan, 2002). Many studies assess trait social anxiety using the social interaction anxiety scale (SIAS) and social phobia scale (SPS; Mattick & Clarke, 1998). In research articles the SPS scale (which was designed to measure the fear of social scrutiny; Mattick & Clarke, 1998) is sometimes described as an indicator of social observation anxiety (e.g., Gomez et al., 2021; Kramer & Rodriguez, 2018).

Social anxiety and reinforcement sensitivity

It has been suggested that clinical social phobia is related to maladaptive patterns of activity in affective brain-behavioral systems that mediate normal variation in personality (Kimbrel, 2008). The severity of social anxiety symptoms a person experiences are related to the amount of intolerance of uncertainty that a person is experiencing (Boelen & Reijntjes, 2009). Anxiety in general is suggested to be activated when uncertainty and anticipation concerning potential threats are experienced (Grupe & Nitschke, 2013). According to the revised Reinforcement Sensitivity Theory (rRST) a neuropsychological behavioral inhibition system (BIS) produces defensive approach behaviors and anxiety in situations of uncertainty and goal conflict. A neuropsychological fight-flight-freeze system (FFFS) produces fear, avoidance behaviors, and responses to threat. By contrast, a neuropsychological behavioral approach system (BAS) operates as a feedback loop for positive information and facilitates anticipated reward and/or approach-based behaviors in response to appetitive stimuli (Gray & McNaughton, 2000).

From a rRST (Gray & McNaughton, 2000) perspective, the magnitude of any effect upon behavior that any particular stimulus will have will be reliant upon three things: the motivating strength of that particular stimulus, the strength of activity in its mediating neuropsychological system, and the strength of activity in the competing neuropsychological system(s). That is to say, behavioral BAS responses are not just regulated by the BAS and the motivating strength of any reward relevant stimulus that is detected, but also by the strength of inhibition that is facilitated by BIS and FFFS activation. Similarly, whereas the FFFS controls rudimentary defensive and/or avoidance behaviors, the BIS facilitates risk analysis which restrains BAS and FFFS based behavioral responses (Smillie, Pickering, & Jackson, 2006). A rRST based explanation of clinical social phobia suggests that a socially anxious phenotype would tend to experience elevated BIS sensitivity, elevated FFFS sensitivity, and dampened BAS sensitivity (Kimbrel, 2008).

Much of the evidence supporting the theory of clinical social phobia proposed by Kimbrel (2008) comes from self-report studies concerning personality and trait levels of social anxiety. For example, research using the Reinforcement Sensitivity Questionnaire (RSQ; Smederevac, Mitrović, Čolović, & Nikolašević, 2014) has shown, using bivariate correlations, that trait social anxiety was positively correlated with BIS, FFFS-flight, and FFFS-freeze scores, and negatively correlated with BAS scores. Multiple regression showed that BIS and FFFS-freeze scores were prominent predictors of social anxiety (Randjelovic & Zeleskov-Djoric, 2017). This study used a measure that assesses social anxiety as a unitary construct.

Research using the Jackson-5 rRST measure (Jackson, 2005) has shown that a high trait social anxiety group (based on aggregating trait social interaction anxiety and trait social phobia scores) reported higher BIS, FFFS-flight, and FFFS-freeze scores and lower BAS scores than a low trait social anxiety group (Kramer, Rodriguez, & Kertz, 2015). Further research using the Jackson-5 rRST measure (Jackson, 2005) and bivariate correlations has shown that trait social phobia scores (which reflect levels of fear of social scrutiny) were positively correlated with BIS, FFFS-flight and FFFS-freeze scores and were non-significantly negatively correlated with BAS scores. Trait social interaction anxiety scores were positively correlated with BIS, FFFS-flight, and FFFS-freeze scores, and were also negatively correlated with BAS scores (Kramer & Rodriguez, 2018). However, multiple regression analyses showed that whereas FFFS-freeze scores were prominently positively related to social phobia and social interaction anxiety, FFFS-flight scores were prominently positively related to social phobia but were not prominently related to social interaction anxiety within the regression model. Moreover, BIS scores were prominently positively related to social interaction anxiety but not to social phobia.

It is also notable that another study using the Jackson-5 measure showed, using bivariate correlations, that trait social anxiety was related to elevated FFFS-flight, and FFFS-freeze scores, reduced BAS scores, but was unrelated to BIS scores (Fayazi & Hasani, 2017). This pattern of correlations might stem from the fact that the total scores on the Liebowitz Social Anxiety Scale (Liebowitz, 1987) used in this study will have been derived from many items that relate to avoidant behavior and/or fear, as the measure assesses avoidance from interaction and/or performance, as well as anxiety. Therefore, the relationship between scores on the Liebowitz Social Anxiety Scale and the FFFS scale (but not the BIS scale) could make some theoretical sense as the Liebowitz Social Anxiety Scale measures fear and avoidance behaviors rather than social anxiety per se. However, it is also notable that the BIS scale from the Jackson-5 measure (Jackson, 2005) is suggested to have poor construct validity (Corr, 2016). This makes interpreting these results with any certainty extremely difficult.

The use of the Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ; Corr & Cooper, 2016) has shown, using bivariate correlations, that trait social phobia and trait social interaction anxiety (as measured using a short form of the SIAS and SPS) are both correlated positively with BIS scores and total FFFS scores and are correlated negatively with reward interest and goal drive persistence BAS subscale scores. However, SIAS but not SPS scores were correlated negatively with BAS reward reactivity and FFFS defensive fight scores. Multiple regression indicated positive relationships concerning how

BIS and total FFFS scores relate to both SIAS and SPS scores, and a negative relationship between FFFS defensive fight scores and SIAS but not SPS scores. In these regression analyses SIAS but not SPS scores were related to reduced BAS reward interest, and both SIAS and SPS scores were related to reduced BAS goal drive persistence scores (Gomez et al., 2021). It is notable here that in both sets of analyses SIAS and SPS scores were differentially related to the FFFS dimension of defensive fight. That is to say, defensive fight appeared to be reduced in elevated social interaction anxiety, but not elevated social phobia.

As some of the studies described above either used a total social anxiety score, or a total FFFS score, information concerning how trait social interaction anxiety and trait social phobia (which reflects the fear of social scrutiny) relate to the different FFFS components is not plentiful. More research is needed in this area, as in rRST anxiety and fear are considered separate constructs that are dealt with by the BIS and FFFS respectively (Gray & McNaughton, 2000). Anxiety relates to psychobiological responses to perceived future threat, whereas fear relates to psychobiological responses to immediate threat (Hamm, 2019).

An rRST perspective would suggest that anxiety and fear can be distinguished by a factor referred to as defensive direction. For example, anxiety related BIS activity would be elevated when approaching (or withholding the approach to) a potentially threat-related situation. By contrast, fear related FFFS activity would be elevated when there is a need to leave a situation where threat has been experienced, and is therefore related to active avoidance behavior (McNaughton & Corr, 2004). However, social threat cues can also activate a freeze-like response in humans that is similar to animal freeze responses (Roelofs, Hagenaars, & Stins, 2010). If social interaction anxiety and social phobia (which reflects the fear of social scrutiny) are phenomenologically distinct, then the rRST based perspective on social anxiety would benefit from a further test of whether SIAS and SPS scores are differentially predicted by BIS scores, and/or the separate FFFS-fight, FFFS-flight, and FFFS-freeze scores.

Variations in reinforcement sensitivity are not the only affective personality constructs that are important here. It is also important to understand how differential levels of self-esteem relate to a rRST based exposition of trait social anxiety as self-esteem might serve as an anxiety-buffering function whereby a high level of self-esteem would be protective against anxiety, and therefore low levels would be a risk factor for anxiety (Pyszczynski et al., 2004). Baseline levels of self-esteem predict social anxiety symptoms at a two-year follow-up stage, which suggests that low self-esteem might be a vulnerability factor for later increases in social anxiety (van Tuijl, de Jong, Sportel, de Hullu, & Nauta, 2014). Research shows that self-esteem is negatively correlated with trait social interaction anxiety (Lowe & Harris, 2019; Rasmussen & Pidgeon, 2011), and trait social phobia (Lowe & Harris, 2019).

Research using the BIS/BAS scales (Carver & White, 1994) has shown that 20% of the variance in trait social anxiety is explained by the combination of BIS, BAS, and self-esteem (Heidari & Nemattavousi, 2021). However, the BIS/BAS scales were inspired by the original version of RST (Gray, 1982), and although the original RST included a fear system, fear and behavioral inhibition were not separated in the BIS/BAS scales. Thus, there is still a need to test how contemporary measures of rRST that separate BIS and FFFS sensitivity combine with measures of self-esteem to predict trait social anxiety.

The present study

It is important to test if the effects of trait social interaction anxiety and trait social phobia (which reflects the fear of social scrutiny) are separable within a rRST framework, as in rRST anxiety and fear are separate constructs that are related to BIS sensitivity and FFFS sensitivity, respectively (Gray & McNaughton, 2000). That is to say, it is important to extend the literature by testing whether (or not) trait social interaction anxiety corresponds with BIS sensitivity more strongly than with any of the FFFS sensitivities, and whether (or not) trait social phobia (as a fear of social scrutiny) corresponds with any of the FFFS sensitivities more strongly than with BIS sensitivity. As discussed above, at present the literature addressing this question is quite small.

In the present study we test how BIS, BAS, and FFFS scores predict trait social interaction anxiety and trait social phobia using a short form of the SIAS and SPS (Peters, Sunderland, Andrews, Rapee, & Mattick, 2012). We use the rRST-Q (Reuter, Cooper, Smillie, Markett, & Montag, 2015), which is a contemporary measure of rRST that was not administered in the above studies. Based upon a synthesis of the results reported by Gomez et al. (2021) and Kramer and Rodriguez (2018) we predict that zero-order corelations will show that both SIAS and SPS will be positively correlated with BIS, FFFS-flight, and FFFS-freeze scores. Based on Kramer and Rodriguez (2018), who used a unitary revised BAS scale, we also predict that both SIAS and SPS will share a negative relationship with BAS scores. Thus, the zero-order correlations are expected to produce similar effects in both the trait social interaction anxiety analysis, and the trait social phobia analysis. These predictions are congruent with, and provide a test of, the rRST based theory of clinical social phobia proposed by Kimbrel (2008).

Predictions for a multiple regression analysis are difficult to make. If one were to make predictions based on Kramer and Rodriguez (2018) one might expect that both SIAS scores and SPS scores will be positively predicted by FFFS-freeze scores, and SPS scores (but not SIAS scores) will be positively predicted by FFFS-flight scores. By contrast, predictions based on Gomez et al. (2021) would suggest that SIAS scores (but not SPS scores) will be negatively predicted by FFFS-fight scores. Thus, the FFFS subscale scores may predict SIAS and SPS scores differently in a regression model. However, the difficulty in making clear predictions here illustrates the need for another test of how the fear related FFFS variables predict trait social interaction anxiety and trait social phobia.

There are also considerable difficulties that arise when justifying any specific predictions concerning BIS sensitivity. If one were to make predictions based on Kramer and Rodriguez (2018) one would expect that SIAS scores will be positively predicted by BIS scores and expect

that SPS scores will *not* be predicted by BIS scores. By contrast, predictions based on Gomez et al. (2021) would suggest that both SIAS scores and SPS scores will be positively predicted by BIS scores. The finding that BIS sensitivity predicts both social interaction anxiety *and* social phobia is not surprising as the BIS is involved in manifesting anxiety (Gray & McNaughton, 2000), and there is a substantial functional overlap between the manifestation of fear and anxiety, as anxiety involves the inhibitory control of pre-existing fears (McNaughton & Corr, 2004). Moreover, clinical social phobia (social anxiety disorder) can co-occur with specific phobia, panic disorder, and generalised anxiety disorder (GAD; Asher & Aderka, 2018; Koyuncu, İnce, Ertekin, & Tükel, 2019). Clinical social phobia and panic disorder are associated with elevated levels of neuroticism (Bienvenu et al., 2001), and there is a strong genetic correlation between neuroticism and GAD (Hettema, Prescott, & Kendler, 2004). From a rRST perspective, BIS sensitivity contributes to the manifestation of neuroticism (Smillie, 2008). Thus, there are many reasons why BIS sensitivity may predict both trait social interaction anxiety *and* trait social phobia in our analysis. Moreover, Kramer and Rodriguez (2018) used the Jackson-5 measure, and Gomez et al. (2021) used the RST-PQ. Thus, we also note that the BIS scale from the Jackson-5 measure (Jackson, 2005) has been suggested to have poor construct validity (Corr, 2016), whereas the BIS scale from the RST-PQ (Corr & Cooper, 2016) has been suggested to have good construct validity (Corr, 2016). Therefore, we do not make specific predictions concerning BIS sensitivity in the regression analysis but intend to reveal whether the relationship with BIS sensitivity differs in trait social interaction anxiety relative to trait social phobia, or not.

Our final prediction concerns self-esteem. It has been suggested that self-esteem has two correlated sub-components that correspond to perceived self-competence, and self-liking. These two sub-components correspond with separate self-assessment and self-acceptance factors within Rosenberg's (1965) self-esteem scale (Tafarodi & Milne, 2002). As these differential components of self-esteem were not examined in the above studies, we extend the literature by doing so in the present study. Based on Lowe and Harris (2019), we can predict that self-esteem will be negatively correlated with both SIAS and SPS scales. However, we will test whether these relationships are present for the separate self-acceptance and self-assessment components of self-esteem.

There are, however, some sex differences reported in the literature. Females report higher BIS, FFFS-flight and FFFS-freeze scores, and lower FFFS-fight scores than males when using the rRST-Q (Reuter et al., 2015). Moreover, females have been shown to score higher than males on the SPS but not the SIAS (e.g., Habke et al., 1997), whereas studies report no sex differences in self-esteem (Miyamoto & Kikuchi, 2012; Zeigler-Hill, Campe, & Myers, 2009). Females are also more likely than males to develop clinical social phobia (social anxiety disorder), and to experience greater severity of symptoms (Asher & Aderka, 2018). Due to these sex differences, we analyse the data separately for females and males.

METHOD

Participants & sampling procedure

Ethical approval was obtained from the Sheffield Hallam University Department of Psychology, Sociology, and Politics. In line with the declaration of Helsinki all participants gave informed consent to participate in a study about personality before they began the survey. All participants had the right to withdraw. The survey was delivered using the Qualtrics platform[1] and was predominantly distributed via online social media platforms (supplemented by some personal email invites). The survey was made available on the social media platforms until no more responses were obtained for a three-week period. Sample size was thus determined by this procedure, as opposed to a priori power analysis. We note for future reference that the data were collected between April 22nd and May 7th in the year 2020, which was during the COVID-19 pandemic.

The Qualtrics survey was designed so that failure to fully complete one of the questionnaires prompted an instruction message requesting that the respondent completed the missed question(s). This message needed to be either accepted and the missing question(s) completed, or the message needed to be declined by the respondent before they could move on to the next page of the survey. Therefore, we defined invalid responses as those submitted by participants who failed to fully complete more than one of the questionnaires. Thus, those participants who failed to fully complete more than one of the questionnaires either declined the message requesting that they complete a missed question on two questionnaires, or they prematurely aborted the survey.

There were 515 respondents initially, but after deleting the invalid responses the final sample of 405 participants were aged between 18 and 75 (mean age = 30.6; *SD* = 12.3) and were 86% female. Less than one third (32.4%) of the final sample identified as students. 2.3% of the final sample were students from the host institution, and were those participants invited to participate by email, and given course credit for participation. The data for the 405 respondents were entered into the confirmatory factor analysis (CFA), but the data was separated by sex for the correlation/regression analyses. Due to some participants failing to fully complete one measure, *N* will vary from 350-352 for the females and will vary from 50-52 for the males in these analyses.

Of the respondents removed as invalid responses 18 identified as male, 79 identified as female, 1 identified as other, and 2 preferred not to say. Notably, the initial sample still reported a mean age of 30.8 and comprised 84% female respondents prior to the removal of invalid responses. Thus, removal of the invalid responses did not alter the mean age or ratio of females to males in the final sample (relative to the initial sample described above) to any great extent. Notably, 95 of the 110 respondents removed as invalid responses failed to fully complete the SIAS/SPS. Specifically, the mean age of those who failed to fully complete the SIAS/SPS was 31.7 (*SD* = 16.2; 76% female; 34% students). The raw data that we base our analysis on was collected for an unpublished study that was supervised by the first author

[1] Qualtrics provides an online platform that allows the creation of, and administration of, self-report surveys.

to provide the data for a postgraduate qualification completed by the second author. Thus, participants also completed some exploratory measures that were not intended for dissemination and are thus not described below.

Self-report measures

Personality

BIS, BAS, and FFFS were assessed using Reuter and Montag's 31 item rRST-Q (Reuter et al., 2015). The rRST-Q requires participants to give self-ratings by responding to statements that relate to personality. Participants respond using a four-point Likert scale ranging from "strongly disagree" to "strongly agree." This measure includes a unitary BAS scale with 8 items (for example, I'm a spontaneous person; I am an outgoing person). In the present study Cronbach's Alpha was 0.73. A unitary BIS scale contains 11 items (for example, I find it hard to bear uncertainty; I often feel torn between two options). In the present study Cronbach's Alpha was 0.80. The rRST-Q includes a 5 item FFFS-fight subscale (for example, attack is the best form of defence). In the present study Cronbach's Alpha was 0.67. A FFFS-flight subscale includes 3 items (for example, when faced with danger, I tend to flee). In the present study Cronbach's Alpha was 0.64. A FFFS-freeze subscale includes 4 items (for example, I often feel paralyzed when in a dangerous situation). In the present study Cronbach's Alpha was 0.61. One BIS item, two fight items and one freeze item are reverse scored. Higher scores indicate higher levels of each reinforcement sensitivity. An individual with a general pattern of elevated FFFS sensitivity would thus report high FFFS-freeze scores, high FFFS-flight scores, but low FFFS-fight scores.

Social anxiety

Social interaction anxiety and social phobia were assessed using the SIAS-6 and the SPS-6 (Peters et al., 2012). This measure is a short form of the original SIAS and SPS (Mattick & Clarke, 1998). Correlations between the original SIAS/SPS scales and measures of fear of negative evaluation, general anxiety, stress, and depression do not significantly differ from the correlations between SIAS-6/SPS-6 and measures of fear of negative evaluation, general anxiety, stress, and depression (Peters et al., 2012). Short forms of the SIAS/SPS are as reliable as the full-length version (Le Blanc et al., 2014; Sunderland et al., 2020). In the SIAS-6 / SPS-6 measures participants are required to indicate the degree to which they feel the statements are characteristic or true of them. Participants respond using a 5-point Likert scale ranging from "not at all characteristic or true of me" to "extremely characteristic or true of me." The SIAS-6 scale contains six items (for example, I have difficulty making eye contact with others; I have difficulty talking with other people). In the present study Cronbach's Alpha was 0.83. The SPS-6 scale contains six items (for example, I would get tense if I had to sit facing other people on a bus or train; I worry about shaking or trembling when I'm watched by other people). In the present study Cronbach's Alpha was 0.90. None of the items are reverse scored. Higher scores indicate higher levels of social interaction anxiety or social phobia (in effect, the fear of social scrutiny).

Self-esteem

Self-esteem was assessed using the 10 item Rosenberg self-esteem scale (Rosenberg, 1965). We used the self-acceptance and self-assessment subscales proposed by Tafarodi and Milne (2002). In this measure participants are required to read a list of statements dealing with general feelings about themselves and are asked to indicate how strongly they agree or disagree with each statement. Participants respond using a 4-point Likert scale ranging from "strongly agree" to "strongly disagree". The self-acceptance subscale contains five items (for example, on the whole, I am satisfied with myself), as does the self-assessment subscale (for example, I am able to do things as well as most other people). Five items are reverse scored: three of those appear in the self-acceptance subscale, therefore two appear in the self-assessment subscale. Higher scores indicate higher levels of self-acceptance and/or self-assessment. In the present study Cronbach's Alpha was 0.88 for the self-acceptance subscale, and 0.84 for the self-assessment subscale.

Data analyses

In the first part of our analysis, we conducted a CFA on the structure of the SIAS-6 and SPS-6 measure in order to justify using the SIAS and SPS subscales as separate constructs. For the CFA we used the whole sample of participants.

In the second part of our analysis, we conducted bivariate correlations between the rRST measures, the self-esteem measures, and the separate SIAS-6 and SPS-6 measures (this was thus based on a 2-factor structure of the SIAS/SPS scale). We considered restricting the analysis that tests our predictions to the sample of females as the sample of males was unexpectedly quite small. However, we opted to present an exploratory analysis of the small sample of males in order to create testable hypotheses for future work.

In the third part of our analysis multiple regression was used (separately for the females and males) to determine how much variance in trait social interaction anxiety and trait social phobia is captured by reinforcement sensitivity, and whether self-esteem adds to the predictive power of the models. This analysis also allowed us to test which of the individual predictors are particularly prominent predictors of trait social interaction anxiety and trait social phobia in order to compare to the results reported in the previous studies discussed above.

RESULTS

Descriptive statistics

Table 1 shows the mean scores, standard deviations (SD) and 95% confidence intervals (95% CI) for the rRST, social interaction anxiety, social phobia, and self-esteem measures. Mann-Whitney tests were conducted to reveal any statistically significant sex differences for each of the measures. Table 1 shows that female participants reported significantly higher BIS, FFFS-flight, FFFS-freeze, and SPS scores relative to male participants. By contrast, male participants reported significantly higher BAS and FFFS-

Table 1: Descriptive statistics for the rRST, self-esteem, and SIAS/SPS measures, and the results of the non-parametric Mann-Whitney tests on the sex differences for each of the measures

	Females			Males			
	Mean	SD	95% CI	Mean	SD	95% CI	**U**
BIS	30.5	4.7	30.0 - 30.1	27.2	5.0	25.8 - 28.6	5867.0***
BAS	22.0	3.2	21.7 - 22.4	23.3	3.2	22.4 - 24.2	7439.0*
Fight	13.8	2.4	13.5 - 14.0	15.1	2.8	14.3 - 15.9	7047.5**
Flight	7.6	1.7	7.4 - 7.8	6.7	2.1	6.1 - 7.2	6831.5***
Freeze	10.1	1.9	9.9 - 10.3	9.5	1.7	9.0 - 10.0	7597.0*
SIAS-6	5.6	4.7	5.1 - 6.1	4.7	4.6	3.4 - 5.9	8042.0
SPS-6	6.4	6.1	5.8 - 7.0	4.3	5.1	2.9 - 5.7	7364.0*
Self-acceptance	11.6	1.5	11.4 - 11.7	11.5	1.8	11.0 - 12.0	8930.5
Self-assessment	11.9	1.3	11.7 - 12.0	11.6	1.8	11.1 - 12.1	8206.5

Note: $p \leq 0.05$*, $p \leq 0.01$**, $p \leq 0.001$***

fight scores relative to female participants. There were no significant sex differences in SIAS, self-acceptance, or self-assessment scores.

Confirmatory factor analysis of the SIAS-6 / SPS-6

CFA was used to examine the structure of the SIAS-6 and SPS-6. The first analysis examined a two-factor model, whereas the second analysis examined a one-factor model. The analysis was conducted using IBM SPSS AMOS version 26. There was some deviation from normality in the data, thus the analysis was based on an asympto tic distribution free (ADF) estimation. Model fit was assessed in each CFA by use of the comparative fit index (CFI; Bentler, 1990), Tucker–Lewis index (TLI; Tucker & Lewis, 1973), and root mean square error of approximation (RMSEA; Browne & Cudeck, 1993). Cut-off scores can be used to determine whether a good degree of model fit has been achieved in CFA. It has been suggested (Hu & Bentler, 1999; Yu, 2002) that CFI and TLI values of > 0.95 and RMSEA values of < 0.06 are acceptable.

Figure 1 illustrates the structure of the two-factor model, and the standardised factor loadings for each of the items that load onto the SIAS or the SPS. For the SIAS the loadings ranged from 0.40 – 0.85. For the SPS the loadings ranged from 0.73 – 0.85. All factor loadings were statistically significant (all *p*s < 0.001). The fit indices produced by the CFA on the 2-factor model showed the following degree of model fit; RMSEA = .046; TLI = 0.835; CFI = 0.867. Thus, the RMSEA index suggested good model fit, but the TLI and CFI indexes suggested that model fit was slightly below the optimal threshold.

Figure 2 illustrates the structure of a one-factor model, and the standardised factor loadings for each of the items that load onto the model. The loadings ranged from 0.42 – 0.84. All factor loadings were statistically significant (all *p*s < 0.001). The fit indices produced by the CFA on the one-factor model showed the following degree of model fit; RMSEA = .064; TLI = 0.672; CFI = 0.732. Thus, the RMSEA index suggested that model fit was on the threshold of acceptability, but the TLI and CFI indexes suggested a poorer level of model fit than those for the two-factor model.

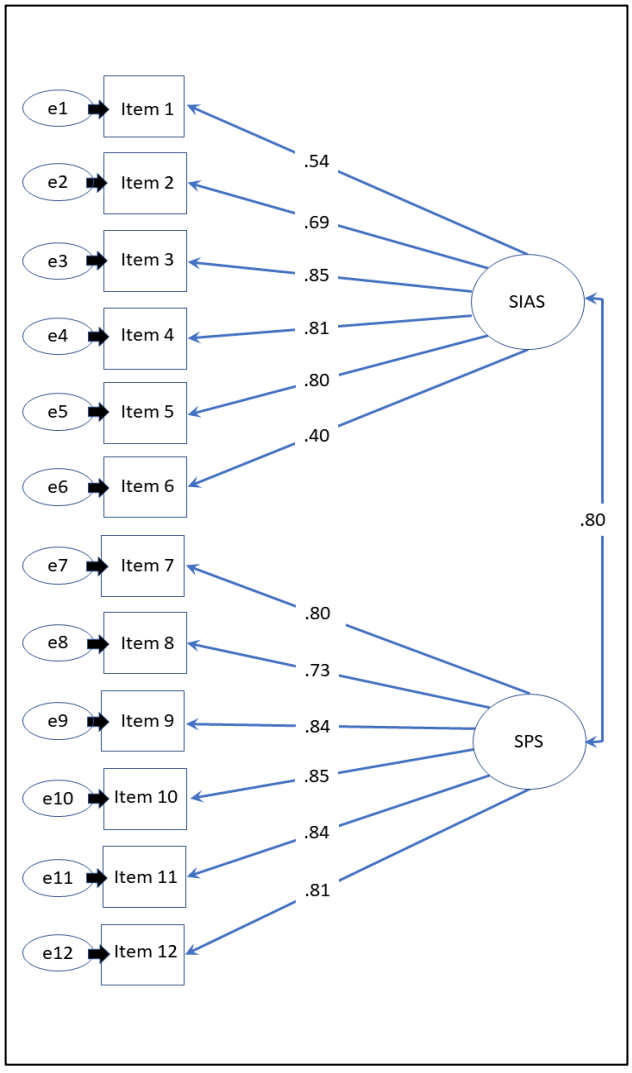

Figure 1. The structure of the two-factor model of the SIAS-6 / SPS-6 measure, and the standardised factor loadings for each of the items that load onto the SIAS or the SPS.

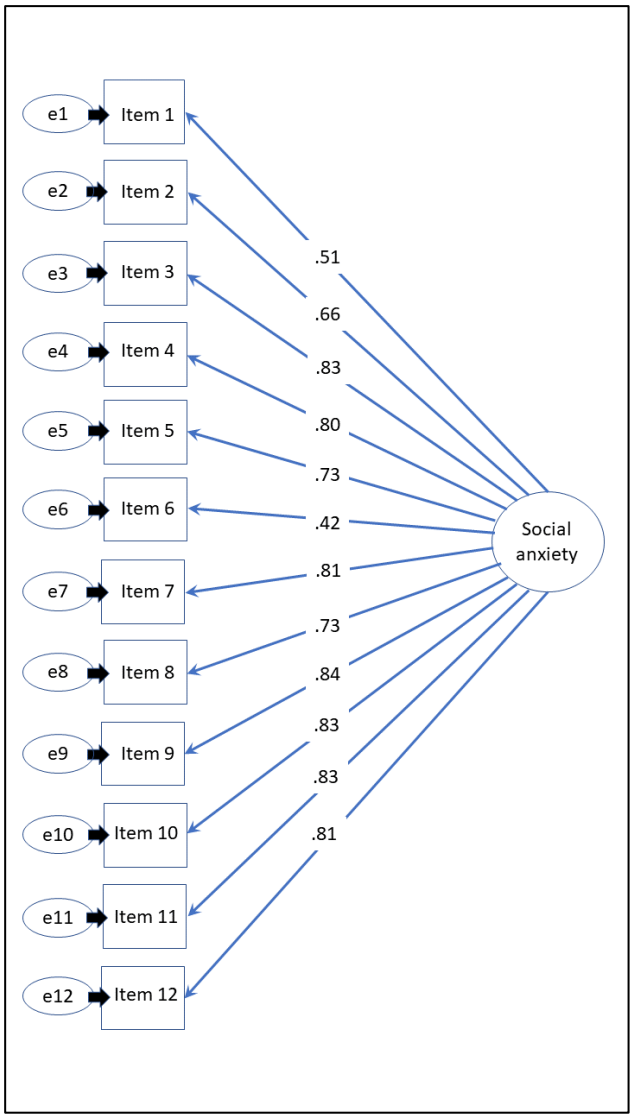

Figure 2. The structure of the one-factor model of the SIAS-6 / SPS-6 measure, and the standardised factor loadings for each of the items that load onto the model.

Predicting the SIAS-6 and SPS-6

Bivariate correlations

Data were analysed using IBM SPSS version 26. We used Pearson's correlations to analyse the relationship between SIAS, SPS, self-esteem, and the rRST variables in the separate groups of 352 female participants and 52 male participants. Initially, the skew and kurtosis values for the data obtained from the self-report measures were examined. For female participants skew values ranged from +/- 0.01-0.94, and kurtosis values ranged from +/- 0.09-0.55. For male participants skew values ranged from +/- 0.03-1.37, and kurtosis values ranged from +/- 0.05-5.90. It has been suggested that the acceptable cut-off points for skew are values of -2 to + 2, and values of -7 to +7 for kurtosis (Hair, Black, Babin, & Anderson, 2010). All of the skew and kurtosis values for the self-report measures were within these thresholds for females and males. The only values that were anywhere near one of these cut-off points were the kurtosis value (of 5.90) for the self-assessment data obtained from the male participants, and the skew value (of 1.37) for the SIAS data obtained from the male participants. However, Pearson's r is not adversely affected when the data are not normally distributed (Havlicek & Peterson, 1976; Zeller & Levine, 1974), unless the sample is especially small (Bishara & Hittner, 2012).

Table 2 shows the bivariate correlations between SIAS scores, SPS scores, and the rRST and self-esteem measures for female participants. SIAS scores were positively correlated with SPS scores. Both SIAS scores and SPS scores were positively correlated with BIS scores, FFFS-flight scores, and FFFS-freeze scores, but were negatively correlated with BAS scores, and FFFS-fight scores. Table 2 also shows that for females both SIAS scores and SPS scores were negatively correlated with self-acceptance scores but were uncorrelated with self-assessment scores.

Table 3 shows the bivariate correlations between SIAS scores, SPS scores, and the rRST and self-esteem measures for male participants. SIAS scores were positively correlated with SPS scores. Both SIAS scores and SPS scores were positively correlated with BIS scores, FFFS-flight scores, and FFFS-freeze scores (at a less robust level of significance), but were negatively correlated with BAS scores, and FFFS-fight scores. Table 3 also shows that for males both SIAS scores and SPS scores were correlated with self-acceptance scores and were also weakly and non-significantly correlated with self-assessment scores.

In summary of the correlational analysis, trait social interaction anxiety was strongly correlated with trait social phobia in both females and males. Both trait social interaction anxiety and trait social phobia were positively correlated with BIS, FFFS-flight, and FFFS-freeze scores in both sexes, and negatively correlated with BAS and FFFS-fight scores in both sexes. Self-acceptance was negatively correlated with trait social interaction anxiety and trait social phobia in both sexes. Whereas self-assessment scores were uncorrelated with trait social interaction anxiety scores and trait social phobia scores in females, they were weakly negatively correlated with both trait social interaction anxiety scores and trait social phobia scores in males. These effects appeared at a trend level of statistical significance, possibly due to the smaller size of the male sub-sample. We advise some caution here, as to reject these correlations might result in a type 2 error.

Multiple correlations

The next part of the analysis was based on four hierarchical multiple regression analyses conducted using IBM SPSS version 26. As the male sub-sample of 52 was small we considered restricting the following multiple regression analysis to the 352 female participants. However, we decided to proceed and run the analysis on the male sub-sample and present the data as an exploratory analysis. Table 4 illustrates the multiple regression of BIS, BAS, FFFS-fight, FFFS-flight, and FFFS-freeze scores onto SIAS and SPS scores. The rRST variables were included as predictors in model 1, and the two self-esteem variables were included as additional predictors in model 2. Table 4 presents the analysis separately for female participants and male participants.

Table 2: The intercorrelations between the SIAS, SPS, rRST, and self-esteem measures for female participants

		1	2	3	4	5	6	7	8
1	SIAS	—							
2	SPS	0.69***	—						
3	Self-acceptance	-0.24***	-0.28***	—					
4	Self-assessment	-0.02	0.01	0.25***	—				
5	BIS	0.53***	0.50***	-0.40***	-0.002	—			
6	BAS	-0.23***	-0.15**	0.01	-0.14*	-0.14*	—		
7	Fight	-0.36***	-0.20***	0.11*	-0.11*	-0.38***	0.37***	—	
8	Flight	0.43***	0.31***	-0.23***	0.08	0.46***	-0.32***	-0.56***	—
9	Freeze	0.35***	0.31***	-0.20***	0.05	0.48***	-0.26***	-0.33***	0.55***

Note: * p ≤ .055, ** p ≤ .010, *** p ≤ .001

Table 3: The intercorrelations between the SIAS, SPS, rRST, and self-esteem measures for male participants.

		1	2	3	4	5	6	7	8
1	SIAS	—							
2	SPS	0.66***	—						
3	Self-acceptance	-0.35*	-0.30*	—					
4	Self-assessment	-0.23	-0.26	0.34*	—				
5	BIS	0.51***	0.49***	-0.33*	-0.05	—			
6	BAS	-0.38**	-0.27*	0.002	-0.10	-0.48***	—		
7	Fight	-0.65***	-0.44***	0.35*	-0.19	-0.60***	0.45***	—	
8	Flight	0.55***	0.44***	-0.28*	0.11	0.70***	-0.57***	-0.65***	—
9	Freeze	0.35*	0.22	-0.13	0.11	0.47***	-0.28*	-0.34*	0.47***

Note: * p ≤ .055, ** p ≤ .010, *** p ≤ .001

Multicollinearity was low in the two analyses conducted on the female data: the virtual inflation factor (VIF) ranged from 1.1 – 2.0. When using multiple regression, the DV and predictor variables do not need to be normally distributed, but the residuals should ideally be normally distributed (Williams, Grajales, & Kurkiewicz, 2013). Histograms and Q-Q plots confirmed that the residuals were approximately normally distributed in each of the two analyses conducted on the female data. The residual plots (residuals versus fitted) for the overall models showed that for female participants the SIAS and SPS data were neither perfectly homoscedastic nor definable as heteroscedastic. Further examination of the residual plots (residuals versus each individual predictor) for each of the rRST and self-esteem comparisons showed that there were no obvious violations of homoscedasticity in the female data.

Multicollinearity was low in the two exploratory analyses conducted on the male data: the VIF ranged from 1.3 – 2.9. Histograms and Q-Q plots confirmed that the residuals were approximately normally distributed in the SIAS analysis, but there was some minor deviation form normality in the residuals for the SPS analysis. Moreover, residual plots (residuals versus fitted) for the SIAS data showed some evidence of heteroscedasticity in the overall model. Further examination of residual plots (residuals versus each individual predictor) for each of the rRST and self-esteem variables in the SIAS analysis showed some evidence of heteroscedasticity in the FFFS-flight comparison. Examination of the residual plots for the male SPS data (residuals versus fitted / residuals versus each individual predictor) suggested that some borderline violations of homoscedasticity might be present, but this was not conclusive. Thus, we suggest some caution is needed when interpreting the exploratory analysis of the smaller sample of male data.

We begin by discussing the predictive effects of the individual predictor variables. Table 4 shows that in the analysis of SIAS scores for female participants, BIS and the FFFS-flight scale were prominent positive predictors of social interaction anxiety, whereas the predictive effect of BAS was less prominent. The effects of the self-esteem variables in model 2 were not particularly prominent. In the analysis of SPS scores for female participants BIS was a prominent positive predictor of social phobia. Again, the effects of the self-esteem variables in model 2 were not particularly prominent.

Table 4 shows that in the analysis of SIAS scores for male participants, the FFFS-fight scale was a prominent negative predictor of social interaction anxiety. The Beta weight for BIS was notably weak in this analysis. Moreover, the effects of the self-esteem variables in model 2 were not particularly prominent. In the analysis of SPS scores for male participants BIS was a positive predictor of social phobia at a trend level of statistical significance. The Beta value suggests that this might be significant effect if the sample of males was larger. It is also possible that the FFFS-fight scale would predict social phobia in a larger sample. Thus, rejecting these correlations might result in a type 2 error. Again, the effects of the self-esteem variables in model 2 were not particularly prominent.

We now discuss the multiple correlations, and the model

Table 4: The hierarchical multiple regression of the rRST variables (model 1) and self-esteem variables (model 2) onto SIAS and SPS scores for the separate female and male groups of participants.

	SIAS (females)			SIAS (males)			SPS (females)			SPS (males)		
MODEL 1	Beta	SE	*p*	Beta	SE	*p*	Beta	SE	*p*	Beta	SE	*p*
BIS	0.41	0.05	<0.001	0.03	0.15	0.858	0.46	0.07	<0.001	0.33	0.20	0.096
BAS	-0.09	0.07	0.058	-0.10	0.19	0.454	-0.07	0.10	0.146	0.02	0.25	0.900
FFFS-Fight	-0.08	0.11	0.151	-0.49	0.24	0.002	0.06	0.15	0.271	-0.20	0.31	0.251
FFFS-Flight	0.15	0.17	0.013	0.14	0.38	0.427	0.09	0.23	0.153	0.12	0.51	0.568
FFFS-Freeze	0.01	0.14	0.842	0.08	0.35	0.548	0.04	0.19	0.485	-0.06	0.46	0.680
MODEL 2												
BIS	0.40	0.06	<0.001	0.03	0.15	0.873	0.42	0.08	<0.001	0.27	0.20	0.169
BAS	-0.10	0.07	0.053	-0.14	0.19	0.297	-0.08	0.10	0.126	-0.02	0.26	0.912
FFFS-Fight	-0.08	0.11	0.140	-0.39	0.25	0.014	0.06	0.15	0.311	-0.09	0.33	0.609
FFFS-Flight	0.15	0.17	0.016	0.21	0.39	0.256	0.08	0.23	0.213	0.21	0.52	0.336
FFFS-Freeze	0.01	0.14	0.841	0.11	0.34	0.394	0.04	0.19	0.484	-0.03	0.46	0.855
Self-acceptance	-0.03	0.15	0.520	-0.07	0.33	0.585	-0.09	0.21	0.076	-0.04	0.44	0.814
Self-assessment	-0.01	0.17	0.899	-0.20	0.32	0.118	0.02	0.23	0.645	-0.24	0.42	0.107

summaries that are presented in Table 5. In the analysis of the SIAS, restricted to the female participants, both model 1 and model 2 were significant. The combination of reinforcement sensitivity and self-esteem explained approximately one third of the variance in trait social interaction anxiety scores, although the addition of the self-esteem variables did not contribute very much to the second model. Similarly, in the analysis of the SPS, restricted to the female participants, both model 1 and model 2 were significant. The combination of reinforcement sensitivity and self-esteem explained approximately one quarter of the variance in trait social phobia scores, although the addition of the self-esteem variables did not contribute very much to the second model.

Table 5 also shows that in the analysis of the SIAS, restricted to the male participants, both model 1 and model 2 were significant. The combination of reinforcement sensitivity and self-esteem explained just under half of the variance in trait social interaction anxiety scores, although the addition of the self-esteem variables did not contribute very much to the second model. In the analysis of the SPS, restricted to the male participants, both model 1 and model 2 were significant. The combination of reinforcement sensitivity and self-esteem explained just under one quarter of the variance in trait social phobia scores, although the addition of the self-esteem variables did not contribute very much to the second model.

DISCUSSION

Both trait social interaction anxiety and trait social phobia were strongly positively correlated with BIS and FFFS-flight scores regardless of sex, and were negatively correlated with BAS and FFFS-fight scores regardless of sex. These results are presented in Tables 2 and 3 and are broadly in line with the predictions of the theory of clinical social phobia proposed by Kimbrel (2008). Trait social interaction anxiety was notably strongly correlated with trait social

Table 5. The multiple correlations and model summaries for each of the four hierarchical multiple regression analyses

	SIAS (females)				SPS (females)			
	R	adjusted R^2			R	adjusted R^2		
Model 1	0.580	0.327	$F(5,343) = 34.8$	$p<0.001$	0.520	0.259	$F(5,343) = 25.4$	$P < 0.001$
Model 2	0.581	0.324	$F(7,341) = 24.8$	$p<0.001$	0.526	0.262	$F(7,341) = 18.6$	$P < 0.001$
Model change	R^2 change = 0.001		F change = 0.3	$p=0.774$	R^2 change = 0.007		F change = 1.6	$P = 0.206$
	SIAS (males)				SPS (males)			
	R	adjusted R^2			R	adjusted R^2		
Model 1	0.698	0.429	$F(5,44) = 8.4$	$p<0.001$	0.532	0.202	$F(5,44) = 3.4$	$P = 0.010$
Model 2	0.728	0.452	$F(7,42) = 6.8$	$p<0.001$	0.580	0.226	$F(7,42) = 3.0$	$P = 0.011$
Model change	R^2 change = 0.043		F change = 1.9	$p=0.162$	R^2 change = 0.053		F change = 1.7	$P = 0.198$

phobia regardless of sex. The results of the BIS comparisons in the present study resonate with previous studies that have shown a positive correlation between BIS and trait social interaction anxiety (Kramer & Rodriguez, 2018), BIS and trait social anxiety (Randjelovic & Zeleskov-Djoric, 2017), and both BIS and trait social phobia *and* BIS and trait social interaction anxiety (Gomez et al., 2021).

In the present study, regardless of sex, trait social interaction anxiety and trait social phobia were negatively correlated with FFFS-fight scores and were positively correlated with FFFS-flight scores. Thus, these results resonate with previous research that used a unitary measure of social anxiety (Fayazi & Hasani, 2017). It is also noteworthy that trait social interaction anxiety (but not trait social phobia) has been shown to be correlated negatively with FFFS defensive fight scores measured using the RST-PQ (Gomez et al., 2021). The correlations in the present study also resonate with previous studies reporting that elevated scores on a unitary measure of trait social anxiety relate to higher FFFS-flight scores (Kramer et al., 2015; Randjelovic & Zeleskov-Djoric, 2017). In the present study, trait social anxiety was also negatively correlated with a unitary measure of BAS sensitivity. This result resonates with previous studies (Fayazi & Hasani, 2017; Kramer et al., 2015; Randjelovic & Zeleskov-Djoric, 2017). Similarly, both trait social phobia and trait social interaction anxiety have been reported to correlate negatively with BAS reward interest and BAS goal drive persistence subscale scores (Gomez et al., 2021).

Concerning the self-esteem variables, Tables 2 and 3 show that self-acceptance was negatively correlated with trait social interaction anxiety and trait social phobia in females and males. The effect of the self-acceptance component was consistent across social interaction anxiety and social phobia regardless of the sex of the participant. This resonates with the results of Lowe and Harris (2019) who used a global score of self-esteem. It has been proposed that self-esteem might serve as an anxiety-buffering function whereby a high level of self-esteem would be protective against anxiety, and therefore low levels would be a risk factor for anxiety (Pyszczynski et al., 2004). Based on the present study, it seems possible that the effects of self-acceptance may be more important than the effects of self-assessment in females (although there were statistical trends towards an effect of self-assessment upon social interaction anxiety and social phobia in males). However, in saying this we note that the effects of the self-esteem variables were not prominent in the multiple regression analyses.

Previous research using multiple regression has produced inconsistent results concerning which reinforcement sensitivity construct is the most prominent predictor of measures of trait social anxiety. For example, BIS scores and FFFS-freeze subscale scores have been reported to be the most prominent predictors of trait social anxiety (Randjelovic & Zeleskov-Djoric, 2017), and BIS, FFFS-freeze, and BAS scores have been reported to be the most prominent predictors of trait social interaction anxiety, with FFFS-freeze and FFFS-flight scores being the most prominent predictors of trait social phobia (Kramer & Rodriguez, 2018). BIS scores have also been reported to be the most prominent predictor of trait social phobia *and* trait social interaction anxiety (Gomez et al., 2021). By contrast logistic regression has also shown that FFFS-freeze and BAS scores might be the most prominent predictors of trait social anxiety group classification (Kramer et al., 2015).

In the present study multiple regression showed that for female participants BIS was a prominent positive predictor of social interaction anxiety and social phobia. BIS scores have also been reported to be the most prominent predictor of trait social phobia *and* trait social interaction anxiety when using a sample containing 73.8% females (Gomez et al., 2021). This is not surprising as from a rRST perspective, as BIS sensitivity contributes to the manifestation of neuroticism (Smillie, 2008), and many affective disorders that share comorbidity (Asher & Aderka, 2018; Koyuncu, 2019), are also associated with elevated levels of neuroticism (Bienvenu et al., 2001; Hettema, Prescott, et al., 2004). Moreover, the BIS is involved in cautious risk assessment and defensive approach behaviors (Gray & McNaughton, 2000), and is thus likely to be implicated in scanning the environment for threat in both social interaction anxiety and social phobia.

For female participants the regression analysis showed that the FFFS-flight subscale was a prominent positive predictor of social interaction anxiety but not social phobia. By contrast, FFFS-flight scores have also been shown to be a prominent predictor of trait social phobia (Kramer & Rodriguez, 2018). In the present study, females reported higher FFFS-flight scores than males, which is consistent with the data reported by Reuter et al. (2015). However, it has been suggested that female stress responses to social threats can manifest as a *tend and befriend* response that involves empathy and prosocial behavior, as opposed to a fight or flight response (Taylor et al., 2000). By contrast, the regression analysis in the present study suggests that the flight component of the FFFS may be particularly reactive in (at least a proportion of) the females recruited in the present study, when they are in situations requiring social interaction and a possible risk has been detected by the BIS. Based on the present study, one can suggest that the flight response may be increased in social interaction anxiety in some females, thus the *tend and befriend* response might be reduced. This suggestion could be tested in future studies.

For male participants the regression analysis showed that the FFFS-fight subscale was a prominent negative predictor of social interaction anxiety but not of social phobia. It is notable here that research using a sample containing 73.8% females has shown that defensive fight scores are reduced in elevated trait social interaction anxiety, *but not* elevated trait social phobia (Gomez et al., 2021). By contrast, this effect was not found in the female subsample in the present study, but it was found in the male subsample. In the present study males reported higher FFFS-fight scores than females which is consistent with the data reported by Reuter et al. (2015). In the rRST-Q (Reuter et al., 2015) the FFFS-fight subscale does not assess the likelihood of people behaving aggressively, it assesses the ability of people to defend themselves against criticism, to use defensive attack behaviors, to stand up for themselves, and to respond with quick wittedness. These processes are likely important functions in social interaction. Thus, if these abilities are reduced in some males (or some females), it is not surprising that anxiety is manifested during social interactions. The analysis of the effect of FFFS-fight on social interaction anxiety in the present study suggests there is a tendency for FFFS-

fight responses to be reduced as levels of social interaction anxiety increase, it does not suggest that all males with elevated social interaction anxiety are likely to report low FFFS-fight sensitivity. Moreover, it is notable that trait general anxiety is positively correlated with trait anger (du Rocher & Pickering, 2022; Mook, Van der Ploeg, & Kleijn, 1990). Clinical research suggests that there are four different anger profiles in clinical social phobia (social anxiety disorder): including a low anger with high control profile; a moderate anger with low control profile; a low anger with moderate control profile; and a high anger with high suppression profile (Versella, et al., 2016). Future research should test how these anger profiles affect the relationship between FFFS-fight and trait social interaction anxiety.

In the present study we tested if the effects of social interaction anxiety and social phobia (which reflects the fear of social scrutiny) are separable within a rRST framework. We did this as in rRST anxiety and fear are considered separate constructs. For example, in rRST anxiety would be elevated when approaching (or withholding the approach to) a potentially threatening social situation. By contrast, fear would be elevated when there is a need to actively avoid a social situation where threat has been perceived (Gray & McNaughton, 2000; McNaughton & Corr, 2004). Synthesising across the present analysis and the analysis of Gomez et al. (2021) it seems as if self-reported BIS sensitivity may not clearly separate trait social interaction anxiety from trait social phobia. However, in the present study there were some subtle differences in how FFFS sensitivity related to the social anxiety constructs. For female participants the FFFS-flight subscale was related to social interaction anxiety but not to social phobia (although FFFS-flight can be a prominent predictor of social phobia; Kramer & Rodriguez, 2018), and for male participants the FFFS-fight subscale was related to social interaction anxiety but not social phobia.

Table 5 suggests that in the present study the combination of the rRST variables and self-esteem explained substantially more of the variance in trait social interaction anxiety (and slightly more of the variance in trait social phobia) than that reported by Heidari and Nemattavousi (2021). Heidari and Nemattavousi showed that 20% of the variance in trait social anxiety is explained by the combination of BIS, BAS, and self-esteem using the BIS/BAS scales (Carver & White, 1994). The BIS/BAS scales did not include any measures of fear related phenomena that were separated from the BIS measure. It is therefore important to use contemporary measures of rRST when investigating the role of reinforcement sensitivity in psychopathology.

The rRST based perspective on social anxiety has been proposed to have some clinical implications. For example, therapy based on exposure, systematic desensitisation and/or flooding may facilitate a reduction in social anxiety due to the habituation of social stimuli processed by BIS and FFFS circuitry. Moreover, selective serotonin reuptake inhibitors (SSRIs) and benzodiazepines may directly reduce excitability of the neural circuitry that mediates BIS and FFFS sensitivity in anxiety provoking social situations (Kimbrel, 2008). Future experimental intervention studies might probe this theory by using the rRST-Q (Reuter et al., 2015) as a pre-treatment and post treatment measure, alongside measures of social anxiety. This procedure may indicate that the above psychological and psycho-pharmacological treatments produce a reduction in self-reported BIS, FFFS-fight, FFFS-flight, and/or FFFS-freeze sensitivity, as well as a reduction in self-reported social anxiety symptoms. Alternatively, this procedure may indicate that when these treatments are administered, social anxiety is reduced with self-reported BIS, FFFS-fight, FFFS-flight, and/or FFFS-freeze sensitivity remaining relatively stable. This might help us to further understand if social anxiety levels, and reinforcement sensitivity levels, can function independently of one another. High pre-treatment BIS sensitivity (measured using the BIS/BAS scales; Carver & White, 1994) compared to low pre-treatment BIS sensitivity has predicted higher post-treatment social anxiety in a small sample of participants' receiving cognitive behavioral therapy for clinical social phobia (social anxiety disorder; Ly, 2011). As Ly used a measure of BIS that was inspired by an earlier version of RST (Gray, 1982), their study would be a good candidate for a larger replication, this time using a contemporary measure of rRST such as the rRST-Q (Reuter et al., 2015). In short, participants with clinical social phobia and high dispositional BIS sensitivity might require a lengthier intervention, relative to those with clinical social phobia and low dispositional BIS sensitivity.

Analytical caveats and limitations

Despite the usefulness of our data, we close by discussing some limitations. The first limitation concerns the fact that the 352 female respondents outnumbered the 52 male respondents in our analyses. We considered restricting the analyses to the female subsample as the male subsample was unexpectedly small. However, we have presented an exploratory analysis of the small sample of males in order to create testable hypotheses for future work. Our multiple regression analyses included 5 predictors in Model 1, and a total of 7 predictors in Model 2. Debates about the minimum sample size needed for multiple regression are abundant. For example, it has been proposed that N should exceed the number of predictor variables included by a minimum of 50 (Harris, 1985). Alternatively, it has been proposed that $N > 104 + m$ (where m is the number of predictors) would suffice for testing the individual predictor regressions (if a medium-sized relationship exists; Green, 1991). Both of these perspectives suggest that the female sample was large enough, but the male sample size was suboptimal. Power analyses based upon null hypothesis testing and statistical significance have often been used prior to collecting data (e.g., Cohen & Cohen, 1975), although this method is now considered inefficient (Jenkins & Quintana-Ascencio, 2020). In the present study the survey was made available until no more responses were obtained for a three-week period. Therefore, our sample size was determined by this procedure and not a priori power analysis. In summary, we suggest that the analysis of the female data can be interpreted with a good degree of reliability. However, the analysis of the male data comes with the substantial analytical caveat that it should be interpreted with caution due to the suboptimal sample size.

We remind the reader here that self-assessment was uncorrelated with trait social interaction anxiety and trait social phobia in females but was negatively correlated with both trait social interaction anxiety and trait social phobia in males at a trend level of statistical significance. This lack of significance may be due to the small size of the male subsample. This should be tested in a larger sample of males. Table 4 shows that for male participants BIS was a non-significant positive predictor of social phobia. The Beta value suggests that this might be a significant effect if the sample of males was larger. This non-significant effect was not present in the SIAS analysis. As discussed above, we included the analysis of the male data as an exploratory analysis, thus these effects should be tested in a larger sample of males. Moreover, in discussing these limitations, we also note here that there is some inconsistency in the ratio of males to females in the samples used in the studies we are comparing our data to. For example, the sample used by Kramer and Rodriguez (2018) contained 52.4% females, but the sample used by Gomez et al. (2021) contained 73.8% females.

The second limitation concerns the fact that we used self-report measures to assess personality constructs that are theorised to be produced by the brain-behavioral systems explained in rRST (Gray & McNaughton, 2000). Thus, our analysis and our interpretation of results come with the analytical caveat that we did not test how well the self-reported levels of reinforcement sensitivity reported by our participants' matches the actual sensitivity of the neuropsychological systems described in rRST.

The third limitation concerns our sample. We used a sample obtained from the general population, therefore a replication with clinical social phobia patients would be beneficial. The fourth limitation also relates to our sampling procedure. As reported above, 95 of the 110 respondents excluded from the analyses as invalid responses failed to fully complete the SIAS/SPS. Thus, we cannot be sure that the correlations between the SIAS/SPS measures and the rRST and/or self-esteem measures in these non-completers would have been the same as those we reported for those who did complete the SIAS/SPS measures.

Conclusion

Trait social interaction anxiety and trait social phobia (which reflects the fear of social scrutiny) were positively correlated with BIS scores and FFFS-flight scores and were negatively correlated with BAS scores and FFFS-fight scores in both female and male participants. These results support the predictions of the theory of clinical social phobia proposed by Kimbrel (2008). Trait social interaction anxiety and trait social phobia were negatively correlated with levels of self-acceptance in both female and male participants which lends some support to the involvement of maladaptive self-esteem processes in social anxiety. Multiple regression showed that for females FFFS-flight was a prominent positive predictor of trait social interaction anxiety, and for males FFFS-fight was a prominent negative predictor of trait social interaction anxiety. Overall, a synthesis of the present study and previous studies suggests that there may be differences in how trait social interaction anxiety and trait social phobia relate to reinforcement sensitivity, but the differences are likely to be subtle.

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