AN INVESTIGATION OF ATTENTIONAL BIAS TO THREAT USING THE DOT PROBE TASK: RELATION TO SOCIAL ANXIETY AND PSYCHOMETRIC CHARACTERISTICS

AN INVESTIGATION OF ATTENTIONAL BIAS TO THREAT USING THE DOT PROBE TASK: RELATION TO SOCIAL ANXIETY AND PSYCHOMETRIC CHARACTERISTICS

By

LAUREN KUTCHER, B.A. (Hons.)

A Thesis Submitted to the School of Graduate Studies in Partial Fulfilment of the Requirements

For the Degree of Master of Science

MASTER OF SCIENCE (2013) McMaster University

Hamilton, Ontario

TITLE: An Investigation of Attentional Bias to Threat Using the Dot Probe Task: Relation to Social Anxiety and Psychometric Characteristics

AUTHOR: Lauren Kutcher, B.A. (Hons.)

SUPERVISOR: Professor Louis A. Schmidt

NUMBER OF PAGES: x, 47

Abstract

Research utilizing the dot probe task to examine attentional bias to threat in social anxiety has yielded inconsistent findings. Many manipulations have been included across dot probe studies, perhaps contributing to the discrepant results. Alternatively, the psychometrics of the dot probe may play a role. Two studies that have examined the psychometric properties of the task found the task to be unreliable (Schmuckle, 2005; Staugaard, 2009).

Prompted by the mixed findings, the present study had two overarching goals. The first was to replicate and extend the extant literature by incorporating a number of manipulations into the dot probe task and examining individual differences in social anxiety, and personality types associated with social avoidance and social approach, or shyness and sociability, respectively. The second goal was to investigate the psychometrics of the dot probe task by assessing its test-retest reliability and internal consistency. To address these goals, participants completed a dot probe task that involved manipulations of emotional valence (happy, angry), intensity (moderate, strong), and exposure time (100ms, 500ms) of facial stimuli on two occasions, separated approximately by a month. Additionally, participants were parsed into high and low groups of social anxiety, shyness, and sociability by way of median splits on two personality measures.

Using attentional bias scores, a group difference was observed only in the sociability grouping at Time 1. In the low sociability group, a marginal (p=0.049) interaction between valence and intensity was found. This interaction, however, was not observed at Time 2. Additionally, poor test-retest reliability and internal consistency of the task were observed.

These findings bring into question the nature of attentional bias in social anxiety, shyness, and sociability, and the psychometric soundness of the dot probe task. Conceptual and psychometric issues are discussed pertaining to the present study's results and the extant dot probe literature.

Acknowledgments

I would like to first thank my supervisor, Louis Schmidt, for his support this last year during the completion of my thesis and as well for his support regarding my future career aspirations. I would also like to thank the members of the Child Emotion Lab for their help with the thesis project and their friendship over the last year. Finally, I would like to give thanks to my family for their unconditional encouragement and support.

List of Tables

List of Figures

List of Appendices

Table of Contents

Introduction

Anxiety can be described as "an unpleasant feeling of fear and apprehension accompanied by increased physiological arousal" (Davison, Blankstein, Flett, & Neale, 2008, p. G1). Generally, it is thought that, in anxiety, certain kinds of information, specifically threat-related, are handled differently than other information by attentional processing (Bar-Haim, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007). Many cognitive theorists describe the nature of information processing in anxiety and emphasize the role of attentional biases to threatening information in anxiety's origins and maintenance.

Early cognitive accounts, such as those proposed by Beck (1976) and Bower (1981), describe schemas that direct cognitive processing. A major prediction of these theories is that anxiety involves schemas biased to threatening material, and that this bias to threat equally affects all cognitive processing stages, namely attention, interpretation, and memory. However, evidence suggests that attentional biases are more greatly associated with anxiety than biases in the other stages of processing, specifically recall (Mogg & Bradley, 1998; Yiend, 2010). As a result of unsupportive data, schema theories (e.g., Beck, 1976; Bower, 1981) have become less prominent in the study of anxiety-associated cognitive biases to threat.

In contrast to schematic theories, more recent accounts predict that a threat-related bias can occur at specific information processing stages, thereby affecting each stage differentially (Mogg & Bradley, 1998). For example, Williams, Watts, MacLeod, and Mathews (1988) argues that anxiety is associated with threat-related biases early on in processing, essentially confined to selective attention and processes prior to awareness. An apparent feature of more recent theories (e.g., Williams et al. 1988) is that the time course of attentional processes plays a role in the maintenance of anxiety. Additionally, some current theories specify the direction of the attentional bias in anxiety, making a distinction between bias towards threat (vigilance) and bias away from threat (avoidance) (Bar-Haim et al., 2007). Overall, the theories agree there is an attentional bias to threat in anxiety.

Attentional Biases and Anxiety

Attentional biases have been explored in many anxious populations. Clinical populations include patients with general anxiety disorder, panic disorder, specific phobia, post-traumatic stress disorder, and obsessive-compulsive disorder (e.g., Asmundson, Sandler, Wilson, & Walker, 1992; Dalgleish, Moradi, Taghavi, Neshat Doost, & Yule, 2001; Mogg & Bradley, 2005; Summerfeldt & Endler, 1998; Wikstrom, Lundh, Westerlund, & Hogman, 2004). Individuals with non-clinical, high trait anxiety have also been examined (e.g., Bradley, Mogg, Fall, & Hamilton, 1998). The majority of studies that investigate attentional biases in anxiety consist of general anxiety disorder, specific phobia, and high trait anxiety populations. A meta-analysis conducted by Bar-Haim et al. (2007) included various clinical and non-clinical anxious populations and experimental methodologies, and demonstrated that a threat-related attentional bias exists. Largely, it is thought that vigilance to threat constitutes the attentional bias in anxious individuals (Yiend, 2010). Additionally, this bias has been observed early in processing and outside awareness.

In addition to the aforementioned anxious populations, attentional biases have been examined in social anxiety. An individual with social anxiety typically is fearful of social situations and experiences discomfort while interacting with others (Crozier, Gillihan, & Powers, 2011). Interestingly, inconsistent findings have been observed in studies of clinical social anxiety and studies that investigate individual differences in non-clinical social anxiety. Some studies support vigilance to threat and others observe avoidance (Miskovic & Schmidt, 2012; Mogg, Philippot, & Bradley, 2004; Asmundson & Stein, 1994; Chen, Ehlers, Clark, & Mansell, 2002; Mansell, Clark, & Ehlers, 2003). Vigilance followed by avoidance has been found in some studies (e.g., Vassilopoulos, 2005), while others have observed no bias (e.g., Pineles & Mineka, 2005; Mansell, Ehlers, Clark, & Chen, 2002). Therefore, the nature of attentional bias to threat in social anxiety is unclear, as is whether or not an attentional bias actually exists (Yiend, 2010).

Emotional Stroop Task and Attentional Biases

Researchers of the various anxious populations have utilized a number of paradigms to investigate attentional biases (Yiend, 2010). One such paradigm is the emotional Stroop task, which has dominated work on attentional biases in social anxiety. The emotional Stroop task is a modified version of the attentional task devised by Stroop (1935). In the original task, participants are presented with the words of colours (e.g., “blue”, “green”) written in coloured ink, either congruent or incongruent with the semantic meaning of the words, and asked to name the ink colour. In the modified version of the task, the stimuli typically consist of emotional words that are positively and negatively valenced (e.g., “smile” and “agony”, respectively), and non-emotional/neutral words as a control (e.g., “chair”). As in the original Stroop paradigm, the words are presented in various ink colours and participants are required to name the colour of each word as they are presented. The speed at which colour-naming takes place following stimulus onset is measured. An attentional bias to threat is inferred when longer latencies occur with threatening words when compared to latencies associated with neutral words (Bar-Haim et al., 2007). Slower reaction times (RTs) in colour-naming threatening words suggest interference between processing the semantic content of the presented word and specifying the ink colour. This observation is thought to indicate allocation of processing resources to semantic content (Mogg & Bradley, 1999).

Interference effects in the Stroop task pose interpretive problems. The longer latencies associated with threat in anxiety may not simply be due to participants selectively attending to the word content alone (Bogels & Mansell, 2004). Some researchers have put forward alternative explanations, arguing that other cognitive processes may confound the observed Stroop effect to threat. For example, an emotional reaction, like a startle, may be elicited by the threatening content of the words. In turn, this startle may temporarily block one's ability to respond, therefore slowing RT (Cloitre, Heimberg, Holt, & Liebowitz, 1992). Another possibility is that participants become preoccupied by themes associated with the emotional word, again leading to slower RTs (Wells & Matthews, 1994). Additionally, as previously mentioned in some cognitive anxiety theories, a distinction is made between vigilance and avoidance in attention. Some studies claim the interference effect indicates vigilance to threatening material (Bogels & Mansell, 2004). However, since the task may be tapping into other cognitive processes, in addition to those involved in selective attention, the results of the emotional Stroop task cannot be directly discussed in terms of selective attention and attentional bias direction in social anxiety (Bogels & Mansell, 2004).

Dot Probe Task and Attentional Biases

The interpretive issues associated with emotional Stroop findings have prompted researchers to use another paradigm, the visual probe task, to study the allocation of attention and attentional biases (Mogg & Bradley, 1998). The visual probe task, also referred to as the dot probe task, does not require participants to respond when emotional information is present; rather a response is made with the presentation of a neutral stimulus, the probe (Yiend, 2010). Therefore, other cognitive processes are not thought to confound dot probe data like they do in the emotional Stroop data.

On a given trial in the dot probe paradigm, a crosshair or fixation point is first presented, followed by an emotional (threatening or positively valenced) stimulus paired with a neutral stimulus for a specified length of time, typically 500ms (Miskovic & Schmidt, 2012). After the offset of the stimuli, a probe is presented. Participants are required to indicate the location or identify the type of probe. The probe replaces either the emotional or neutral stimulus. A trial in which the probe replaces the emotional stimulus is considered a congruent, or valid, trial. When the probe appears in the location of the neutral stimulus, the trial is referred to as incongruent, or invalid. Congruent and incongruent trials occur with equal probability. The participants' RTs are recorded, and in most cases, a bias score or index is calculated using RTs of both the incongruent and congruent trials (e.g., Mogg & Bradley, 2002; Vassilopoulos, 2005). The score is calculated by subtracting RT of congruent trials from RT of incongruent trials for each participant. A positive bias score indicates vigilance to threat, while a negative score signifies avoidance from threat.

Many aspects of the dot probe task have been altered and can vary between studies. In the original dot probe task developed by MacLeod, Mathews, and Tata (1986) stimuli consisted of threatening words paired with neutral words. The verbal stimuli were presented vertically, with one word in the upper location of a computer screen, and the other below. When presented with the stimuli, participants were required to read aloud the upper word. This instruction was included so that the participant was focused on the same location at the onset of each trial (Asmundson & Stein, 1994). The original task also included trials without probes.

The dot probe paradigm has evolved since the original study to no longer require participants to read verbal stimuli (e.g., Mansell et al., 2002). In addition, more recent studies tend to present a probe on all trials, however this is not always the case (e.g., Asmundson &

Stein, 1994). A major change in dot probe studies is the incorporation of facial expression stimuli (e.g., Chen et al., 2002; Mogg et al., 2004). The inclusion of facial stimuli into the paradigm is largely due to the evolutionary perspective that threat-related facial expressions (e.g., anger) may be more biologically relevant, having greater threat value, than threat-relevant words (Bradley, Mogg, Falla, & Hamilton, 1998). It may be argued that findings from studies using faces are more representative of the nature of attentional biases to threat.

Some dot-probe studies introduce social stress to participants (e.g., Pineles & Mineka, 2005; Vassilopoulos, 2005). Prior to completing the dot probe task, participants may be told they will be giving a speech later in the session. A "speech" condition such as this may be contrasted with a "no speech" condition, where social stress is not introduced (e.g., Pineles & Mineka, 2005). Sometimes, however, only a "speech" condition is used (e.g., Vassilopoulos, 2005).

Studies with other variations in stimuli also exist in the literature: for example, pairing facial stimuli with household objects in a given trial (e.g., Mansell et al., 2002) and, occasionally, including more than one exposure time in the task (e.g., Miskovic & Schmidt, 2012). Manipulating exposure time has been included in the task as a way to examine the time course of attentional biases in information processing. This manipulation can allow for the exploration of biases early on in attentional processing and those that may occur later, with elaboration. Additionally, the strength or intensity of a stimulus' emotional facial expression can be manipulated in dot probe tasks. It appears, though, that manipulating this dimension in social anxiety is rare, as Miskovic and Schmidt (2012) may be the only authors to date to do so.

The described variations of the dot probe have been incorporated into social anxiety research. The heterogeneity of the dot probe tasks across studies may contribute to the apparent inconsistent and contradictory observations in socially anxious individuals. It may be the case that each variation of the paradigm taps into different phenomena by introducing variables that are not apart of other variations. One research group has done a direct comparison of two versions of the dot probe in trait anxiety and found similar results when participants were asked to indicate probe location and classify the probe (Mogg & Bradley, 1999). While similar results were observed, research that directly compares dot probe versions in a systematic fashion by altering one or few aspects of the task is uncommon. Thus, it is not clear whether the heterogeneity of manipulated variables in social anxiety research across studies is directly contributing to the mixed results.

Another explanation for the variable findings in social anxiety research may be that the task is not psychometrically sound. Indeed, examination of the dot probe's psychometrics is almost non-existent in the literature. To date, there appear to be only two studies that have specifically investigated the reliability of the dot probe. In the first study (Schmuckle, 2005), stimuli consisted of threatening and neutral words paired together and presented for 500ms on each trial. Non-clinical participants were required to indicate the presence of a probe. The task was administered for a second time one week after the first. Internal consistency and test-retest reliability estimates revealed that the task was unreliable, as split-half correlation, Cronbach's alpha, and Pearson r correlation values were very low and statistically non-significant. The experiment was repeated using paired threatening and neutral scenes and similar results were observed.

Another psychometric study of the dot probe was conducted by a different research group. Staugaard (2009) explored the test-retest reliability of the dot probe after a one to two week interval. Unlike the previous study, this experiment used facial stimuli (happy or angry paired with neutral) that were presented for two exposure times, 100ms and 500ms. In addition, Staugaard (2009) manipulated the length of time the stimuli remained onscreen until response, which involved classifying the probe. Once more, the dot probe was found to be an unreliable measure.

The Present Study

As it was discussed earlier, dot probe findings from studies examining attentional biases in clinical and non-clinical social anxiety are mixed. The heterogeneity of manipulated variables in the task across studies may in part account for the discrepant findings, as may the lack of sound psychometric characteristics of the task. In order to attempt to reconcile the described discrepancies, the present study had two overarching goals. The first goal was to replicate and extend the literature by investigating attentional bias to threat and individual differences in personality types associated with social approach and social avoidance behavioural styles, and social anxiety in a non-clinical sample while incorporating various modifications into the dot probe task. More specifically, individual differences were explored through measuring preference for affiliation and social avoidance, or sociability and shyness, respectively. Shyness and sociability are related but distinct personality types (Cheek & Buss, 1981). The former is characterized by fear and discomfort in social situations, as well as avoidance behaviours like gaze aversion. The latter personality type is described as a desire to be with others.

A number of variables were manipulated in the present task in order to achieve the primary goal of this study. Angry and happy facial stimuli of varying emotional strength were paired with neutral facial stimuli at 2 exposure times. The design of the present experiment was guided by a detailed study of attentional bias in non-clinical social anxiety by Miskovic and Schmidt (2012). Unlike in most previous dot probe work, many stimuli manipulations were incorporated into their single dot probe task, such as stimulus valence, exposure time, and intensity. Their findings suggest vigilance to threat in early processing is associated with high social anxiety.

The extent of emotional ambiguity conveyed by facial expression may also be important in anxious individuals, in that vigilance may occur with more moderate and ambiguous emotional expressions in high social anxiety. If Miskovic and Schmidt (2012)'s findings regarding a non-clinical sample can be generalized, it was expected that, in the present study, vigilance would be observed with threatening stimuli presented at a shorter exposure time when contrasted to non-threatening stimuli in those who are high in social avoidance, discomfort, and fear. It was also expected that individuals high in sociability would be associated with attentional bias towards non-threatening, positively-valenced stimuli in comparison to threatening stimuli. This bias may occur even with moderate intensity. It appears attentional bias and sociability have not been explored using the dot probe; however, electrophysiological data suggests people high in sociability may experience more positive emotion, thereby promoting approach behaviour and a general positive perspective of stimuli in the environment (Schmidt & Fox, 1994).

In light of the findings by Schmuckle (2005) and Staugaard (2009), the second goal of the present research was to examine the test-retest reliability and internal consistency of the dot probe paradigm. In order to do this, participants completed the dot probe task twice, on separate days, approximately one month apart in time. It was expected that any attentional biases to stimuli revealed by the task at one instance in time would be observed again with a second administration of the task, after one month. The relation between responses at T1 and T2 were determined by three types of reliability analyses: Pearson r correlation; intraclass correlation, which takes into account rank order; pairwise *t*-tests of mean responses at T1 and T2; and Cronbach's alpha of internal consistency. These types of analyses are comparable to those utilized by Schmukle (2005) and Staugaard (2009), as well as in other test-retest reliability work (Schmidt et al., 2012).

Method

Participant Demographics

Participants consisted of 42 undergraduate students from McMaster University (*M* age = 19.39 years, range 18 to 30; 28 females, 14 males) and were recruited through the Experimetrix system in the Department of Psychology, Neuroscience, and Behaviour. Most participants received two psychology course credits for their participation in both visits. Those who did not require credits were paid $20 remuneration for their participation in both visits.

Personality Measures

Social Phobia Inventory (SPIN) (Connor et al., 2000). The SPIN is a widely used self-report measure consisting of 17 items that capture fear, avoidance, and the physiological symptoms of social anxiety. Good psychometric properties have been demonstrated in the SPIN, specifically, strong test-retest reliability, internal consistency, and convergent and divergent validity in a clinical sample (see Appendix A for questionnaire).

Shyness and Sociability Scale (SSS) (Cheek & Buss, 1981).The SSS is a 10-item self-report measure that captures discomfort during social interactions and preference for being with others through two separate subscales, a shyness subscale (SHY) and sociability subscale (SOC), respectively. The SSS has demonstrated good psychometric properties in non-clinical individuals (see Appendix B for questionnaire).

Procedure

The testing took place at the Child Emotion Laboratory at McMaster University. Prior to testing, participants were given a brief overview of the experiment and provided with a consent form to sign. Participants were told they could terminate the experiment at any time and refrain from answering all questionnaire items without penalty if they did not feel comfortable to do so. After signing the consent form, participants filled out a demographic questionnaire, regarding their age, year of study, ethnic background, handedness, and current medication usage (if applicable) (see Appendix C for questionnaire).

The dot probe task was then administered on a computer using E-prime in a dimly lit room. Participants were seated approximately 100cm from the computer monitor (~4.5° visual angle). Following the task, participants completed the personality measures.

At the first visit, the date of the second visit was scheduled. Participants were asked to return 4-weeks after the first visit. On average, the amount of time between visits was 28.24 days. At the second visit and after experimentation, participants were debriefed and either paid or assigned course credit.

Face Stimuli

Photographs of two males (models 24 and 25) and two females (models 3 and 10) with angry, happy, and neutral facial expressions were selected from the NimStim Face Stimulus Set. The photographs of angry and happy facial expressions underwent a morphing procedure previously devised by Gao and Maurer (2009) and utilized by Miskovic and Schmidt (2012) to create two emotional intensity levels: moderate and strong. In brief, both intensities were achieved by morphing each valence of facial expression (i.e., angry and happy) with a neutral face of the same individual to 50% strength for moderate and 100% for strong (see Figure 1 for an example of the facial stimuli).

Dot Probe Task

Each trial began with the presentation of a fixation cross in the centre of the screen for 500ms. Following this duration, a pair of faces from the same model appeared simultaneously on the right and left. Pairs of facial expressions consisted of angry-neutral, happy-neutral, and neutral-neutral faces. Each pair was presented for an exposure duration of either 100 or 500ms. At the offset of the pair, a probe 'X' appeared, replacing one of the facial stimuli. Participants were instructed to indicate the location of the probe (left or right), and respond as quickly and accurately as possible. They were also instructed to keep their eyes on the fixation cross during each trial and ignore the faces. Participants had 1500ms to provide their response before the next trial began. Responses given within the 1500ms interval immediately initiated the next trial (see Figure 2 for illustration). Participants completed a set of 15 practice trials, followed by 2 blocks of experimental trials, consisting of 256 trials overall and separated by a short break. Exposure duration, intensity, and valence were randomized and counterbalanced for each participant and visit. Randomization and counterbalancing of probe and stimuli screen position, and gender of the models were also used.

Overall, there were 16 RT conditions at each visit as a result of manipulating exposure time [short(S); long(L)], valence [happy(H); angry(A)], and intensity [moderate(M); strong(S)], as well as classifying trials as either congruent (C) or incongruent (I). Attentional bias scores were calculated by subtracting congruent RTs from incongruent RTs, thus creating 8 bias score conditions.

Data Loss and Exclusion

Data from correct trials only were used for analyses. Incorrect trials were excluded and accounted for 1.2% of trials overall. Trials in which participants responded faster than 100ms and slower than 1000ms were also excluded. These trial exclusion criteria were chosen in order to remain consistent with the recent and comprehensive work of Miskovic and Schmidt (2012). In total there were 0.1% extreme trials. After applying the exclusion criteria, SPSS box plots of the data in all 16 conditions from both visits were inspected for outliers. Five participants were found to skew the data in a positive direction and were therefore excluded to obtain more appropriate normality within the conditions. A sixth participant was also excluded from analyses because the participant did not return for a second visit. Accordingly 36 participants (25 females, 11 males) were included in the analyses described below.

Data Analyses

To examine individual differences, participants were parsed into high and low groups of SPIN (high=18; low=18), SHY (high = 19; low = 17), and SOC (high=18; low=18) based on a medium split on the respective personality measure.

Separate mixed model analyses of variance (ANOVAs) were conducted for each personality grouping (SPIN, SHY, SOC) at each visit, with Group (high/low) as the between-subject factor, and Exposure Time, Valence, and Intensity as within-subject factors. The dependent measure was attentional bias score.

To examine the test-retest reliability of the dot probe task, Pearson r correlations, intraclass correlations (ICC), and pairwise *t*-tests were performed on the 16 RT conditions and 8 attentional bias scores conditions between Time 1 and Time 2.

Results

I. Relations between Personality and Attentional Bias

The primary goal of the present study was to replicate and extend the extant literature by investigating the relation between individual differences in personality and attentional biases to threat while incorporating various modifications into the dot probe task. Within-subject relations between personality measures and attentional biases are reported first. Next, between-subject/individual differences in personality and their relations to attentional bias scores are presented.

1. Within-subject Relations

In order to explore the relation between personality measures and attentional bias scores, the stability of the personality measures was first established. Pearson r values of the three personality measures were highly stable across the one month from Time 1 to Time 2 (see Table 1). The ICC values revealed high agreement between participants' scores at Time 1 and Time 2. The means did not significantly change, as demonstrated by non-significant pairwise *t*-tests. Overall, these three analyses suggest that the retest reliability of the three personality measures was excellent. Because of the high stability across time for the personality measures, for each subscale, means at Time 1 and Time 2 were averaged to create one set of scores for each personality measure and used in further analyses.

Using these composite scores, each personality measure was examined in relation to the attentional bias scores separately at each visit. A series of Pearson correlations revealed no relations between the SPIN, SHY, and SOC composite measures and the attentional bias scores (see Table 2). Pearson r values were generally low and occasionally negative.

Attentional bias scores were then collapsed across intensity, valence, and exposure time (see Table 3). Collapsing across each of these conditions allowed for easier comparison of test-retest reliability values to other findings in the literature, particularly where intensity was not manipulated. Valence and exposure were also collapsed across so as to be comprehensive in the investigation of attentional bias scores. Here again, Pearson r values were generally low, occasionally negative, and not significant.

2. Between-subject/Individual Differences Relations

A significant Group x Valence x Intensity was predicted separately for each of the three personality groupings. Separate mixed model ANOVAs were performed for each personality measure at Time 1 and Time 2, with Group (high/low) as the between-subjects factor and Exposure Time (short/long), Valence (happy/angry), and Intensity (moderate/strong) as within-subjects factors. The dependent variable was the dot probe attentional bias scores across the various conditions. No significant main effects or interactions were observed for the SHY or SPIN groupings at either visit. Accordingly, these results are not discussed further.

There was, however, a significant Group x Valence x Intensity interaction for the sociability grouping on attentional bias, but those effects were for the low SOC group. A significant Group x Valence x Intensity interaction was observed at Time 1 for the sociability scale ($F(1,34) = 4.155$, $p=0.049$). Low SOC demonstrated greater vigilance to moderate happy faces ($M = 4.975$, $SD = 2.416$) relative to moderate angry faces ($M = 1.282$, $SD = 2.310$), and greater vigilance to strong angry faces ($M = 8.724$, $SD = 2.628$) relative to strong happy faces ($M = 1.000$, $SD = 3.061$) (see Figure 3). However, the Group x Valence x Intensity interaction was no longer significant at Time 2 ($F(1,34) = 0.031$, $p=0.860$).

II. Dot Probe Task Psychometrics

The second goal of the present study was to reconcile and clarify the inconsistencies in the extant attentional bias literature that has used the dot probe by investigating the test-retest reliability and internal consistency of the dot probe task. Test-retest reliability of the dot probe over time was measured by performing Pearson r correlations, ICC, and pairwise *t*-tests on the 16 RT conditions from which the attentional bias scores were derived from Time 1 and Time 2 and the 8 attentional bias scores. As well, the attentional bias scores were also collapsed across valence, intensity for additional comparison.

A. Dot Probe Task: Test-Retest Reliability

i. RT Across Conditions

Pearson r and ICC values for the 16 individual conditions from which the attentional bias scores were derived revealed medium to strong effects, indicating good overall test-retest reliability between Time 1 and Time 2 for the individual conditions (see Table 4). Pairwise *t*-tests revealed that the means for most of the conditions differed from Time 1 to Time 2, suggesting a possible practice effect from Time 1 to Time 2. At Time 2, in all conditions, overall the participants performed faster. However, as indicated by the ICC, the participants maintained their rank order across both visits.

ii. Attentional Bias Scores

The test-retest reliability was not, however, as promising for the attentional bias scores. Pearson r and ICC values for the 8 attentional bias scores conditions were not significant, small and sometimes negative, therefore indicating poor test-retest reliability across visits (see Table 5). As well, the means of the conditions did not differ significantly from Time 1 to Time 2, as indicated by non-significant pairwise *t*-tests. Interestingly, all of the attentional bias score conditions' means at Time 1 and Time 2 for all groups were positive values save one, indicating vigilance, as it is generally described in the dot probe literature. Using Cooper and Langton (2006) as a guide, one-sample *t*-tests were performed, revealing that these values did not significantly differ from 0, a value that denotes no attentional bias. The means of the interaction reported in the low SOC group at Time 1 in the previous section were positive values, yet did not differ significantly from 0 either. The results of the *t*-tests therefore suggest that positive bias score values are not necessarily indicative of vigilance. A similar pattern of results was observed with collapsed bias scores as with the non-collapsed scores (see Table 6).

B. Dot Probe Task: Internal Consistency

i. Attentional Bias Scores

Cronbach's alpha was calculated for within each stimulus category (i.e., valence, exposure time, and intensity) using the attentional bias score conditions' means. The values were generally low and sometimes negative, indicating poor internal consistency. The alpha coefficients at Time 1 were the following: happy = 0.268; angry = -0.213; short exposure = 0.621; long exposure = -0.013; moderate intensity = -0.315; and strong intensity = 0.493. At Time 2, the alpha coefficients were 0.026, 0.291, 0.456, -0.076, -0.119, and 0.522 for happy, angry, short, long, moderate, and strong, respectively.

Discussion

The dot probe task has been widely used to study attentional bias to threat in many anxious populations, including socially anxious individuals. Interestingly, inconsistent findings have been observed in dot probe studies of clinical and non-clinical social anxiety. Some studies report vigilance and/or avoidance, as well as no bias to threat. The discrepancies in the literature may be due in part to the heterogeneity of manipulated variables across studies, such that each variation of the paradigm may be sensitive to different phenomena by introducing variables that are not apart of other variations. The inconsistency in findings in social anxiety may also be due to the psychometric soundness of the task. To date, there appear to be only two studies that have specifically investigated the test-retest reliability of the dot probe and both have found the task to be unreliable.

The present study had two overarching goals, prompted by the inconsistent findings in the social anxiety dot probe literature. The first goal was to replicate and extend the literature by investigating attentional bias to threat and individual differences in personality types associated with social approach (sociability) and social avoidance (shyness), and a clinical measure of social anxiety in a non-clinical sample while incorporating various modifications into the dot probe task.

Using the recent study by Miskovic and Schmidt (2012) as a guide, it was predicted that vigilance would be observed with threatening stimuli presented at 100ms when contrasted to non-threatening stimuli in those who were assigned to the high SHY and high SPIN groups. Contrary to prediction, no differences were found in shyness and social anxiety at either visit on any of the attentional bias scores. Additionally, angry and happy faces were attended to similarly regardless of exposure time or intensity. The present experiment, therefore, did not replicate the findings of Miskovic and Schmidt (2012), despite using their study as a guide and incorporating a number of their modifications into the task.

A second prediction regarding individual differences and attentional biases was that individuals in the high SOC group would be associated with vigilance towards non-threatening, positively-valenced stimuli in comparison to threatening stimuli. Moreover, it was thought this bias would occur with more moderate and ambiguous expression. This prediction was not met. However, an interaction between valence and intensity was observed in the low SOC group at Time 1. When intensity was strong, the low SOC group paid greater attention to angry faces than to happy faces. With moderate intensity, happy faces were more greatly attended to than angry faces.

The second goal of the present study was to examine the psychometric properties of the dot probe task, specifically test-retest reliability and internal consistence, by having participants complete a task with manipulations of stimulus valence, intensity, and exposure time, twice, approximately one month apart in time. It was expected that any attentional biases to stimuli revealed by the task at one instance in time would be observed again with a second administration of the task, one month later. The correlational analyses performed on the 16 conditions revealed good test-retest reliability across visits. Although many of the means of these conditions significantly differed from Time 1 to Time 2, inspection of the means at both visits showed that, in all 16 conditions, participants responded faster at Time 2, perhaps indicating a practice effect.

In contrast to the 16 conditions, the 8 bias score conditions that were derived from these individual RTs were not as reliable. The low and sometimes negative Pearson r and ICC values demonstrated that the patterns of the participants' scores in the bias score conditions were not stable, such that rank order was not maintained across visits. Despite this shift in participants' scores across visits, the means of the bias score conditions did not shift. RT differences between congruent and incongruent trials in all bias score conditions were similar across time. Testing the means to a value of 0 revealed no attentional bias in any condition. The same method was used for the means of the significant interaction found in the low SOC group at Time 1. Again, no attentional bias was found, despite the mean values being positive.

Cronbach's alpha was also calculated to assess internal consistency of each stimulus category (i.e., valence, exposure time, and intensity) at both visits. Internal consistency was poor.

Discussion on the Present Results and the Dot Probe Task

The results of the present study highlight a number of issues that currently exist in the social anxiety dot probe literature. These issues are conceptual and psychometric in nature. These issues also are important to consider because they may have implications for interpreting dot probe findings and drawing conclusions about attentional biases to threat in the literature. Some of these issues are touched on below.

I. Conceptual Issues

Individual differences in social anxiety and shyness were not found, nor were any attentional biases to threat, unlike in Miskovic and Schmidt (2012)'s study. These findings were unexpected since the design of the present study was based on their experiment and the SPIN was utilized by both experiments to assess social anxiety in a non-clinical sample.

Discrepant findings between any two dot probe studies could be due to how attentional bias is defined. The absence of attentional bias to threat in the present study was determined by comparing the mean scores of the attentional bias conditions, almost all of which was a positive value, to 0, a value denoting no bias. An alternative approach is to establish whether there is a significant difference between congruent and incongruent trials prior to calculating bias scores (e.g., MacLeod & Mathews, 1988). No significant difference would indicate that RTs on the two trial types were similar. Attentional bias score values then calculated would be comparable to bias score values of 0. Comparisons like these are not made in all studies (e.g., Vassilopoulos,

2005) If neither approach is used, positive values arising from faster responses on congruent trials may then be construed as vigilance, simply because they are positive. Likewise, negative scores may be interpreted as avoidance due to the fact that they are negative. As a result, the finding that there was no attentional bias may be underrepresented in the literature, since positive and negative values may not always be indicative of vigilance and avoidance, respectively. Differences in defining a bias across studies could distort the general conclusions about attentional biases drawn from dot probe work.

The discrepant findings between the present study and those of Miskovic and Schmidt (2012) were unlikely due to differences in how bias was defined. As a first step in their study, it was established that the means of congruent and incongruent trials were significantly different from each other. Miskovic and Schmidt (2012) too used *t*-tests to compare mean bias scores to 0, to verify the presence and direction of bias. However, discrepancies could have come about from participant selection. Miskovic and Schmidt (2012) used the RT data from participants selected from a larger sample who had the most extreme scores on the SPIN (i.e., lowest and highest), whereas in the present study, participants were not selected for high and low social anxiety, but rather a median split was utilized. Another difference between the study conducted by Miskovic and Schmidt (2012) and the present one was the incorporation of a third exposure time and intensity level.

Perhaps discrepancies across studies are also related to the phenomenon of interest, not simply the differences outlined so far. Social anxiety is thought to be associated with cognitive biases; for example, socially anxious individuals tend to have negative thoughts about their performance in social interactions, and may engage in pre- and post-processing of social situations (Clark & McManus, 2002; Wallace & Alden, 1997). However, in terms of the existence and nature of attentional allocation to threat in social anxiety, it is not clear. The dot probe task was specifically developed to more directly measure attention allocation than other existing tasks, but, as described elsewhere, results from dot probe studies examining social anxiety have been mixed. In addition, the personality construct of shyness and its relation to threat-related biases did not appear to have been explored using the dot probe prior to this study. Thus, attention allocation to threat in shyness is not clear as well.

Assuming the existence of a bias, the observation of an attentional bias to threat may depend on what variables or manipulations are present in a dot probe experiment. Each variation of the paradigm may tap into different phenomena by introducing variables that are not included in other variations. This idea was alluded to in comparing the Miskovic and Schmidt (2012) study to the present study. It is possible the present experiment did not have the ‘right’ variables in place, in order to observe an attentional bias to threat in the high SHY and SPIN groups. Also, perhaps group differences in attentional bias did not become apparent because participants with extremely high and low levels of social anxiety were not examined, whereas they were in Miskovic and Schmidt (2012).

Individual differences in sociability were also examined in the present study, and, similar to shyness, it seems this was the first to explore attentional bias to threat in this personality type using the dot probe. The low SOC interaction at Time 1 may fit with existing behavioural data on sociability from other lines of work. For example, although low sociability has been linked to introversion, individuals low in sociability were found to exhibit more behaviours associated with social anxiety than individuals high in sociability during a social interaction with a stranger (Schmidt & Fox, 1994). The low SOC group may then conceptually overlap with those high in SHY and SPIN. In the low SOC group, greater attention was paid to strong angry faces than moderate angry faces, as indicated by a more positive value in the former condition. This finding is somewhat in line with the high SPIN results in Miskovic and Schmidt (2012). With a short exposure time, high SPIN participants showed an attentional bias to strong angry faces and to ambiguous emotional expressions more generally.

Although the low SOC findings may be supported by other work, the interaction observed at Time 1 was marginal (*p*=0.049) and no longer present at Time 2. The marginality of the significant interaction and inability to reproduce Time 1's results at Time 2 brings into question the meaningfulness of the phenomenon observed at Time 1. Perhaps it is not representative of the nature of selective attention allocation in sociability. Similar to the shyness and social anxiety groups, the 'right' variables may not have been in place to tap into the phenomenon, providing attentional biases are associated with sociability.

II. Psychometric Issues

The psychometric soundness of the dot probe task itself is also in question. While the 16 conditions from which the bias scores were derived demonstrated good test-retest reliability, the bias score conditions did not. The test-retest reliability and internal consistency results from the bias score conditions are comparable to those of Schmuckle (2005) and Staugaard (2009). Cronbach's alpha values and Pearson r values were low, and in some cases the correlations were negative. The means of the bias score conditions did not significantly differ between the two visits in the present study, however, poor test-retest reliability was confirmed by examining the agreement in rank order between the scores at Time 1 and Time 2. To better illustrate this latter finding, a participant in a given condition may be on average faster to respond to a probe on congruent trials than incongruent at Time 1, but at Time 2, faster on incongruent trials than congruent in that same condition. The participant would have a positive mean bias score at Time

1 and a negative mean score at Time 2. The change in the magnitude of the score would result in a change in that participant's rank order.

This present study appears to be the third to suggest the task is unreliable. However, the lack of stability across visits may not be simply due to the measure alone. Other factors may be contributing to the lack of reliability observed. One matter potentially worth exploring would be the faster RTs observed at Time 2. All of the means at the second visit decreased, and in most of the 16 conditions, the difference between Time 1 and Time 2 RT means was significant. The speeded responses at Time 2 may be due to a practice effect or perhaps a change in motivation to complete the task the second time. Indeed, some participants commented on the monotonous nature of the task. At the second visit, participants may have felt more compelled to finish the task as quickly as they could, in order to end the session sooner. Nonetheless, the means of the bias score conditions could have been impacted by the speeded responses. A way in which to explore the effect of this shift in RTs on the test-retest reliability analyses, and to therefore account for some of the error between scores at Time 1 and Time 2, would be to standardize the RTs of one visit to the other for each participant, calculate new bias scores, and perform the test-retest reliability analyses on the new scores. Standardization of the RTs may remove any unknown variables from the data and make the responses at both visits more comparable. If each RT condition is equally affected by the change, it can be inferred that the same variable (or combination of variables) is affecting every condition. Removal of the unknown variable (or variables) may or may not alter the bias score correlation values.

Schmuckle (2005) and Staugaard (2009) did not report any information regarding the RT conditions from which their bias scores were derived, so it is unclear whether this decrease in RT means is unique to the present study or if it is characteristic of repeated dot probe studies.

Administration of the task for a third time may be informative. If the RT means at the third visit are not significantly different from those at the second visit, one could speculate that a variable unique to Time 1 may have been at play. On the other hand, this pattern of findings may be typical of the dot probe task administered multiple times and potentially a reflection of a practice effect. This has yet to be done, however.

Overall, the results of the present study were not able to reconcile the discrepancies observed in the social anxiety dot probe literature. It is also unclear what contributed to the discrepancies across visits seen in the current results. Little is known about the measure itself, since few studies have examined its psychometric properties. Additionally, the information regarding the phenomenon of interest in social anxiety, shyness, and sociability is limited. The manipulations incorporated into the task may interact with the measure and phenomenon as well in ways that are currently unknown. There is also a subtle but important issue regarding the definition and interpretation of attentional bias. Therefore, a number of conceptual and psychometric issues may be occurring in the literature. Further investigation is required to account for the differences in findings across studies and across time.

Future Considerations

The present study was a first step in examining the widely used dot probe task in a comprehensive manner. A number of manipulations were incorporated into the task, therefore extending the extant dot probe literature. In addition, the reliability of the task was investigated by way of a repeated measures design. Based on the findings of the existing dot probe literature and the results of the present study, some suggestions can be made regarding future work. In general, future work could focus on addressing some of the conceptual and measure-related issues discussed previously. The discrepancies in findings regarding social anxiety may therefore be better accounted for and general knowledge regarding attentional bias to threat may be further developed.

A major finding of the present experiment was that observations at one instance in time may not persist. In light of this, the field may benefit from moving beyond cross-sectional work, which currently dominates the extant literature, to work that involves repeated administrations of the task. For example, this approach would allow for the test-retest reliability of the measure to be investigated further. Repeating the same task multiple times could eventually establish the measure's range of variability. Any observed variability beyond that range could then be more easily attributed to a non-measurement factor, such as the phenomenon being measured or another external factor, or an interaction of the two.

Future work could also benefit from examining various combinations of manipulations. Attentional bias to threat in personality types associated with social approach and social avoidance behavioural styles, and social anxiety may be tapped into by certain sets of manipulations; however, it is currently difficult to determine which combinations are associated with which findings particularly in social anxiety. Thus, an approach may involve minimizing differences in variables across studies and altering the sets of manipulations in a systematic fashion, so as to be able to attribute more easily particular findings to specific combinations of manipulations. Moreover, repeated measures designs could be of use in determining whether the findings associated with a set of variables hold over time, thereby potentially clarifying the nature of the measured phenomenon. An example of a set of manipulations that may tap into social anxiety and the personality types of interest is the presence of social evaluative stress in conjunction with threatening facial stimuli of strong intensity, presented for a short duration. Some cognitive models (e.g., Clark, 1999) emphasize the importance of social evaluation in social anxiety, and presently, none of the studies that introduce social stress (e.g., Pineles & Mineka, 2005; Vassilopoulos, 2005) manipulate intensity.

An aspect of the task that may be important in better understanding mechanisms underlying attentional allocation is the visual angle of the facial stimuli relative to fixation. When ones' eyes are fixated on a crosshair at the centre of the computer monitor, the image of the crosshair falls on the fovea of the retina. If the eyes remain on the crosshair during the presentation of the facial stimuli, the stimuli's images will coincide with the parafoveal region of the retina, since they appear on either side of the crosshair. It is thought that a stimulus will be attended to if it is presented within approximately 1° radius from the point of fixation, while it is controversial whether stimuli presented outside of this radius may be attended to (Fox, Russo, Bowles, & Dutton, 2001). The position of stimuli relative to fixation may make a difference as to whether external information is processed. The visual angle, calculated using the distance of the stimuli from fixation and the distance of the observer from the computer monitor, was approximately 4.5° in the current study. Participants were instructed to ignore the faces and to keep their eyes fixated on the crosshair during the experiment at both visits. Assuming the participants followed this instruction, it is possible none of the stimuli were attended to, since they did not fall on the foveal region. Visual angle and instructions given to participants could be manipulated in future work in order to investigate the impact of these variables on responses in the dot probe task more generally. Eye-tracking may be of use in this endeavor in determining where participants are looking during the experiment and verifying compliance with instructions.

Future research could further investigate personality types associated with social avoidance and social approach. The present study seemed to be the first to use shyness and sociability as personality measures in threat-related attentional bias work. Other personality constructs could also be explored. Perhaps parsing participants based on other personality measures would reveal individual differences in attentional bias to threat that were expected but not observed in the current study. Additionally, the developmental trajectory of attentional biases to threat in social anxiety, shyness, and sociability is not known. The present sample of participants consisted of young adults. Studies examining children and older adults are more or less non-existent in the dot probe literature. Longitudinal, repeated measures designs could be utilized to examine attentional bias to threat over long periods of time in a group of non-clinical participants selected for social anxiety and/or a clinical group with social anxiety disorder.

Finally, to address the attentional bias definition issue described previously, a meta-analysis could be conducted. The presence of attentional bias to threat and its direction in social anxiety could be verified by performing one-sample *t*-tests on extant dot probe data. This work could elucidate the impact of different data interpretations on the general conclusions made about threat-related attentional biases in, not only the social anxiety literature, but also the dot probe literature as a whole.

Limitations

Some limitations of the present study may involve items that make this study less comparable to other dot probe studies of social anxiety. One item could be the use of only one social anxiety subjective measure, the SPIN. Other social anxiety measures, such as the Fear of Negative Evaluation and Social Phobia and Anxiety Inventory can be found in dot probe studies (e.g., Mogg, Philippot, & Bradley, 2004; Vassilopoulos, 2005). Additionally, in contrast to the study by Miskovic and Schmidt (2012), only two exposure times and intensity levels were used, not three. Further, high and low groups on the SPIN, SHY, and SOC could have been created by selecting the highest and lowest scorers on those measures. A replication of the Miskovic and

Schmidt (2012) study would have permitted a more direct comparison between the two studies' results.

The present study also did not fully assess the validity of the task except for predictive validity. One can infer from the poor reliability results that validity too would be poor, since a measure technically cannot be valid and have poor reliability. However, performing validity analyses would have allowed for more explicit and general conclusions to be made about the psychometric characteristics of the task in this study.

Conclusion

Inconsistent findings exist in the dot probe literature pertaining to social anxiety and attentional bias to threat. It is not clear what may be contributing to the discrepancies between studies. The present study sought to replicate and extend the literature by incorporating a number of variables into a single dot probe task and examining individual differences in social anxiety and the personality constructs of shyness and sociability. Additionally, an attempt to reconcile the mixed findings was made by way of examining the test-retest reliability and internal consistency of the dot probe measure. The results of the study highlight a number of issues that currently exist in the extant literature, and they are conceptual and psychometric in nature. There are many avenues for further exploration, however. The focus of future endeavors could be on addressing these issues as a way to reconcile discrepant findings and more generally expand on extant knowledge of threat-related attentional biases.

References

Asmundson, G. J. G., Sandler, L. S., Wilson, K. G., & Walker, J. R. (1992). Selective attention toward physical threat in patients with panic disorder. *Journal of Anxiety Disorders, 6,* 295–303.

Asmundson, G. J. G., & Stein, M. B. (1994). Selective processing of social threat in patients with generalized social phobia: Evaluation using a dot-probe paradigm. *Journal of Anxiety Disorders*, *8*(2), 107-117.

Bar-Haim, Y., Pergamin, L., Bakermans-Kranenburg, M. J., & van Ijzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin*, *133*(1), 1-24.

Beck, A. T. (1976). *Cognitive therapy and the emotional disorders*. New York: International Universities Press.

Bogels, S. M., & Mansell, W. (2004). Attention processes in the maintenance and treatment of social phobia: Hypervigilance, avoidance and self-focused attention. *Clinical Psychology Review*, *24*, 827-856.

Bower, G. H. (1981). Mood and memory. *American Psychologist*, *36*, 443-455.

Bradley, B. P., Mogg, K., Falla, S. J., & Hamilton, L. R. (1998). Attentional bias for threatening facial expressions in anxiety: Manipulation of stimulus duration. *Cognition and Emotion*, *12*(6), 737-753.

Cheek, J. M., & Buss, A. H. (1981). Shyness and sociability. *Journal of Personality and Social Psychology*, *41*(2), 330-339.

Chen, Y. P., Ehlers, A., Clark, D. M., & Mansell, W. (2002). Patients with generalized social phobia direct their attention away from faces. *Behaviour Research and Therapy*, *40*(6), 677-687.

Clark, D. M. (1999). Anxiety disorders: Why they persist and how to treat them. *Behaviour Research & Therapy*, 37, S5-S27.

Clark, D. M., & McManus, F. (2002). Information processing in social phobia. *Biological Psychiatry*, *51*, 92-100.

Cloitre, M., Heimberg, R. G., Holt, C. S., & Liebowitz, M. R. (1992). Reaction time to threat stimuli in panic disorder and social phobia. *Behaviour Research and Therapy*, *30*, 305-307.

Connor, K. M., Davidson, J. R. T., Churchill, L. E., Sherwood, A., Foa, E., & Weisler, R. H. (2000). Psychometric properties of the Social Phobia Inventory (SPIN). *British Journal of Psychiatry*, *176*, 379-386.

Cooper, R. M., & Langton, S. R. H. (2006). Attentional bias to angry faces using the dot probe task? It depends when you look for it. *Behaviour Research and Therapy*, *44*, 1321-1329.

Crozier, M., Gillihan, S. J., & Powers, M. B. (2011). Issues in differential diagnosis: Phobias and phobic conditions. In D. McKay and E. A. Storch (Eds.), *Handbook of Child and Adolescent Anxiety Disorders* (7-22). DOI 10.1007/978-1-4419-7784-7_2

Dalgleish, T., Moradi, A. R., Taghavi, M. R., Neshat Doost, H. T., & Yule, W. (2001). An experimental investigation of hypervigilance for threat in children and adolescents with post-traumatic stress disorder. *Psychological Medicine, 31,* 541–547.

Davison, G. C., Blankstein, K. R., Flett, G. L., & Neale, J. M. (2008). *Abnormal psychology* (3rd ed.). Mississauga: John Wiley & Sons Canada, Ltd.

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General*, *130*(4), 681-700.

Gao, X., & Maurer, D. (2009). Influence of intensity on children's sensitivity to happy, sad, and fearful face expressions. *Journal of Experimental Child Psychology*, *102*, 503-521.

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology*, *95*(1), 15-20.

MacLeod, C., & Mathew, A. (1988). Anxiety and the allocation of attention to threat. *The Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology*, *40A*(4), 653-670.

Mansell, W., Clark, D. M., & Ehlers, A. (2003). Internal versus external attention in social anxiety: An investigation using a novel paradigm. *Behaviour Research and Therapy*, *41*(5), 555-572.

Mansell, W., Ehlers, A., Clark, D. M., & Chen, Y. (2002). Attention to positive and negative social-evaluative words: Investigating the effects of social anxiety, trait anxiety and social threat. *Anxiety, Stress and Coping*, *15*(1), 19-29.

Miskovic, V. & Schmidt, L. (2012). Early information processing biases in social anxiety. *Cognition and Emotion*, *26*(1), 176-185.

Mogg, K., & Bradley, B. P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour Research and Therapy*, *36*(9), 809-848.

Mogg, K., & Bradley, B. P. (1999). Some methodological issues in assessing attentional biases for threatening faces in anxiety: A replication study using a modified version of the probe detection task. *Behaviour Research and Therapy*, *37*, 595-604.

Mogg, K., & Bradley, B. P. (2005). Attentional bias in generalized anxiety disorder versus depressive disorder. *Cognitive Therapy and Research*, *29*, 29-45.

Mogg, K., Philippot, P., & Bradley, B. P. (2004). Selective attention to angry faces in clinical social phobia. *Journal of Abnormal Psychology*, *113*(1), 160-165.

Pineles, S. L., & Mineka, S. (2005). Attentional biases to internal and external sources of potential threat in social anxiety. *Journal of Abnormal Psychology*, *114*, 314-318.

Schmidt, L. A., & Fox, N. A. (1994). Patterns of cortical electrophysiology and autonomic activity in adults' shyness and sociability. *Biological Psychology*, *38*, 183-198.

Schmidt, L. A., Santesso, D. L., Miskovic, V., Mathewson, K. J., McCabe, R. E., Antony, M. M., & Moscovitch, D. A. (2012). Test-rest reliability of regional electroencephalogram (EEG) and cardiovascular measures in social anxiety disorder (SAD). *International Journal of Psychophysiology*, *84*, 65-73.

Schmukle, S. C. (2005). Unreliability of the dot probe task. *European Journal of Personality*, *19*, 595-605.

Staugaard, S. R. (2009). Reliability of two versions of the dot-probe task using photographic faces. *Psychology Science Quarterly*, *51*(3), 339-350.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*(6), 643-662.

Summerfeldt, L. J., & Endler, N. S. (1998). Examining the evidence for anxiety-related cognitive biases in obsessive-compulsive disorder. *Journal of Anxiety Disorders*, *12*, 579-598

Vassilopoulos, S. (2005). Social anxiety and the vigilance-avoidance pattern of attentional processing. *Behavioral and Cognitive Psychotherapy*, *33*, 13-24.

Wallace, S. T., & Alden, L. E. (1997). Social phobia and positive social events: The price of success. *Journal of Abnormal Psychology*, *106*(3), 416-424.

Wells, A., & Matthews, G. (1994). *Attention and emotion*: *A clinical perspective*. Hove: Lawrence Erlbaum.

Wikstrom, J., Lundh, L. G., Westerlund, J., & Hogman, L. (2004). Preattentive bias for snake words in snake phobia? *Behaviour Research and Therapy, 42,* 949–970.

Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1988). *Cognitive psychology and emotional disorders*. Chichester, UK: Wiley.

Yiend, J. (2010). The effects of emotion on attention: A review of attentional processing of emotional information. *Cognition and Emotion*, *24*(1), 3-47.

Table 1

Test-Retest Reliability of the Three Personality Measures used in the Present Study

	T1 Mean (SD)	**T2 Mean (SD)**	**Pearson r**	**ICC**	***t*-value**
SPIN	1.71 (0.699)	1.73 (0.770)	0.892*	0.942*	-0.469
SHY	1.79 (0.889)	1.83 (0.797)	0.887*	0.938*	-0.584
SOC	2.70 (0.757)	2.64 (0.861)	0.804*	0.889*	0.732

Pearson correlations, ICC, and pairwise *t*-test values for the SPIN and SSS (two subscales). Means and standard deviations (SD) given for Time 1 and Time 2.
* = significant after correcting for multiple comparisons (alpha/number of comparisons) (2-tailed, alpha = 0.05).

Table 2

Relation between Personality Measures and Attentional Bias Scores at Time 1 and Time 2

	SPIN	**SHY**	**SOC**
SHM T1	0.120	0.095	-0.144
SHS T1	0.079	0.044	-0.039
SAM T1	0.079	0.253	0.198
SAS T1	0.119	0.095	-0.261
LHM T1	-0.052	0.044	-0.031
LHS T1	0.142	0.025	0.185
LAM T1	0.078	0.014	-0.027
LAS T1	-0.089	0.040	0.127
SHM T2	0.009	0.017	-0.110
SHS T2	-0.126	-0.028	-0.271
SAM T2	0.158	0.043	0.115
SAS T2	0.014	0.097	-0.057
LHM T2	-0.156	-0.198	0.112
LHS T2	-0.113	-0.076	0.076
LAM T2	0.146	0.257	0.108
LAS T2	-0.101	0.005	0.212

Pearson correlations between all bias scores conditions (Time 1 and Time 2, separately) and each subjective measure (averaged across visits) (2-tailed).
Condition labels: exposure time [short (S)/long (L)], valence [happy (H)/angry (A)], and intensity [moderate (M)/strong (S)], respectively.

Table 3

Relation between Personality Measures and Attentional Bias Scores, Collapsed Across Intensity, Exposure Time, and Intensity, at Time 1 and Time 2

	SPIN	**SHY**	**SOC**
SH T1	0.124	0.088	-0.120
SA T1	0.127	0.225	-0.038
LH T1	0.072	0.053	0.122
LA T1	-0.011	0.042	0.078
SH T2	-0.075	-0.006	-0.253
SA T2	0.120	0.096	0.041
LH T2	-0.190	-0.190	0.133
LA T2	0.034	0.166	0.192
HM T1	0.077	0.124	-0.162
AM T1	0.141	0.237	0.151
HS T1	0.126	0.038	0.087
AS T1	0.017	0.098	-0.090
HM T2	-0.104	-0.128	-0.004
AM T2	0.224	0.217	0.164
HS T2	-0.148	-0.067	-0.105
AS T2	-0.054	0.072	0.093
SM T1	0.131	0.215	0.015
SS T1	0.125	0.088	-0.195
LM T1	0.022	0.038	-0.039
LS T2	0.027	0.044	0.207
SM T2	0.105	0.037	0.007
SS T2	-0.062	0.046	-0.190
LM T2	0.002	0.059	0.170
LS T2	-0.151	-0.054	0.195

Pearson correlations between collapsed bias scores conditions (Time 1 and Time 2, separately) across intensity (SH; SA; LH; LA), exposure time (HM; AM; HS; AS), and valence (SM; SS; LM; LS) and each subjective measure (averaged across visits) (2-tailed).
Condition labels: exposure time [short (S)/long (L)], valence [happy (H)/angry (A)], and intensity [moderate (M)/strong (S)], respectively.

Table 4

Test-Retest Reliability of Reaction Times for the Individual Conditions Used to Derive the Attentional Bias Scores

	T1 mean (SD)	**T2 mean (SD)**	**Pearson r**	**ICC**	***t*-value**
SCHM	331.054 (33.691)	313.555 (31.137)	0.536*	0.641*	3.353*
SCAM	329.440 (34.501)	312.202 (30.442)	0.536*	0.641*	3.284*
SCHS	334.323 (37.530)	314.779 (31.401)	0.568*	0.655*	3.608*
SCAS	331.081 (29.062)	318.629 (35.820)	0.591*	0.706*	2.495
SIHM	334.097 (35.411)	319.043 (32.462)	0.549*	0.670*	2.794
SIAM	331.772 (32.456)	317.676 (30.023)	0.549*	0.669*	2.844
SIHS	334.111 (36.117)	317.263 (32.373)	0.493*	0.614*	2.920
SIAS	337.341 (31.051)	319.425 (35.210)	0.487*	0.599*	3.185*
LCHM	316.303 (28.831)	302.870 (27.772)	0.597*	0.703*	3.171*
LCAM	317.301 (29.753)	304.362 (26.729)	0.622*	0.723*	3.144*
LCHS	318.279 (31.868)	304.789 (30.061)	0.751*	0.816*	3.694*
LCAS	317.412 (33.001)	299.809 (26.854)	0.615*	0.684*	3.937*
LIHM	318.350 (32.197)	305.440 (24.125)	0.686*	0.752*	3.294*
LIAM	320.643 (34.863)	307.053 (30.601)	0.578*	0.696*	2.690
LIHS	322.537 (32.919)	307.641 (27.666)	0.733*	0.787*	3.945*
LIAS	322.767 (33.221)	302.786 (23.050)	0.663*	0.670*	4.817*

16 RT conditions: means and standard deviations (SD) at Time 1 and Time 2, and test-retest reliability analyses.
* = significant after correcting for multiple comparisons (alpha/number of comparisons) (2-tailed, alpha = 0.05).
Condition labels: exposure time [short (S)/long (L)], congruence (congruent (C)/incongruent (I)], valence [happy (H)/angry (A)], and intensity [moderate (M)/strong (S)], respectively.

Table 5

Test-Retest Reliability of Attentional Bias Score Conditions

	T1 mean (SD)	T2 mean (SD)	Pearson r	ICC	*t*-value
SHM	3.042 (24.132)	5.488 (19.882)	-0.078	-0.170	-0.452
SHS	-0.212 (17.793)	2.484 (18.305)	-0.165	-0.404	-0.587
SAM	2.332 (20.160)	5.473 (20.892)	-0.144	-0.344	-0.607
SAS	6.260 (19.875)	0.796 (20.621)	0.159	0.271	1.248
LHM	2.047 (18.522)	2.570 (18.442)	-0.058	-0.128	-0.117
LHS	4.258 (18.951)	2.852 (21.309)	0.036	0.071	0.301
LAM	3.342 (20.634)	2.690 (19.946)	0.103	0.191	0.144
LAS	5.354 (21.138)	2.977 (18.269)	0.251	0.402	0.589

8 bias score conditions: means and standard deviations (SD) at Time 1 and Time 2, and test-retest reliability analyses.

Condition labels: exposure time [short (S)/long (L)], valence [happy (H)/angry (A)], and intensity [moderate (M)/strong (S)], respectively.

Table 6

Test-Retest Reliability of Attentional Bias Score Conditions Collapsed Across Intensity, Exposure Time, and Valence

	T1 mean (SD)	**T2 mean (SD)**	**Pearson r**	**ICC**	***t*-value**
SH	1.415 (17.349)	3.986 (14.136)	-0.216	-0.550	-0.626
SA	4.296 (15.528)	3.135 (15.050)	0.046	0.090	0.330
LH	3.153 (12.050)	2.711 (13.862)	-0.108	-0.249	0.137
LA	4.349 (13.533)	2.834 (15.690)	0.103	0.188	0.463
HM	2.545 (12.477)	4.029 (12.930)	0.036	0.071	-0.505
AM	2.837 (11.375)	4.082 (13.922)	0.149	0.259	-0.449
HS	2.023 (16.238)	2.668 (15.936)	-0.062	-0.137	-0.165
AS	5.807 (13.879)	1.887 (14.483)	0.310	0.466	1.411
SM	2.687 (17.136)	5.481 (16.595)	-0.160	-0.391	-0.652
SS	3.024 (15.060)	1.640 (16.143)	0.155	0.273	0.409
LM	2.695 (14.638)	2.630 (12.431)	0.046	0.090	0.021
LS	4.806 (14.938)	2.915 (14.049)	0.284	0.446	0.654

Bias scores collapsed across intensity (SH; SA; LH; LA), exposure time (HM; AM; HS; AS), and valence (SM; SS; LM; LS). Means and standard deviations at Time 1 and Time 2, and test-retest reliability analyses.
Condition labels: exposure time [short (S)/long (L)], valence [happy (H)/angry (A)], and intensity [moderate (M)/strong (S)], respectively.

Figure Captions

Figure 1. An example of the neutral and valenced facial stimuli in a female model. Moderate and strong emotional intensities are displayed for (A) angry and (B) happy facial expressions.

Figure 2. An example of a congruent and an incongruent trial in the present dot probe task using an angry-neutral pair only.

Figure 3. The Valence x Intensity interaction observed in the Low Sociability Group at Time 1. Positive values indicate greater attention to the stimulus of interest. Bars denote standard error of the attentional bias score mean.

Figure 1

Figure 2

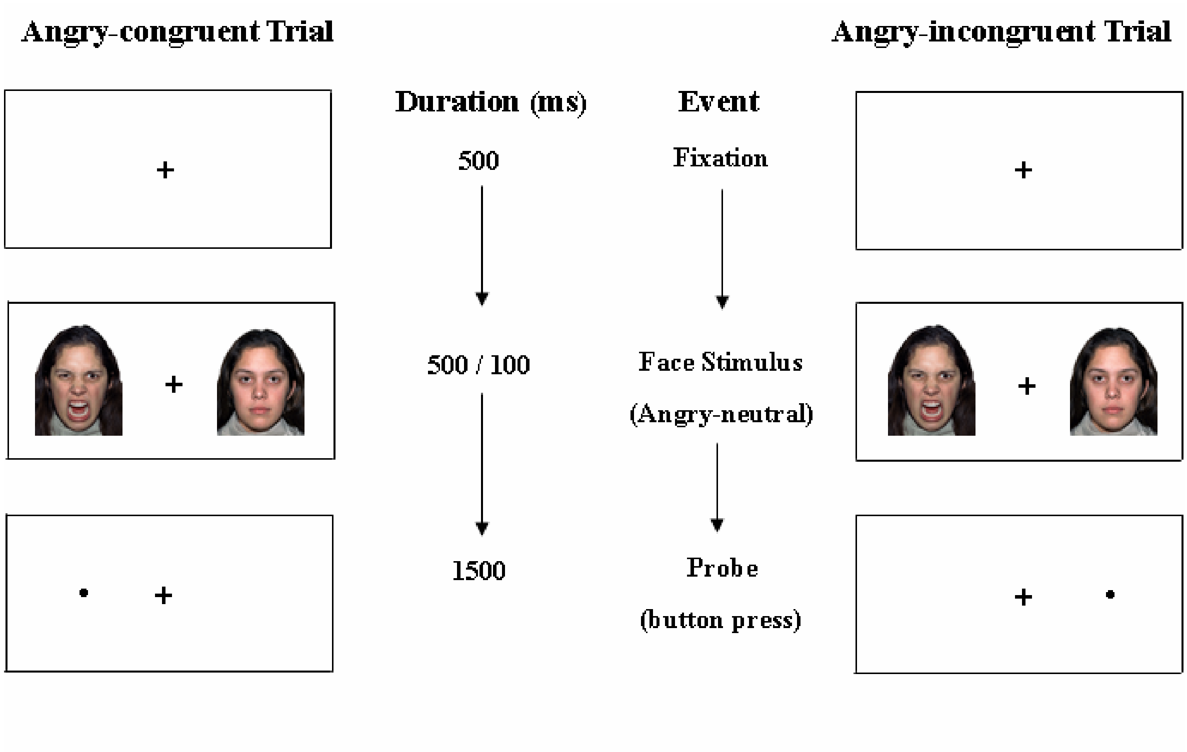
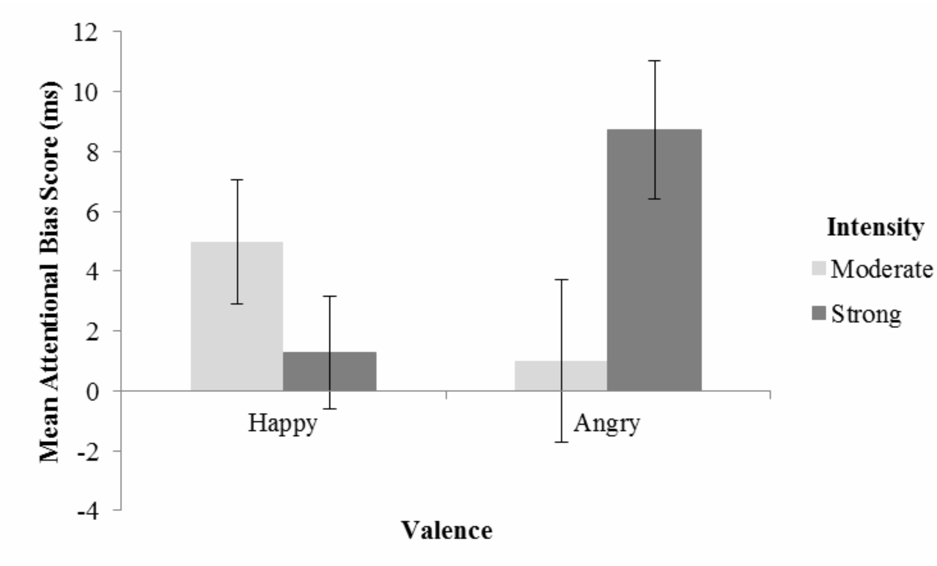

Angry-congruent Trial
Angry-incongruent Trial
Duration (ms)
Event
500
Fixation
500 / 100
Face Stimulus
(Angry-neutral)
1500
Probe
(button press)

Figure 3


12
10
8
6
4
2
0
-2
-4
Mean Attentional Bias Score (ms)
Happy
Angry
Valence
Intensity
Moderate
Strong

Appendix A

SPIN

Please check how much the following problems have bothered you during the past week. Mark only one box for each problem, and be sure to answer all items.

		Not At All	A Little Bit	Somewhat	Very Much	Extremely
1.	I am afraid of people in authority	□	□	□	□	□
2.	I am bothered by blushing in front of people	□	□	□	□	□
3.	Parties and social events scare me	□	□	□	□	□
4.	I avoid talking to people I don't know	□	□	□	□	□
5.	Being criticized scares me a lot	□	□	□	□	□
6.	Fear of embarrassment caused me to avoid doing this or speaking with people	□	□	□	□	□
7.	Sweating in front of people causes me distress	□	□	□	□	□
8.	I avoid going to parties	□	□	□	□	□
9.	I avoid activities in which I am the centre of attention	□	□	□	□	□
10.	Talking to strangers scares me	□	□	□	□	□
11.	I avoid having to give speeches	□	□	□	□	□
12.	I would do anything to avoid being criticized	□	□	□	□	□
13.	Heart palpitations bother me when I am around people	□	□	□	□	□
14.	I am afraid of doing things when people might be watching	□	□	□	□	□
15.	Being embarrassed or looking stupid are among my worst fears	□	□	□	□	□
16.	I avoid speaking to anyone in authority	□	□	□	□	□
17.	Trembling or shaking in front of others is distressing to me	□	□	□	□	□

Appendix B

SSS

Directions: for each of the items below, please <u>circle</u> how characteristic or atypical the statement is of you using the following scale: 0 = Not at all characteristic, 1 = Slightly characteristic, 2 = Moderately characteristic, 3 = Very characteristic, 4 = Extremely characteristic

1. I find it hard to talk to strangers..0 1 2 3 4

2. When I'm in a group of people, I have trouble thinking of the right things to talk about..................................0 1 2 3 4

3. I feel nervous when speaking to someone of authority..0 1 2 3 4

4. I feel inhibited in social situations..0 1 2 3 4

5. It takes me a long time to overcome my shyness in new situations..0 1 2 3 4

6. I like to be with people..0 1 2 3 4

7. I welcome the opportunity to mix with people..0 1 2 3 4

8. I prefer working with others rather than alone..0 1 2 3 4

9. I find people more stimulating than anything else..0 1 2 3 4

10. I'd be unhappy if I were prevented from making many social contacts..0 1 2 3 4

Appendix C

Participant Demographic Questionnaire

Please circle your answers

Gender: Male Female

Date of birth (dd/mm/yyyy): _____ / _____ / _______

Current age: ______

Handedness: Left Right

Ethnicity: Caucasian
Asian
African-American
Hispanic/Latino
Indian
Other

Year at university: 1 2 3 4

Do you have a history of head injury/seizures: Yes No

Are you currently taking any mood-altering or antipsychotic medications (e.g., antidepressants)?

Yes No

If so, please specify.

____

____

____