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Friend or Foe? Memory and Expectancy Biases for Faces in Social Anxiety

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Abstract

Studies examining memory biases for threat in social anxiety (SA) have yielded mixed results. In the present study, memory and expectancy biases were tested using a novel face recognition paradigm designed to offset methodological challenges that have hampered previous research. Following a social threat induction, undergraduates with high (*n* = 40) and low (*n* = 40) levels of SA viewed a series of neutral faces randomly paired with positive or negative social feedback. Recognition memory was tested for previously encountered faces, and for the categorization of each encoded face as having been associated with negative (mean) or positive (nice) interpersonal statements. For new faces, participants were asked whether the person seemed mean or nice. Results provided no evidence of a general memory bias to threat in SA, but suggested that high SA individuals lack a positive expectancy bias toward new social partners. Implications are considered for cognitive-behavioral and interpersonal models of SA.

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Keywords: face memory, cognitive biases, memory biases, expectancy, social anxiety

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Introduction

An extensive body of research demonstrating attention biases in social anxiety (SA) has emerged in recent years (e.g., Gilboa-Schechtman, Foa, & Amir, 1999; Chen, Ehlers, Clark, & Mansell, 2002; Mogg & Bradley, 2002; Mogg, Philppot, & Bradley, 2004; Pishyar, Harris, & Menzies, 2004; Buckner, Maner, & Shmidt, 2010). However, research on memory biases for threatening information in SA has been relatively sparse, and findings have been inconsistent across different methodological approaches, in which the nature of the threat stimuli used (e.g., faces, words, etc.) and the type of memory tested (e.g., recall, recognition, implicit memory, autobiographical memory) have varied greatly. For example, many studies using threatening words have failed to find a memory bias (Cloitre, Cancienne, Heimberg, Holt, & Liebowitz, 1995; Rapee, McCallum, Melville, Ravenscroft, & Rodney, 1994), whereas others that have used sentences or passages related to social threat have found memory biases, some showing enhanced memory for socially anxious participants (e.g., Amir, Foa & Coles, 2000), and others demonstrating enhanced memory for non-anxious participants (e.g., Wenzel, Jackson, & Holt, 2002).

It has been argued that verbal stimuli in studies of information processing biases in SA may be less effective than face stimuli in eliciting concerns related to social evaluation, and may thus have limited ecological validity (e.g., Pishyar et al., 2004). Indeed, for this reason, the use of faces as social threat stimuli has become popular in contemporary research on this topic (Lundh & Öst, 1996; Coles & Heimberg, 2005; Foa, Gilboa-Schechtman, Amir, & Freshman, 2000; Pérez-López & Woody, 2001). However, results of studies examining face memory biases in socially anxious participants have also been mixed (for a review of this literature, see Staugaard, 2010). For instance, several studies have failed to find any differences in the recognition and recall of threatening faces between control participants and both clinical and analog samples of participants with high levels of SA (Chen et al.,

2002; D'Argembeau, Van der Linden, Etienne, & Comblain, 2003; Hunter, Buckner, & Schmidt, 2009; Mansell, Clark, Ehlers, & Chen, 1999; Silvia, Allan, Beauchamp, Maschauer, & Workman, 2006). A limited number of studies have found differences in memory between participants high and low in SA, but there still is considerable disagreement related to the nature of these differences. For example, in a study comprising two experiments, Foa et al. (2000) found, first, that participants with generalized social anxiety disorder demonstrated better overall memory for facial expressions than did controls, and second, that individuals with social anxiety disorder also recognized more negative than positive faces—a difference not evident in the control group. Conversely, however, Pérez-López and Woody (2001) found that participants with social anxiety disorder demonstrated significantly poorer memory for facial expressions than healthy controls while anticipating a public speech.

Moreover, there is some evidence that the face stimuli used in some studies in this area elicited response biases which were mistakenly interpreted as memory biases. For example, in a seminal study (Lundh & Öst, 1996), participants with social anxiety disorder and non-anxious controls were exposed to a series of neutral faces and asked to rate each of them as being either critical or accepting before subsequently engaging in a recognition task for previously rated and novel faces. Individuals with social anxiety disorder were more likely to categorize those faces that were rated as being critical as having been previously encountered, whereas controls exhibited the opposite type of bias. A follow-up study by Coles and Heimberg (2005) replicated these findings, but also extended Lundh and Öst's (1996) original study by obtaining external ratings (from a different set of participants) of the face stimuli as being accepting or critical. Using these ratings, Coles and Heimberg demonstrated that the difference between participants with and without social anxiety disorder was more likely reflective of a response bias than of a bona fide memory bias per se. Specifically, their findings suggested that rather than the two groups differing in their recognition accuracy for threatening faces, which would indicate a true memory bias, they differed instead in the ways that they responded to faces perceived as critical versus accepting, regardless of whether they were seen before. Thus, they argued that this group difference is more accurately conceptualized as a response bias for faces with various characteristics (i.e., seeming critical or accepting), rather than a memory accuracy bias. In particular, Coles and Heimberg (2005) found that non-anxious controls tended to categorize accepting faces (both old and new) as having been previously seen, whereas individuals with social anxiety disorder trended toward categorizing critical faces (both old and new) as having been previously seen. These findings demonstrate that individuals with and without SA may have differing ways of responding to and remembering faces that seem subtly more critical or accepting.

Using face stimuli with objectively valenced (e.g., angry, happy) facial expressions to study memory biases is problematic for at least two reasons. First, they are inherently more distinctive and memorable than neutral faces, implying that attentional shift toward or superior memory for these faces may not reflect a threat bias per se, but rather a natural preference for unusual stimuli (e.g., Hunt & Lamb, 2001). Second, as per the findings of Coles and Heimberg (2005), subtly and overtly negative facial expressions may be eliciting differing response tendencies in high and low SA participants, which are difficult to disentangle from a true memory bias.

One of the main aims of the present study, therefore, was to devise a novel approach to examine memory bias for faces in SA that would not be confounded by the use of objectively valenced face stimuli. In our study paradigm, which was based on the procedure used by Todorov, Gobbini, Evans, and Haxby (2007), objectively neutral faces were paired with socially threatening (negative: critical or 'mean') and non-threatening (positive: accepting or 'nice') phrases. The faces were, thus, "valenced" through their association with negative and positive phrases, rather than by virtue of their expressions. Participants viewed one face-phrase associate pair at a time. Following encoding, participants'

recognition of the faces as 'old' or 'new' was tested, as was their memory for their associated valence (i.e., their ability to label faces as having been 'mean' or 'nice'). In addition, participants' ability to freely recall the phrases themselves was also tested. Given previous findings that information processing biases in SA are more likely to be activated under conditions of social threat (Leber, Heidenreich, Stangier, & Hofmann, 2009), all participants were led to believe at the start of the experiment that they would be required to deliver a speech in front of an evaluative audience following their completion of the face memory tasks.

We sought to answer three distinct research questions. First, we wished to examine whether high relative to low SA individuals would exhibit enhanced memory for interpersonally critical (i.e., 'mean') social partners (i.e., faces). Finding such a difference between groups would support the memory bias hypothesis in SA (e.g., Foa et al., 2000; Pérez-López & Woody, 2001). Alternatively, null findings might suggest that previously cited evidence of memory biases in SA within the literature may have been confounded by response biases or methodological problems.

The paradigm used in this study allowed us to simultaneously test participants' memory for previously-encountered threatening faces and to assess their expectations with respect to new, ambiguous social partners. Thus, the second research question was whether individuals high in SA differ from those low in SA in their expectancies related to novel social partners. That is, are high vs. low SA individuals biased in their a priori categorizations of new social partners as likely 'mean' or 'nice,' even before any information about those partners is available? Because participants viewed a series of new faces presented only in the recognition phase, we were able to examine these expectancies by comparing the proportions of such faces that high vs. low SA participants labelled as 'mean' or 'nice.' Evidence from research on interpersonal processes in SA suggests that individuals high in SA interpret ambiguous social information in a negative manner (e.g., Amir, Foa, & Coles, 1998), and that they possess negative interpersonal schemas that influence them to enter social encounters with more negative and/or less positive expectancies (e.g., Jones & Briggs, 1984; Leary, Kowalski, & Campbell, 1988; Taylor & Alden, 2005).These studies relied primarily on self-report measures and real or imagined social interactions. No previous studies, to our knowledge, have examined expectancy biases for new social partners in SA using a standardized computer task with tightly controlled partner characteristics. In addition, none has examined both memory and expectancy biases using a single paradigm within the same study.

Finally, in an attempt to reconcile mixed findings in this area of research, some investigators have advocated for a reduced experimental focus on generic threat stimuli (e.g., faces with negatively valenced facial expressions) in favor of incorporating personally-relevant threatening information into studies of face processing biases in SA (see Cody & Teachman, 2010). Indeed, objectively valenced threat stimuli such as negative facial expressions are likely to elicit a variety of subjective interpretations from participants, such that each type of expression may be meaningful to each participant for different reasons. For example, viewing a disgusted face may be associated for one participant with the thought, "*He thinks that I am ugly,*" and for another person with the thought, "*He thinks that I am incompetent,*" and so on, depending on each individual's unique self-related concerns (see Moscovitch, 2009). As we have argued elsewhere, each high SA individual may differ from the next in the nature of their self-related concerns across three nonorthogonal dimensions: social competence, signs of anxiety, and/or physical appearance (Moscovitch & Huyder, 2011). Because negative facial expressions might trigger heterogeneous subjective interpretations depending upon each participant's specific self-portrayal concerns, it is difficult, if not impossible, for researchers whose studies successfully detect information processing biases among high SA individuals in response to viewing such faces to determine why, exactly, this might be occurring. Thus, a third, largely exploratory, research question that was addressed in the present study was whether the personal relevance of socially threatening information encountered

during the experiment might impact the extent to which that information would later be remembered. To this end, we examined the relation between participants' specific self-reported self-portrayal concerns across the dimensions of social competence, signs of anxiety, and physical appearance, and their recollection of threatening (and non-threatening) stimuli within each corresponding dimension presented during the experimental task. We reasoned that the personal relevance of social information would likely impact its memorability, such that memory for threatening phrases would be positively correlated with self-portrayal concerns within each of the three corresponding dimensions.

Method

Participants

Several standardized prescreening questionnaires, including the *Social Phobia Inventory* (SPIN; Connor et al., 2000), were administered to all potentially eligible participants in the undergraduate Psychology research pool at the University of Waterloo in Canada. High and low SA individuals from that pool were invited to participate if their scores on the SPIN met a cutoff of above 30 or below 12, respectively, in order to create an analogue sample of participants whose SPIN scores resemble those of individuals with social anxiety disorder and healthy controls (more details are provided in *Additional measures*, below).

Eighty individuals (40 high and 40 low in SA) were recruited to participate in the present study. All participants provided informed consent and received course credit for their participation.

Materials

Development and selection of experimental stimuli.

Fifty-four neutral Caucasian and Asian faces were selected from the NIMSTIM standardized face set (Tottenham et al., 2009) and the Japanese and Caucasian Neutral Faces standardized face set (JACNeuF; Matsumoto & Ekman, 1988). Both sets depict a series of models displaying various facial expressions, and the neutral faces were selected for use in this study. Both face sets have been standardized and widely used and cited in empirical studies. Given the large minority of students within the University of Waterloo undergraduate participant pool who typically identify their ethnic background as Asian (with the majority typically identifying themselves as Caucasian), approximately 40% of the faces selected were Asian, and 60% were Caucasian. While the JacNeuF includes only Asian and Caucasian faces, the NIMSTIM face set also includes a series of African-American faces, which were not included in the present study given the small proportion of students attending the University of Waterloo who identify their cultural/ethnic background as Black/African (5% of the student body; $n = 1$ in the present study). Of the available Asian and Caucasian faces in each set, we excluded any faces *a priori* that possessed unusual features (e.g., distinctive hairstyle, ambiguous or suppressed facial expression). The remaining faces were randomly assigned to be viewed during encoding (i.e., *old*) or to be viewed only during the recognition phase (i.e., *new*). The final set of face stimuli ensured a balanced distribution of gender (50% male) and ethnic (60% Caucasian, 40% Asian) groups, and represented both face sets equally. All faces were presented on a white background with image sizes of 300 × 400 (±10) pixels. Thirty-six faces were randomly assigned to three face-phrase association sets of 12 faces each. Each set was equally divided into males and females, and within each gender, 40% were Asian faces. During the recognition phase of the study, an additional 18 faces (six in each set) were presented, maintaining the aforementioned proportions of gender and ethnicity within each set. Both the order of face presentation and the specific face-phrase pairings were randomized across participants.

Fifty-four phrases (half positively valenced, half negatively valenced) were developed as pairings for each face. The negative phrases were based on items from the Negative Self-Portrayal Scale (NSPS; Moscovitch & Huyder, 2011). As described below (see *Additional measures*), the NSPS evaluates respondents' concerns about displaying perceived flaws across three self-attribute dimensions: (a) social competence, (b) signs of anxiety, and (c) physical appearance. The positively valenced phrases were designed to mirror the negative ones. Prior to their use as experimental stimuli in the present study, the valence of all phrases was rated by a sample of 19 pilot participants on a 7-point scale (−3 = *very negative*; 0 = *neutral*; 3 = *very positive*). All ratings conformed to a priori groupings, with a mean rating of 1.83 (*SD* = 0.41) for positive phrases, and −1.60 (*SD* = 0.72) for negative phrases. None of the phrases obtained a rating that was more than ±2 SD from the group mean and none was excluded. Following the rating task, pilot participants were confronted with an unexpected free recall task in which they were asked to recall as many of the previously presented phrases as possible. The number of times each word was recalled across participants was divided by the total number of participants (*n* = 19) to obtain a memorability proportion score for each word. Positively-valenced words obtained a mean memorability score of 0.24 (*SD* = 0.2), and negatively-valenced words a mean of 0.20 (*SD* = 0.17). Outlier analyses were conducted for both valences, and two phrases ("fat" and "attractive") were excluded as having memorability scores greater than 2 *SD* above their group means. The authors selected 36 of the remaining 52 phrases for the study. These phrases were selected because they were judged by the authors as being most representative of each NSPS domain. The complete list of phrases and their memorability and valence scores from the pilot study are provided in the Appendix.

Social threat induction.

Previous studies have shown that information processing biases may emerge among high SA individuals only under conditions of social threat (e.g. Leber et al., 2009). Thus, prior to beginning the computer tasks, participants were deceptively led to believe that they would be required to deliver a short speech after they completed these tasks. Specifically, the experimenter delivered the following script as part of the instructions to all participants at the start of the experiment:

"You will first complete three tasks on the computer. Following the computer tasks, you will be asked to give a short speech. Another researcher will come in and rate your speech performance and their first impressions of you. I will give you more information about the speech following the computer tasks."

Valence, arousal, and distress ratings.

As a manipulation check for the social threat induction, immediately before and after the induction, participants were asked to rate their subjective units of distress (SUDS) on a scale from 0 to 100. In addition, using the Self Assessment Manikin (SAM; Bradley & Lang, 1994), participants rated their arousal level and the valence of their emotional state on a 9-point scale (1 = *low arousal and positive valence*; and 9 = *high arousal and negative valence*) at the same time points.

Additional measures.

All participants completed the following self-report measures:

The *Social Phobia Inventory* (SPIN; Connor et al., 2000) is a 17-item self-report instrument that measures fear, avoidance, and physiological discomfort in social situations (e.g., fear of people in authority; avoids parties; distressed by sweating). Participants completed the SPIN several weeks prior to the study, along with other prescreening questionnaires administered to all potentially eligible students in the Psychology research pool at the University of Waterloo. Each item on the SPIN is rated on a scale from 0 ("not at all") to 4 ("extremely"), with higher scores representing greater levels of distress; thus, the

full scale score ranges from 0 to 68. The SPIN has been shown to be an excellent measure of social anxiety, with good test-retest reliability, strong convergent and divergent validity, good construct validity, and high levels of internal consistency (Antony, Coons, McCabe, Ashbaugh, & Swinson, 2006; Connor et al., 2000). Although Connor and colleagues (2000) proposed a cut-off score of 19 and higher to select participants likely to have social anxiety disorder, we followed the suggestion of others (e.g., Moser, Hajcak, Huppert, Foa, & Simons, 2008) who have expressed a preference for using a more stringent cut-off score of 30. We selected a cut-off score of 12 or below for controls because Connor et al. (2000) reported that their nonpsychiatric control group had a mean SPIN total score of 12.1. This cut-off score resembles the score of 10 or below that has been used by Moser et al. (2008) to identify low anxious controls. The internal consistency of the SPIN total score in the present study was strong (α = .93).

The DASS-21 is a 21-item self-report measure divided into three subscales designed to assess anxiety, depression, and stress. It is a condensed version of the DASS-41 (Lovibond & Lovibond, 1995), a commonly-used measure of these three constructs. The Depression Scale assesses dysphoric mood states, including self-deprecation, lack of interest/ involvement, hopelessness, and anhedonia. The Anxiety Scale assesses arousal states, including autonomic arousal, muscular tension, and anxious affect. Finally, the Stress Scale is reported to assess negative emotional reactions to stressors as well as general tension. The reliabilities (internal consistencies) of the DASS-21 Anxiety, Depression, Stress, and Total Scales in the present study were estimated using Cronbach's alpha, and were .86 for the Depression scale, .79 for the Anxiety scale, .85 for the Stress scale, and .92 for the Total scale. The DASS-21 was completed by participants immediately following the computer tasks.

The NSPS (Moscovitch & Huyder, 2011) is a questionnaire designed to assess participant concerns that specific self-attributes that they view as flawed or deficient will be exposed to scrutiny and evaluation by critical others in social situations. Across two large samples of North American undergraduate students with normally distributed symptoms of social anxiety, exploratory and confirmatory factor analyses supported a (non-orthogonal) 3-factor solution representing concerns about (a) social competence, (b) physical appearance, and (c) signs of anxiety (Moscovitch & Huyder, 2011). In the original study, the NSPS demonstrated good internal consistency (α = .95 for full scale and α = .87–.92 for the 3 subscales) and test-retest reliability (r = .75), and adequate convergent and discriminant validity (r = .63–.70 with symptom measures of social anxiety and r = .47–.62 with measures of OCD and depression). Cronbach's alpha coefficients for the NSPS in the present study were .90 for the social competence subscale, .83 for the signs of anxiety subscale, .91 for the physical appearance subscale, and .95 for the total score. The NSPS was completed by participants immediately following the computer tasks.

Procedure

For the duration of the study, individual participants were seated alone in a room at a computer desk on which a 22-inch monitor was mounted. The experimenter left the room after delivering the instructions and allowing participants to ask any clarifying questions. The experimenter entered the room following the presentation of each learning-recognition stimulus set to type instructions on the computer in order to set up the next part of the experiment. As shown in Figure 1, during the encoding task, participants were presented with three sets of 12 face-phrase pairs (six 'mean' and six 'nice'; see below) for a total of 36 face-phrase associates. Prior to each face, a blank screen appeared for 1000 ms, followed by a fixation cross, which appeared for 500 ms. Following the fixation cross, an image of a neutral face appeared centered on the computer screen. Each face appeared simultaneously with a phrase immediately below it, which was typed in Courier font size 14. Each phrase consisted of the stem "I can see that you are/have", followed by the target word(s) (see Appendix). Each face-phrase pair was presented for 5000 ms. Participants were asked to rate each face as 'mean' or 'nice', a rating made using the "M" and "N"

keyboard keys. Participants were also instructed to try and remember who was *mean* and who was *nice* for later in the study.

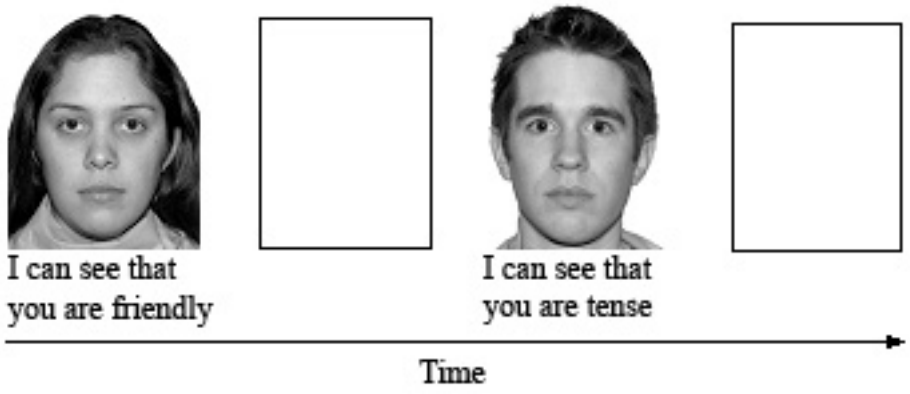

Figure 1: Participants encountered a total of 36 face-phrase pairs. Each pair was presented for 5000 ms. Between pairs, participants viewed a blank screen for 1000 ms, followed by a fixation cross presented for 500 ms. The specific pairings of neutral faces and phrases were randomized across participants.

The recognition phase was comprised of three sets of 18 faces, and each set immediately followed an encoding phase. In each recognition set, participants viewed three sets of 18 faces (12 of which were presented in the encoding task (‘old’ faces), as well as 6 faces not previously encountered (‘new’ faces). Participants were instructed to indicate whether they recognized the face from the learning phase by pressing ‘”O” for ‘old’ and ‘”N” for ‘new’. For faces rated as ‘old’, participants were then asked to indicate whether the face was mean or nice (previously associated with a mean or nice comment) by pressing “M” for ’mean’ and “N” for ‘nice.’ For faces rated as new, participants were asked to indicate whether the person seemed mean or nice, also by pressing “M” or “N”, respectively. Participants had unlimited time to complete these ratings as accurately as they could. Participants were prohibited from backtracking to correct any perceived response errors.

Immediately after each encoding and recognition set, participants completed the recall phase, in which they were asked to write down as many of the phrases from the preceding set as they could recall. The stem “I can see that you are/have” was provided, followed by 12 blank lines for participants to complete. Following the recall task, participants were debriefed and compensated for their participation.

Preparation of Data and Analytic Procedure

In preparation for analysis, responses for each participant across the 54 trials were organized into different categories according to (a) whether the face encountered was actually old or new, (b) whether the face was categorized by the participant as being old or new, (c) whether the face (if old) was previously associated with a nice or mean comment, and (d) whether the associated valence was correctly identified by the participant, thus yielding various combinations of hits and misses for both the initial old/new and subsequent mean/nice decisions (e.g., old faces correctly categorized as being old and correctly labelled as mean/nice, old faces incorrectly categorized as being new and correctly labelled as mean/nice, new faces correctly categorized as being new and then labelled as mean/nice, etc.). These combinations represent various important distinctions in how faces were encoded and recalled. The number of times each participant labelled a face in each way was tallied across trials, and

the mean tallies for high vs. low SA participants were examined in a series of analyses, as outlined below.

Results

Preliminary Analyses

Descriptive group characteristics.

Table 1: Characteristics of Participant Groups

	Low SA (*n* = 40)	**High SA (*n* = 40)**
Age in years (SD)	18.44 (1.38)	19.30 (3.56)
Gender (% female)	62.5%	62.5%
Ethnicity		
Caucasian	42.5%	22.5%
Asian	25.0%	60.0%
Other	32.5%	17.5%

Descriptive characteristics of participants in both groups are presented in Table 1. Groups did not differ significantly in age, $t(74) = 1.35$, $p = .18$, or gender composition, $X^2(1) = 0.0$, $p = 1.00$. Groups did differ in ethnic composition (Caucasian, Asian, Other), $X^2(2) = 10.03$, $p < .01$, with a higher proportion of Asian participants represented in the high SA group. To examine the role of ethnicity in our findings, we repeated the primary analyses with ethnicity entered as a covariate[1].

As displayed in Table 2, high and low SA participants differed significantly in the expected direction across the self-report measures, including the SPIN, DASS, and NSPS. The Bonferroni-adjusted alpha level of 0.0125 per test was used to correct for multiple comparisons (all ts > 3.99, all ps < .001).

[1] In the present study, self-reported ethnicity was coded into three categories: Caucasian, Asian and Other. Given that our high and low SA groups represented different proportions of participants of different ethnicities, with a higher number of Asian participants in the high SA group, we examined whether ethnicity may have moderated our main finding of interest, or in other words, whether the lack of a positive expectancy bias in high SA participants generalized across ethnicities. First, we re-ran our primary analysis of interest, examining the rates of participants labeling correctly-identified novel faces as mean vs. nice in a 2 (Group [high, low SA]) × 2 (Valence [Mean, Nice]) mixed-design analysis of covariance (ANCOVA), with ethnicity entered as a covariate. This analysis yielded no significant main effects for valence, group, or ethnicity (Fs ≤ 3.69, ps ≥ .59). There were also no significant 2-way or 3-way interactions involving ethnicity (Fs ≤ 1.46, ps ≥ .21). However, once ethnicity was controlled for, the group × valence interaction (i.e., the expectancy effects for new faces) previously outlined was no longer significant $F(1,76) = 2.0$, $p = .16$.
In order to better understand the potential impact of Caucasian and Asian group membership on expectancy effects for new faces, we then conducted two separate 2 (Group [high, low SA]) × 2 (Valence [Mean, Nice]) mixed-design ANOVAs on the numbers of correctly-identified novel faces rated mean vs. nice, first in Caucasian participants only and then in Asian participants only (the participants who comprised the group coded “other” were ethnically heterogeneous and these diverse subgroups lacked the sample size requirements for conducting further post-hoc analyses). Results of the two ANOVAs indicated that the expectancy bias for new faces was driven primarily by the response patterns of Caucasian participants. For participants who identified as Caucasian (low SA n = 17, high SA n = 9), the main effect of valence was significant, $F(1, 24) = 7.0$, $p = .01$, and the group by valence interaction effect was marginally significant in the expected direction, $F(1, 24) = 3.37$, $p = .08$. In contrast, for the Asian participants (low SA n = 10, high SA n = 24), neither effect was significant (Fs ≤ 2.41, p ≥ .13). This finding indicates that high and low socially anxious individuals of different ethnic backgrounds may differ substantially in the ways they approach novel social contacts. However, our analyses were conducted post-hoc and may have been underpowered. Future studies can address these differences by recruiting equal number of Asian and Caucasian participants into the high and low SA groups.

Table 2: Comparison of Participant Group Scores on Self-Report Measures

	High SA *M (SD)*	Low SA *M (SD)*	*t*-test
SPIN	38.1 (6.9)	6.4 (3.3)	$t(78) = 8.12$*
DASS Total	24.72 (11.5)	10.03 (8.06)	$t(68) = 6.54$*
Depression	15.1 (10.2)	7.3 (6.9)	$t(77) = 4.00$*
Anxiety	7.43 (4.6)	2.10 (2.84)	$t(65) = 6.18$*
Stress	9.72 (4.1)	4.28 (4.12)	$t(76) = 5.86$*
NSPS Total	78.53 (16.5)	53.89 (18.5)	$t(77) = 6.17$*
Social competence	33.95 (6.4)	22.81 (8.7)	$t(66) = 6.40$*
Signs of anxiety	22.10 (6.1)	15.54 (5.9)	$t(77) = 4.88$*
Physical appearance	22.48 (6.8)	15.90 (7.3)	$t(77) = 4.14$*

Note. Differences in degrees of freedom across t-tests reflect differences in missing values across measures; SPIN = Social Phobia Inventory; DASS = Depression Anxiety and Stress Scale, Depression Subscale; NSPS = Negative Self-Portrayal Scale (Concern Subscale); *$p < 0.01$.

Subjective Distress Prior to and Following Social Threat Induction.

High and low SA participants provided higher SUDS and SAM ratings (valence and arousal) prior to and following the social threat induction (means and SDs are presented in Table 3). Pre-treatment group differences were significant across all SUDS and SAM ratings (all *t*s > 2.2, all *p*s < .05). Pre-to-post changes in SUDS and SAM ratings were examined across the two groups in three separate 2 × 2 mixed-design analyses of variance (ANOVA). For each analysis, the between-subjects variable was group (high vs. low SA) and the within-subjects variable was SUDS or SAM ratings across the two assessment points (pre-induction vs. post-induction). As expected, there were significant or marginally significant main effects of time for SUDS and SAM arousal and valence ratings, indicating that across both anxiety groups, the threat induction resulted in significant or near-significant increases in SUDS (distress), and SAM valence and arousal ratings (all *F*s > 3.45, *p*s < .07, partial η^2s > .04). A marginally significant group by time interaction emerged for the SUDS ratings, $F(1,78) = 2.93$, $p = .09$, partial $\eta^2 = 0.04$, indicating that the high SA group experienced a marginally greater increase in distress after the threat induction. There were no significant group by time interactions for SAM arousal or valence ratings (*F*s < 1.17, *p*s > 0.28, partial η^2s < 0.02).

Table 3: Comparison of Participant Group Scores Prior to and Following Social Threat Induction

	High SA M (SD)	Low SA M (SD)
SUDS baseline	34.80 (22.47)	23.68 (20.82)
SUDS post-induction	42.80 (23.00)	26.77 (21.86)
SAM arousal baseline	3.42 (1.47)	2.65 (1.37)
SAM arousal post-induction	4.20 (1.84)	3.10 (1.61)
SAM valence baseline	3.95 (1.24)	3.12 (1.18)
SAM valence post-induction	4.20 (1.45)	3.23 (1.21)

Note. Subjective Units of Distress (SUDS) and Self-Assessment Manikin (SAM) Valence and Arousal Scale ratings prior to and following the social threat induction.

Accuracy of Face Recognition Across Categories.

Independent-samples t-tests were conducted to examine whether the two groups differed in their overall accuracy for categorizing old, new, mean, and nice faces. The groups did not differ in their rates of correctly categorizing old faces as being old, $t(78) = .16$, $p = .87$. For rates of correctly categorizing novel faces as being new, a significant group difference emerged, with high SA participants showing enhanced recognition of novel faces overall relative to low SA participants, $t(78) = 2.60$, $p = .01$, indicating that high SA participants were more accurate at identifying faces they had not previously encountered as being new. Finally, the two groups did not differ in their rates of correctly labeling previously-seen faces as being mean, $t(78) = .95$, $p = .35$, or nice, $t(78) = 1.90$, $p = .66$.

Hypothesis 1: Testing for the Presence of a Memory Bias for Threatening Faces

Were high SA individuals, relative to their low SA counterparts, more likely to remember old (i.e., previously seen) faces as having been mean rather than nice? A series of mixed-design 2 (group) × 2 (valence) ANOVAs were conducted, first for faces that were correctly identified as being old, and then for faces that were incorrectly identified as being old (see Table 4).

Table 4: Mean Number of Faces Labeled as Being Mean or Nice Across Groups

	High SA *M (SD)*	Low SA *M (SD)*	*p*	Partial η^2
Old Faces Labeled Old				
Mean rated Mean	9.58 (3.30)	9.33 (3.16)	.19	0.02
Nice rated Nice	9.93 (3.08)	9.58 (3.30)		
Nice rated Mean	4.08 (2.06)	4.15 (2.06)	.29	0.01
Mean rated Nice	3.58 (2.41)	4.35 (2.03)		
New Faces Labeled Old				
Mean	2.23 (1.80)	2.88 (2.28)	.63	< 0.01
Nice	1.68 (1.67)	2.60 (1.55)		
New Faces Labeled New				
Mean	7.48 (3.06)	4.53 (2.76)	< .001	0.16
Nice	6.63 (2.55)	8.00 (3.15)		
Old Faces Labeled New				
Mean rated Mean	2.10 (1.85)	1.70 (1.74)	.14	0.03
Nice rated Nice	2.03 (1.80)	2,43 (1.96)		
Nice rated Mean	1.98 (1.97)	1.40 (1.65)	.06	0.04
Mean rated Nice	2.18 (1.87)	2.58 (2.22)		

For faces correctly identified as being old, there was a main effect of valence, whereby more nice faces were correctly identified overall as being nice, collapsed across both participant groups, $F(1, 78) = 5.44$, $p = .02$, partial $\eta^2 = .07$. However, as shown in Table 4, the two groups did not differ in the number of faces they identified as being mean or nice. This was true both when participants' valence judgments were correct (i.e., for faces that were encoded as being mean or nice, respectively, and subsequently labeled during the recognition test as being mean or nice, respectively) and when their valence judgments were incorrect (i.e., faces that were encoded as being mean and subsequently labeled during the recognition test as being nice, and vice versa). Moreover, there was no group by valence interaction effect. Finally, for faces that were incorrectly identified as being old, no significant effects emerged (all Fs ≤ 2.17, all ps ≥ .14, all partial η^2s ≤ .03).

Hypothesis 2: Testing for the Presence of an Expectancy Bias for New Faces

Were high SA individuals, relative to their low SA counterparts, more likely to predict that new faces would be mean rather than nice? A series of mixed-design 2 (group) × 2 (valence) ANOVAs were conducted, first for faces that were correctly identified as being new, and then for faces that were incorrectly identified as being new (see Table 4).

For faces correctly identified as being new, results revealed a significant effect of valence, $F(1, 78) = 5.21$, $p = .03$, partial $\eta^2 = .06$, as well as a significant group by valence interaction, $F(1, 78) = 15.26$, $p < .001$, partial $\eta^2 = .16$. A series of follow-up paired and independent-samples t-tests were conducted to further examine the nature of the significant interaction. These indicated that low SA participants labeled fewer new faces as being mean than nice, $t(79) = 2.11$, $p < .001$, and that high SA participants labeled more new faces than low SA participants as being mean, $t(78) = 4.52$, $p < .001$, and fewer faces than low SA participants as being nice, $t(78) = 2.10$, $p = .04$. This interaction is displayed in Figure 2.

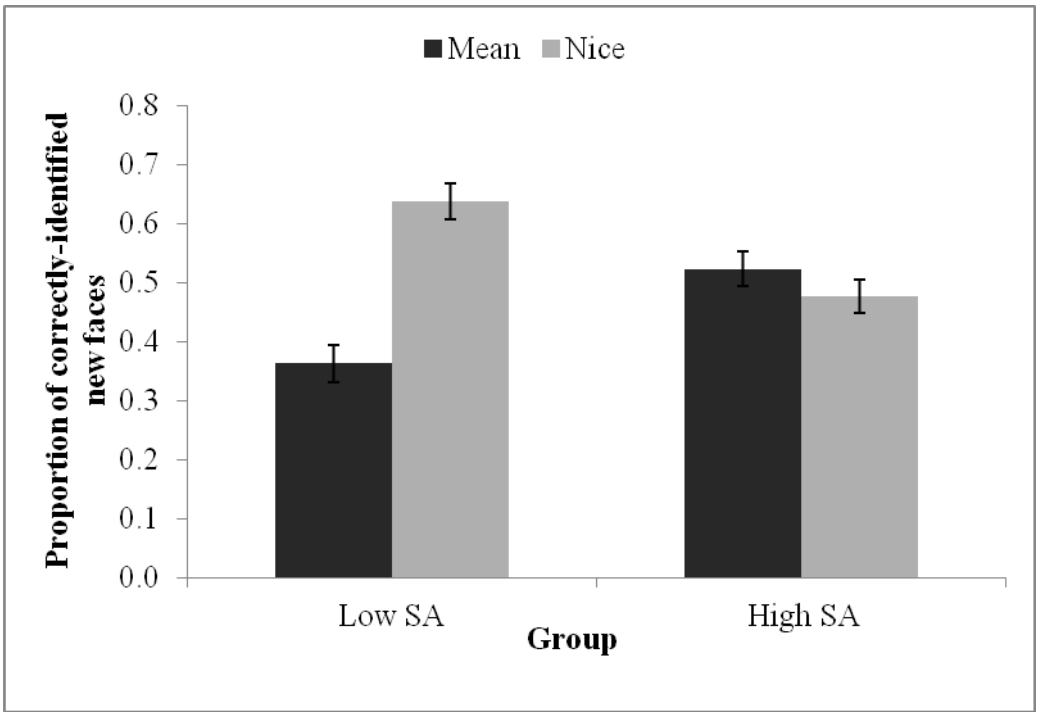

Figure 2: Proportions of correctly-identified new faces subsequently rated as mean vs. nice. A group-by-valence interaction indicated that low SA participants were less likely to label new faces as being mean than nice, while individuals high in SA did not differ in their proportion of labels across the two categories. High SA participants were also more likely than low SA participants to label new faces as being mean and less likely than low SA participants to label new faces as being nice. Error bars represent standard error of the mean.

For old faces that were incorrectly labeled as being new, but subsequently correctly labeled as mean or nice, there were no significant effects (all Fs < 2.27, all ps > .1, all partial η^2s < .03). Finally, for old faces that were incorrectly labeled as being new and subsequently incorrectly labeled as mean or nice, there was a main effect of valence, $F(1, 78) = 7.02$, $p = .01$, partial $\eta^2 = .08$, and a marginally significant group by valence interaction, $F(1, 78) = 3.53$, $p = .06$, partial $\eta^2 = .04$. A series of follow-up paired and independent-samples t-tests were conducted to further examine the nature of the marginally significant interaction. Paired-samples t-tests indicated that low SA participants were more likely to label mean faces erroneously as being nice than nice faces erroneously as being mean $t(79) = 3.01$, $p < .001$. No other comparisons were significant, ts < 1.13, ps > .26.

Hypothesis 3: Testing the Relation between Self-Portrayal Concerns and Recall Memory for Personally-Relevant Threat

Were participants' idiosyncratic self-portrayal concerns associated with specific memory biases for threatening phrases that reflected those concerns? A series of bivariate correlations was conducted including all 80 participants collapsed across both groups. Correlations were computed between the three NSPS subscale scores representing the three dimensions of concerns, namely: (a) signs of anxiety, (b) social competence, and (c) physical appearance, and the total number of freely recalled positive and negative phrases related to these domains. Results indicated that, first, NSPS signs of anxiety scores were modestly correlated with higher recall of negative (r = .19, p = .10) than positive (r = .10, p = .39) phrases related to this domain, but the difference in strength between the correlations was non-significant, z = .57, p = .57. Second, NSPS social competence scores were also modestly associated with higher recall of negative (r = .21, p = .07) than positive (r = –.12. p = .31) phrases related to this domain, with a significant difference between the strengths of these two correlations, z = 2.08, p = .04. Finally, NSPS physical appearance scores were not associated with recall of negative (r = 0.0. p = .99) phrases and were modestly correlated with positive phrases related to this domain (r = –.15. p = .19), with a non-significant difference in strength between the two correlations, z = .94, p = .35.

Discussion

The present study utilized a novel approach to investigating face threat processing and memory biases in SA, in which participants high and low In SA viewed neutral faces associated at random with positively or negatively valenced social feedback. We attempted to extend previous work in this area of research by addressing three distinct research questions: (a) Using a paradigm that eliminated the possibility of a response bias toward explicitly negative facial expressions, might high SA individuals show a memory bias for faces paired with threatening information? (b) Might high SA individuals demonstrate negatively biased expectancies related to interactions with new social partners?; and (c) To what extent might idiosyncratic social concerns account for individual differences in the recall of threatening versus non-threatening face stimuli?

Results indicated, first, that high SA individuals demonstrated neither superior nor impoverished memory for threatening faces relative to their low SA counterparts. Although these findings are inconsistent with a minority of studies that have reported the presence of such biases among high SA participants (Foa et al., 2000; Pérez-López & Woody, 2001), they are consistent with a sizable number of previous experiments that failed to detect the presence of recognition and recall biases toward threatening faces in SA (Chen et al., 2002; D'Argembeau et al., 2003; Hunter et al., 2009; Mansell et al., 1999; Silvia et al, 2006). Given the rigorous methodological features of the present study (e.g., the use of neutral faces associated with threatening and non-threatening social feedback), we eliminated the possible impact of a response bias that has hampered previous work in this area, as described above. Hence, we believe that our findings provide strong support against the presence of a memory bias to threatening faces in SA.

Conversely, analyses examining participants' expectancies related to new social interactions yielded clear evidence in support of the absence of a positive expectancy bias for novel faces amongst high SA individuals. Whereas low SA participants predicted that it was significantly more likely that new faces would be nice rather than mean (thus, giving new faces 'the benefit of the doubt' in the absence of any information to the contrary), high SA participants expected that it was equally likely that new faces would be mean or nice. While a positive expectancy bias likely facilitates an adaptive approach-oriented mindset and a willingness among low SA participants to engage in interactions with new social partners, high SA participants, who tend to enter novel social interactions with a withdrawal-oriented mindset (for a

review, see Taylor & Alden, 2004) may do so, at least in part, because they are uncertain and insecure about the interpersonal characteristics of their potential interaction partners and the extent to which these partners will likely accept or reject them. Through this lens, new social situations are likely to be viewed by high SA individuals as being risky and, therefore, anxiety-provoking. In addition, if such suspicious and/or fearful interpersonal schemas can become activated within high SA individuals in the context of a simulated, computer-based social task, as in the present study, they are likely to become activated even more readily in high SA individuals during actual social encounters within real-world contexts in which the risk of interaction with "mean" individuals can be more legitimately perceived as carrying genuine social costs.

Interpersonal models of SA (e.g., Taylor & Alden, 2004) stress the centrality of maladaptive interpersonal cycles that become established between high SA individuals and their interaction partners, which ultimately perpetuate the likelihood of negative social outcomes. According to such models, individuals high in SA, particularly those with negative early social experiences, possess more negative relational schemas (Taylor & Alden, 2005) and, as a result, may be more likely to view other people as being more critical, and less friendly, warm, and courteous than those without SA (e.g., Jones & Briggs, 1984; Leary et al., 1988). Moreover, according to cognitive-behavioral models (e.g., Clark & Wells, 1995; Rapee & Heimberg, 1997), one important factor in the maintenance of social anxiety symptoms is high SA individuals' tendency to overestimate the probability of negative social and interpersonal outcomes, a theoretical claim that has now been supported by several experimental studies, (e.g., Foa, Franklin, Perry, & Herbert, 1996; McManus, Clark, & Hackmann, 2000; Smits, Rosenfield, McDonald, & Telch, 2006; Taylor & Alden, 2008). Our findings complement this research by providing a possible reason for these biases. Specifically, if high SA individuals view novel partners as relatively more likely to be mean, then the probability of negative outcomes in these interactions would seem correspondingly high.

Finally, an additional, yet preliminary and relatively modest contribution of our study relates to the potential role of individuals' idiosyncratic self-relevant concerns in the recall of threatening social stimuli. Following Cody and Teachman's (2010) recent study that demonstrated that high SA participants were more likely to remember social feedback if it was personally relevant, the present study was the first to explore whether the nature of individuals' perceived personal flaws might be associated with their ability to process and remember salient social information. Our findings suggested that participants' memory for negative (i.e., threatening) self-relevant interpersonal feedback about signs of anxiety and social competence was modestly correlated with the extent to which they endorsed having concerns within each of those domains on a self-reported measure (the NSPS). These correlations provide some preliminary support for the suggestion that individuals with self-portrayal concerns related to specific themes (e.g., showing poor social competence or visible signs of SA) demonstrated enhanced memory for social threat that is consistent with these concerns. It is possible, therefore, that the inconsistent findings within the memory bias literature in SA to date may be due, in part, to the failure of the threatening stimuli in previous studies to activate self-relevant themes or concerns that were particularly relevant to individual participants. Unfortunately, our ability to perform a strong test of the personal relevance hypothesis was constrained by the small number of negative and positive stimuli per NSPS dimension (n = 6 for each) that participants encountered during the study and were, thus, able to later recall. Future studies focusing on this hypothesis should include more experimental stimuli to ensure that the analyses are adequately powered.

Overall, the present study had several important strengths, as well as a number of limitations. In terms of strengths, the methodological features of our paradigm (i.e., using neutral faces paired with explicit rather than implicit social feedback) enabled a stringent test of the memory bias hypothesis without the need to disentangle the effects of a possible memory bias from those of a response bias, as described

above. Moreover, although the encoding task in the present study differs in many ways from real life social interaction, it was designed to enhance ecological validity by incorporating at least one feature of many genuine social encounters, which is arguably absent from the commonly used tasks that have relied on objectively valenced facial expressions, as others have argued previously (e.g., Coles & Heimberg, 2005). Specifically, strongly and overtly negative facial expressions are rarely encountered outside the experimental setting and are even uncommon in expressions of negative social evaluation, in which ambiguous or, perhaps, subtly negative expressions are likely to predominate. Thus, results of the present study may be more generalizable to the way social information may be processed and remembered by individuals high in SA who encounter familiar or unfamiliar neutral faces in real social contexts outside the laboratory and must acquire positive or negative interpersonal associations. In this way, our findings with respect to the absence of a positive expectancy for new faces amongst high SA participants complement other studies that have shown that high SA individuals tend to interpret ambiguous information in a negative manner, even when alternate, positive interpretations are available (e.g., Amir et al., 1998).

In terms of limitations, this study investigated an analog sample of high SA university students. While we believe that a sample of individuals with a clinical diagnosis of social anxiety disorder would display a similar non-positive expectancy bias as our analogue sample, if not an even more pronounced one, it is important to replicate our findings in a sample of community outpatients with social anxiety disorder in order to establish that the absence of a positive expectancy bias is a valid, replicable feature of the disorder. It would have strengthened our study to have included an anxious control group of participants with anxiety symptoms other than SA in order to examine whether the differences between groups were due to differences in trait anxiety more generally or specific to SA per se. It would also have been informative to have examined differences in how quickly participants labeled faces as ‘mean’ vs. ‘nice’, since it is possible that high SA participants would be quicker to label faces as mean than those low in SA. However, our participants were allowed an unlimited amount of time to make their responses during the recognition phase of the study in order to allow them to access any trace for the association (if available) for a given phase. Given this experimental approach, it was not possible using this paradigm to compare or make conclusions based on the time it took to respond to different faces. In addition, the interesting and unexpected findings regarding the role of ethnicity in our primary findings raise new questions. Cross-cultural differences in the expression of SA between Western and Eastern cultures is a small but growing area of research with intriguing implications, with some preliminary studies suggesting that cultural factors may play an important role in the prevalence, experience and expression of SA (e.g., Hong & Woody, 2007; Schreier et al., 2010). With regards to our finding related to the expectancy bias towards new social partners, it is possible that individuals hold different expectancies for members of their own ethnicity/race and members of other ethnicities/races. It is also possible that Caucasian and Asian participants differ fundamentally in their expectancies in novel interactions. Future hypothesis-driven studies are needed to better understand how and why Caucasian and Asian participants may differ in their expectancies of threat associated with novel social partners. Finally, while our study paradigm may be more akin to social threat than those used in previous face processing studies, the use of a computerized task to assess biases related to social interactions is still inevitably limited in ecological validity, as it lacks the dynamic interactions that characterize real-life social situations. To determine more conclusively what, if any, face processing biases exist in SA, future studies should employ methodological approaches that both replicate social interaction as closely as experimentally possible and ensure that potential social costs of negative social outcomes (e.g., negative evaluation, rejection, etc.) are as realistic and threatening to participants as they are in normative social interactions.

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Appendix: Pilot data on the selection of phrase stimuli based on the NSPS

Descriptor	Mean Valence Rating	Memorability Proportion Score	Valence (Mean/ Nice)	NSPS Category
Loner	**-2.37**	**0.11**	**Mean**	**Social Competence**
(Absentminded)	-1.58	0.00	Mean	Social Competence
Anxious	**-0.89**	**0.42**	**Mean**	**Signs of Anxiety**
Apprehensive	-0.47	0.05	Mean	Signs of Anxiety
Awkward	**-1.79**	**0.00**	**Mean**	**Social Competence**
(Blemished)	-2.05	0.05	Mean	Physical Appearance
Boring	**-2.68**	**0.11**	**Mean**	**Social Competence**
Chubby	**-1.63**	**0.11**	**Mean**	**Physical Appearance**
(Clumsy)	-1.26	0.11	Mean	Social Competence
(Distant)	-1.05	0.00	Mean	Social Competence
(Fat)	-2.47	0.63	Mean	Physical Appearance
(Frumpy)	-1.26	0.53	Mean	Physical Appearance
(Indifferent)	-0.63	0.05	Mean	Social Competence
Introverted	**-0.21**	**0.21**	**Mean**	**Social Competence**
Nervous	**-1.00**	**0.32**	**Mean**	**Signs of Anxiety**
On edge	**-1.26**	**0.05**	**Mean**	**Signs of Anxiety**
Overweight	**-2.11**	**0.37**	**Mean**	**Physical Appearance**
Plain	**-1.74**	**0.00**	**Mean**	**Physical Appearance**
(Restless)	-0.79	0.32	Mean	Signs of Anxiety
Tense	**-0.89**	**0.16**	**Mean**	**Signs of Anxiety**
Ugly	**-2.74**	**0.32**	**Mean**	**Physical Appearance**
Unattractive	**-2.53**	**0.26**	**Mean**	**Physical Appearance**
Uneasy	**-1.21**	**0.37**	**Mean**	**Signs of Anxiety**
Unfriendly	**-2.42**	**0.21**	**Mean**	**Social Competence**
Uptight	**-1.89**	**0.16**	**Mean**	**Signs of Anxiety**
Big nose	**-1.95**	**0.32**	**Mean**	**Physical Appearance**
Lack charisma	**-2.26**	**0.16**	**Mean**	**Social Competence**
(Handsome)	2.21	0.00	Nice	Physical Appearance
Articulate	**2.21**	**0.11**	**Nice**	**Social Competence**
(At ease)	1.53	0.26	Nice	Signs of Anxiety
(At peace)	1.68	0.05	Nice	Signs of Anxiety
(Attractive)	2.32	0.84	Nice	Physical Appearance
Calm	**1.16**	**0.32**	**Nice**	**Signs of Anxiety**
(Charismatic)	2.16	0.37	Nice	Social Competence
(Clear skin)	1.32	0.00	Nice	Physical Appearance
(Comfortable)	1.58	0.16	Nice	Signs of Anxiety
Composed	**1.37**	**0.05**	**Nice**	**Signs of Anxiety**
Confident	**2.21**	**0.42**	**Nice**	**Signs of Anxiety**
Fit	**2.16**	**0.32**	**Nice**	**Physical Appearance**
Friendly	**2.16**	**0.53**	**Nice**	**Social Competence**
Good-looking	**2.16**	**0.11**	**Nice**	**Physical Appearance**

Descriptor	Mean Valence Rating	Memorability Proportion Score	Valence (Mean/ Nice)	NSPS Category
Interesting	**1.68**	**0.11**	**Nice**	**Social Competence**
(Kind)	2.11	0.05	Nice	Social Competence
Likeable	**1.89**	**0.16**	**Nice**	**Social Competence**
(Motivated)	2.00	0.05	Nice	Social Competence
Pleasant	**1.58**	**0.11**	**Nice**	**Social Competence**
Poised	**1.53**	**0.37**	**Nice**	**Signs of Anxiety**
Relaxed	**1.21**	**0.42**	**Nice**	**Signs of Anxiety**
Self-assured	**1.32**	**0.16**	**Nice**	**Signs of Anxiety**
Slim	**1.21**	**0.42**	**Nice**	**Physical Appearance**
Sociable	**1.84**	**0.26**	**Nice**	**Social Competence**
Attractive face	**2.05**	**0.05**	**Nice**	**Physical Appearance**
Beautiful eyes	**2.53**	**0.37**	**Nice**	**Physical Appearance**
Great hair	**2.32**	**0.42**	**Nice**	**Physical Appearance**

Note. Bolded descriptors were ultimately chosen as the stimuli for the present study, while those in parentheses were piloted but not used in this study; NSPS = Negative Self Portrayal Scale.