Internet Interventions 2 (2015) 227–234

Contents lists available at ScienceDirect

Internet Interventions

journal homepage: www.invent-journal.com/

Cognitive bias measurement and social anxiety disorder: Correlating self-report data and attentional bias

Alexander Miloff *, Andreas Savva, Per Carlbring

Department of Psychology, Stockholm University, Sweden

ARTICLE INFO

Article history:
Received 10 February 2015
Received in revised form 25 March 2015
Accepted 28 March 2015
Available online 7 April 2015

Keywords:
Attentional bias
Attentional bias modification
Dot-probe
Social anxiety disorder
Social phobia
Internet

ABSTRACT

Social anxiety disorder (SAD) and attentional bias are theoretically connected in cognitive behavioral therapeutic models. In fact, there is an emerging field focusing on modifying attentional bias as a stand-alone treatment. However, it is unclear to what degree these attentional biases are present before commencing treatment. The purpose of this study was to measure pre-treatment attentional bias in 153 participants diagnosed with SAD using a home-based Internet version of the dot-probe paradigm. Results showed no significant correlation for attentional bias (towards or away from negative words or faces) and the self-rated version of the Liebowitz Social Anxiety Scale (LSAS-SR). However, two positive correlations were found for the secondary measures Generalized Anxiety Disorder 7 (GAD-7) and Patient Health Questionnaire 9 (PHQ-9). These indicated that those with elevated levels of anxiety and depression had a higher bias towards negative faces in neutral–negative and positive–negative valence combinations, respectively. The unreliability of the dot-probe paradigm and home-based Internet delivery are discussed to explain the lack of correlations between LSAS-SR and attentional bias. Changes to the dot-probe task are suggested that could improve reliability.

1. Introduction

Typically, the visual-attention system is selectively biased towards stimuli of biological importance, such as cues of threat (predators, dangerous individuals) and reward (food, mates) (Frewen et al., 2008). These attentional processes are considered to have a fundamental role to play in the maintenance of social anxiety (SAD) and other anxiety disorders (Bar-Haim et al., 2007). The understanding that attentional processes may be modified using attention bias modification (ABM) training (MacLeod et al., 2002) with a commensurate reduction in clinical presentation of anxiety (Amir et al., 2009; Schmidt et al., 2009) has generated strong interest in the area (Kuckertz and Amir, 2015).

Cognitive models of SAD tend to specify a two-stage theory of attentional bias, an initial automatic threat-detection system that orients an individual in response to danger, followed by a conscious, voluntary system that can maintain or override attention (Cisler and Koster, 2010). In accordance with cognitive models, those with SAD will tend to bias attention not only towards biological risks but also threatening social information, such as negative facial expressions of nearby individuals, or internal emotional and physical disequilibrium, such as the shaking of their own hands (Boettcher et al., 2013a). Persistent negative and distorted views of social situations may reinforce an attentional bias towards threats (Beck and Clark, 1997).

Attentional bias can be measured using the dot-probe task, by timing the responses of subjects to threatening, neutral and positive images (normally faces) or words displayed on a screen. A typical example of this task has subjects shown two words or images for a short period of time (e.g., 500 ms), after which one of two possible probes appear behind one of the images. Typically the probe is the letter E or F, or one or two dots. The subject must identify the location and differentiate the probe type and then respond by pressing the corresponding button on a mouse or keyboard. Probe placements are balanced between neutral, negative and positive images or words and mean-reaction times for stimuli of each emotional valence are compared to the other. Attentional bias towards threat (hypervigilance) is determined when response times are shorter to probes placed behind threatening stimuli as compared to neutral or positive stimuli. This would indicate that the subject was drawn to the threatening over the neutral or positive. The opposite result (attentional avoidance) would indicate a subjects turning away from negative stimuli.

Alternative tasks for measuring attentional bias have included the *modified Stroop*, which compares response times to color identification of threatening and neutral words (Andersson et al., 2006); the *spatial cueing task* in which rectangles on either side of a fixation point are illuminated with a neutral or threatening image, after which a target is presented and subject response time measured; or the *visual search*

* Corresponding author at: Stockholm University, Department of Psychology, SE-106 91 Stockholm, Sweden. Tel.: +46 0769179153.
E-mail address: alexander.miloff@psychology.su.se (A. Miloff).

http://dx.doi.org/10.1016/j.invent.2015.03.006

task, for which participants are asked to identify a threatening or neutral word within a matrix of rows and columns of the opposite valence (Cisler and Koster, 2010). For example, the word cancer may be embedded in a 5 × 5 matrix of distracting neutral words such as table or vice-versa. The dot-probe task was developed to overcome limitations of the modified Stroop task (Bar-Haim et al., 2007) and has become the most common experimental paradigm used, with hundreds of studies to date (Price et al., 2014).

According to a meta-analysis by Bar-Haim et al. (2007), the attentional bias effect is quite prevalent in anxious populations at a moderate effect size (d = 0.45). Studies using the dot-probe task have identified both hypervigilance and attentional avoidance at various stimuli presentation times. Boettcher et al. (2013a) have reviewed the evidence. Hypervigilance at 500 ms is currently understood to be the predominant form of attentional bias in individuals with anxiety disorders (Asmundson and Stein, 1994; Musa et al., 2003; Mogg and Bradley, 2002; Helfinstein et al., 2008; Klumpp and Amir, 2009; Mogg et al., 2004). Fewer studies have identified hypervigilance at very fast presentation times of <200 ms (Mueller et al., 2009; Vassilopoulos, 2005; Roberts et al., 2010), while longer presentation times (>1000 ms) have not been successful at identifying hypervigilance (Asmundson and Stein, 1994; Musa et al., 2003; Mogg et al., 2004; Helfinstein et al., 2008). A few studies have identified attentional avoidance at 500 ms (Chen et al., 2002; Vassilopoulos, 2005). Supplementary verification using eye-tracking studies have verified both hypervigilance (Schofield et al., 2012; Wieser et al., 2009) and attentional avoidance (Wieser et al., 2009; Mühlberger et al., 2008). There has also been success identifying attentional bias using the modified Stroop task (Linnman et al., 2006), visual search (Juth et al., 2005), and spatial cueing tasks (Bar-Haim et al., 2007).

Multiple experimental paradigms showing evidence of attentional bias reduce the chance that it is merely an artifact of a particular paradigm (Cisler and Koster, 2010). Nevertheless, some studies have shown no attentional bias effect at similar time periods (Mohlman et al., 2013; Waters et al., 2004). The results are particularly poor for Internet-based studies (Boettcher et al., 2013a). The sometimes conflicting results for both attentional bias and the reduction of anxiety during ABM training (Hakamata et al., 2010; Hallion and Ruscio, 2011; Andersson et al., 2005) have led some to refer to ABM as "the emperor's new clothes" (Emmelkamp, 2012). Others such as Clarke et al. (2014), have drawn the conclusion that further experimentation and "scrutiny into the precise task conditions and modes of delivery" (p. 4) are needed.

Certain presentations of the dot-probe task have shown stronger effects than others. Two meta-analyses have suggested that using top and bottom placement of images has better results than placing images side-to-side (Hakamata et al., 2010; Beard et al., 2012). Results have tended to be more reliable when the dot-probe has a bottom placement rather than a top placement as subjects might preferentially reference the top image regardless of its valence (Price et al., 2014). Dot-probe studies that presented words rather than faces have shown stronger effects, despite the suggestion that it is less ecologically valid (Hakamata et al., 2010; Beard et al., 2012). The type of facial stimuli (cf., Samuelsson et al., 2012) used may also be a factor. Boettcher et al. (2012) in a program delivered online at home, failed to find attentional bias while carrying out methodologies similar to those that found strong effects (Amir et al., 2009; Schmidt et al., 2009), but using different facial stimuli.

Altering attentional bias towards threatening stimuli using ABM training has resulted in success reducing clinically significant anxiety and created strong interest in the area. A recent review by Kuckertz and Amir (2015) identified 231 studies via PsychINFO using the search terms "attention bias modification" OR "attention training" OR "attention modification," with over half in the last 3 years. However, while ABM treatment appears promising, the reliability of measuring attentional bias in Internet administered studies has proven problematic and requires further exploration (Kuckertz and Amir, 2015).

2. The present study

The purpose of this study was to measure attentional bias towards threatening, neutral and positive images or words using an Internet administered dot-probe task and to identify to what degree this bias correlated with a variety of outcome measures. Subjects in the study were all diagnosed with SAD as identified by the Liebowitz Social Anxiety Scale or LSAS-SR (Liebowitz, 1987). Outcome measures included the Quality of Life Inventory scale (QOLI; Frisch et al., 1992), the mini Social Phobia Inventory (Mini-SPIN; Connor et al., 2001), the General Anxiety Disorder scale (GAD-7; Spitzer et al., 2006), and the Patient Health Questionnaire scale (PHQ-9; Kroenke et al., 2001).

3. Method

3.1. Participants

Before commencing an online treatment for SAD, and in exchange for a cinema ticket, a total of 209 participants were invited to complete within 4 days an online version of the dot-probe paradigm (see Boettcher et al., 2013b). A total of 49 (23.45%) participants were excluded for not completing the attentional bias assessment and 6 (2.87%) were excluded for not noting their age. In addition, 1 (0.48%) person was excluded due to low certainty of bias measurement as a result of too many errors and slow response time (29.16% certainty). Thus a total of 153 participants were included in the analysis, with an average age of 34.80 years (SD = 12.72). The gender and age breakdown of participants is described in Table 1.

The following inclusion criteria were applied to participants: 1. minimum age of eighteen, 2. have fulfilled SAD diagnostic criteria according to DSM-IV (APA, 2000), 3. no suicidal ideation, 4. at time of bias measurement scoring, participant had higher than 75% correct response rate, 5. free of psychological treatment three months prior to inclusion, 6. if the participant was on prescribed medication for anxiety/depression, prescription had to be constant for 3 months before start of study, 7. must have access to the Internet and computer, and 8. be a Swedish resident. Participants that were either receiving psychological treatment, received medication (for at least the last three months), or were diagnosed as having a high suicide risk were excluded. High suicide risk was understood as scoring over two or three on the relevant question on the PHQ-9 scale.

3.2. Apparatus and material

The self-rated version of the Liebowitz Social Anxiety Scale (LSAS-SR; Liebowitz, 1987; Baker et al., 2002) is one of the most commonly used measuring tools for SAD and has been shown to be both reliable and valid (Heimberg et al., 1999). The scale provides a list of various situations and the possibility to rate that situation in fear and avoidance. Each fear and avoidance measurement is graded from 0 to 3. LSAS-SR has shown excellent internal consistency, high convergent and high discriminant validity as well as good test–retest reliability (Fresco et al., 2001) even when administered on the Internet (Hedman et al., 2010). A cut-off score over 30 is often used to denote the existence of SAD in a patient (Mennin et al., 2002).

Table 1
Characteristics of the included participants.

	N	Total	Age	
		%	Mean	SD
Male	34	22.1	34.39	12.37
Female	119	77.9	34.89	12.88

The Quality of Life Inventory (QOLI; Frisch et al., 1992) has a total of thirty-two questions covering sixteen areas of life. Defined as a domain-based measuring tool (Frisch 2004), it calculates quality of life and requires that an individual report their perception of life satisfaction, not prevalence of symptoms. It is written in a simple language and takes approximately 5 min to complete. It covers several different important areas including: overall health, economic situation, socialization/network, leisure activity, and relationships (Lindner et al., 2013). The respondent rates their perception of satisfaction (from 0 denoting not at all important to 2 denoting extremely important) which is combined with an answer regarding their satisfaction with the relevant question (−3 denoting very dissatisfied to 3 denoting very satisfied). The score used is a composite of the overall satisfaction of the individual in the inspected areas of life measured by the scale. Previous studies (Carlbring et al., 2007) have shown Cronbach's alpha fluctuating from 0.77 to 0.89 and test–retest reliability of $r = 0.80–0.91$, which is considered high.

The General Anxiety Disorder 7 Item Scale (GAD-7; Spitzer et al., 2006) is a self-report scale used to screen general anxiety disorder. Spitzer et al. (2006) have shown that GAD-7 is a valid instrument for screening of general anxiety disorder, with good internal consistency (Cronbach's alpha = 0.92). When the sum score of the questionnaire is gathered any score higher than 8 suggests the presence of an anxiety disorder in the participant (Löwe et al., 2008). The GAD-7 has been shown to correlate with disability measures as well as specific anxiety in a study demonstrating the validity of the scale (Ruiz et al., 2011).

The Patient Health Questionnaire 9 (PHQ-9; Kroenke et al., 2001) is a tool that focuses on a depression related understanding of health, using the definition of depression from the DSM-IV. It is considered a valid tool in the context of clinical application (Spitzer et al., 2006), has good psychometric properties when administered online (Titov et al., 2011), and is considered to have good internal reliability (Cronbach's alpha = 0.89), test–retest reliability, and good validity for screening of depression in the general population (Martin et al., 2006). A score of under 4 is considered minimal depression, a score of 5–9 is mild, and from 10 on the categories are moderate, moderately severe (15–19), and severe (20–27) (Kroenke et al., 2001).

A mini version of the Social Phobia Inventory (Mini-SPIN; Connor et al., 2001) contains three questions with answers ranging from 1 (not true at all) to 5 (very true). It is based on the 17-item self-administered Social Phobia Inventory (SPIN; Connor et al., 2000). Mini-SPIN has been shown to be an efficient tool in diagnosing the presence of generalized SAD and has also been demonstrated to have good validity as a screening tool for SAD (De Lima Osório et al., 2007). A cut-off score of 6 is used to identify generalized SAD (Connor et al., 2001). Measurements of Cronbach's alpha were performed for all completed questionnaires and results are shown in Table 2.

3.3. The dot-probe task

The flash based program presented a blank white screen (#FFFFFF) in full screen mode for 500 ms, followed by a black fixation cross (+) presented for 500 ms. After the cross disappears, two stimuli were presented as vertically cascaded (one on top of the other) for 500 ms. The stimuli were either a pair of words or a pair of faces. In each presentation, one stimulus had a different emotional valence than the other, and when faces were presented the person pictured was the same. Stimuli presentations were balanced between three different possible combinations: a positive–neutral, positive–negative, or neutral–negative combination. After the stimuli disappeared, a probe appeared 1 ms later either in the position of the upper or the lower previously displayed stimulus. The probe was a left (<) or right arrow (>) in Arial size 16, black font color, and remained printed on the screen until the equivalent key was pressed. The participant was instructed to press the relevant arrow on the keyboard as fast as possible while simultaneously avoiding errors. Following a response, the white screen was shown for 500 ms after which the black fixation cross reappeared for 500 ms and then the process began again (see Fig. 1). Issues relating to screen resolution and distance are discussed later in the text. The stimuli consisted of 62 male faces and 62 female ones expressing either happiness as positive, neutral as neutral, or disgust as negative. There are 333 social phobia related words available for display with 111 for each of the positive, neutral and negative categories. An example of a negative valence word might include “embarrassment.” Additional information concerning word and face stimuli, as well as the dot-probe task design, can be found in the study protocol (Boettcher et al., 2013b).

Measurement of reaction time to the dot-probe stimulus was conducted over 96 trials. However, prior to this measurement period there was an initial 10 trial test run that was used to check participant understanding of instructions. During this test run participants were given written feedback after completing each dot-probe response i.e., “correct” or “wrong.” This written feedback lasted for 500 ms after which the white screen reappeared and then the next test automatically commenced. The stimuli used during this test-period were unique and did not appear again during the following 96 trials. They only depicted faces that show surprise (identical top and bottom) and neutral words (also identical top and bottom). Participants were required to answer 10 test-trials correctly in a row before automatically proceeding to the 96 trial period.

3.4. Procedure

This study uses participants gathered as part of a twelve-month long randomized-controlled trial at Stockholm University called Challenger. Approval for this study was provided by the regional ethical review board and informed consent was given. Participants from the ongoing study ($n = 209$), already diagnosed with SAD by way of a semi-structured telephone interview, were invited to participate in this attention bias trial and received a link to the online surveys. When these questionnaires were completed, an additional link was presented that redirected him/her to another website where the attention bias measuring program is hosted. The participant was informed that the program only functions on computers and that tablets/phones are to be avoided for proper software functionality. The participant answered three further questions relating to social phobia (Mini-SPIN) and then the flash based software commenced, beginning with the 10 trial period and following with the 96 trial period in which reaction time measurements were recorded.

3.5. Data processing

All analysis was done in IBM SPSS Statistics 22. For each of the various questionnaires a variable was created that summarized the total score of each participant's answers. Using SPSS Syntax the attentional bias was calculated from reaction times of each participant. First the bias measuring software measured reaction times towards more positive cues and towards more negative cues respectively, then the reaction times for the various combinations of either neutral/negative/positive words or faces i.e., neutral–negative, neutral–positive, negative–positive combinations, were carried out. When these reaction

Table 2
Summarization of the questionnaire results for the entire sample ($n = 153$).

	LSAS-SR	Mini-SPIN	GAD-7	PHQ-9	QOLI
Average score	75.34	8.72	8.22	8.808	0.46
(SD)	(19.18)	(2.44)	(4.72)	(4.93)	(9.23)
Cronbach's alpha	0.92	0.72	0.86	0.87	0.75

Note: LSAS-SR = Liebowitz Social Anxiety Scale; Mini-SPIN = Social Phobia Inventory mini-version; GAD-7 = General Anxiety Disorder 7; QOLI = Quality of Life Inventory.

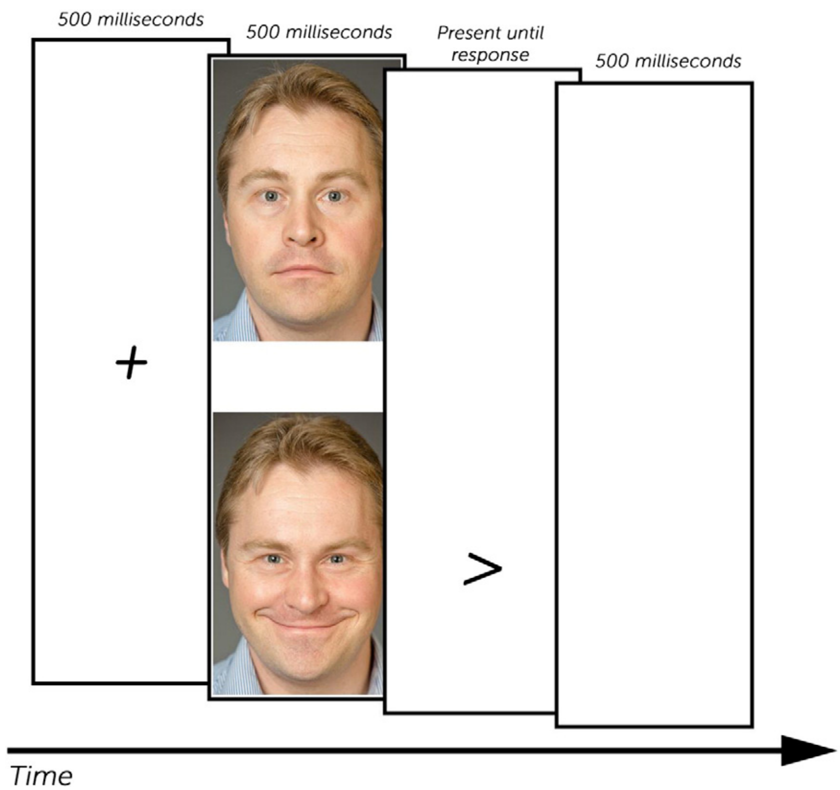

Fig. 1. Presentation of the attention bias measuring process.

times were measured, times that were either equal or shorter than 200 ms, as well as times equal and over 2000 ms were excluded.

To generate a combined measure of attentional bias (relative bias), reaction times to any of the three types of stimuli (positive, negative, and neutral) were given a negative or positive number relative to their opposing stimuli. In a display of positive and negative images or words, attention to the former would be calculated as a positive score and the later a negative. In the neutral–negative, attention to the neutral would receive a positive score, and the negative display, a negative score. Finally, in the neutral–positive display, attention to the neutral would receive a negative score, and the positive, a positive. A combined measurement was created, consisting of a sum of all positive and all negative scores for both image and word categories. Bivariate correlations (Pearson correlations) were calculated for all the variables and the results from the questionnaires.

4. Results

The average response time to pressing either the right or the left arrow on the keyboard after presentation of stimuli was 736.08 ms (SD = 147.66). The normal distribution of the data is demonstrated in Fig. 2. The reaction time results broken down by the three stimuli combinations are summarized in Table 3. The results from correlation analysis for attentional bias to specific stimuli type are displayed in Table 4. For each of the three valence combinations, attention towards the positive, neutral or negative stimuli compared to its alternative, contributed to the calculation of a relative positive or relative negative attentional bias figure. Measurement of relative positive attentional bias (n = 82) had an average score of 18.95 ms (SD = 16.42) and the relative negative attentional bias (n = 71) had an average score of −17.40 ms (SD = 15.14). The average response time towards more positive cues, both words and faces, was 732.40 ms (SD = 209.98) and towards more negative cues was 733.63 ms (SD = 206.02). The results from the correlation analysis for relative positive and negative attentional bias are summarized in Table 5.

There was no correlation observed between the LSAS-SR and attentional bias. However, the more general measure of anxiety (GAD-7) showed a small but significant positive correlation when images in the neutral–negative combination were shown ($r = .18$, $p = .02$) (Table 4). This indicated that the higher the total score on GAD-7, the larger the bias was towards the negative stimuli. In addition, a small but significant positive correlation between the level of depression (PHQ-9) and negative image bias in the positive–negative combination was identified ($r = .15$, $p = .04$).

Subjects that did not complete the bias assessment task within the four day window (n = 49), did not note their age (n = 6), or were excluded for slow response time (n = 1) were not statistically different from those who participated (n = 153) in respect to level of

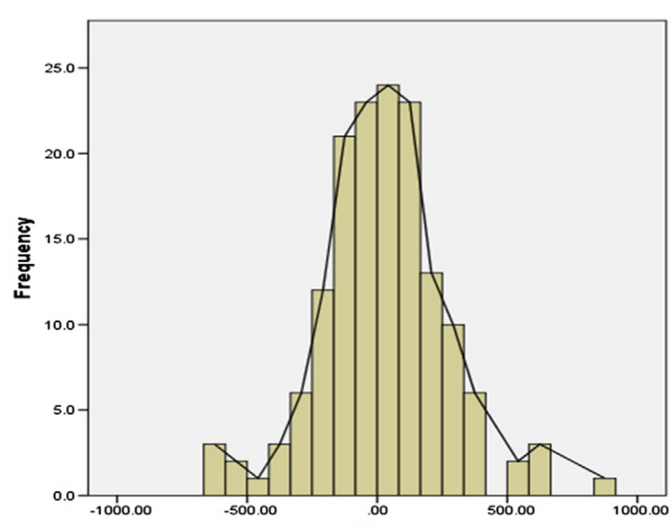

Fig. 2. Distribution of normality for attention bias measurements (milliseconds).

Table 3
Reaction times in milliseconds for words or faces in various cue combinations.

		Neutral–negative trials		Neutral–positive trials		Negative–positive trials	
		Negative cues	Neutral cues	Neutral cues	Positive cues	Negative cues	Positive cues
Words	Average response time	735.51	733.99	728.79	729.74	736.60	733.48
	(SD)	(207.84)	(206.88)	(203.16)	(202.92)	(207.01)	(214.06)
Faces	Average response time	734.21	733.87	729.03	726.31	732.66	731.61
	(SD)	(205.11)	(202.67)	(197.36)	(195.01)	(200.85)	(203.01)

social anxiety as measured by the LSAS-SR or any other self-report questionnaire or demographic variable except for age. Non-participants were slightly older and the difference was significant if adjustment for multiple comparisons was not made (mean age 38.75 vs. 34.17 years, SD = 11.93, $t(207) = 2.42$; $p = .016$).

5. Discussion

The purpose of this study was to correlate self-report data about social phobia from the Liebowitz Social Anxiety Scale (LSAS-SR), the Quality of Life Inventory scale (QOLI), the mini Social Phobia Inventory (Mini-SPIN), the General Anxiety Disorder scale (GAD-7) and the Patient Health Questionnaire scale (PHQ-9), from participants diagnosed with SAD alongside a measurements of their attentional bias.

Contrary to the primary hypothesis, no significant relationship was found between LSAS-SR results and the combined positive/negative attentional bias measure. There was also no significant correlation evident between the combined attentional bias measure and the other questionnaires. Furthermore, as is often found in Internet-based social anxiety studies (Boettcher et al., 2013c) the male–female ratio was uneven potentially limiting generalizability. Positive correlations that were found were between an attentional bias that was observed when either neutral–negative or positive–negative image stimuli (faces in this case) were presented. These attentional biases correlated positively with levels of anxiety (GAD-7) and symptoms of depression (PHQ-9), respectively. The positive correlations that were observed are in both cases biased only when images with a negative valence were presented. The interpretation of what exactly these positive correlations mean is presently unclear.

There are at least three possible explanations for these results: either it is the case that there is no correlation, or the results are a consequence of the specific data gathered, or the tools used to measure it are not up to the task. A review by Bar-Haim et al. (2007) postulated based on their findings that "bias is related to a core anxiety component that is common to all anxiety disorders as well as to nonclinical anxiety" (p. 16). As demonstrated by Waters et al. (2012), highly anxious children with SAD were identified as displaying an attentional bias for threatening faces whereas children with lower anxiety severity showed bias in the opposite direction. In a sense perhaps, the positive correlation with the GAD-7 could be explained alongside these conclusions.

Depression is frequently comorbid with anxiety disorders (Lamers et al., 2011) and identified in anxious individuals in studies of attentional bias but rarely is it controlled for (Bar-Haim et al., 2007). The relationship between attentional bias and depression comorbidity is equivocal. A review of the area (see Mogg & Bradley, 2005) identified attentional bias in depressed patients towards negative words during long stimuli exposure (1000 ms) and to social threat words at shorter exposures (500 ms), however a number of other studies reviewed found no evidence for the effect using negative words and faces. The authors suggest that anxiety and depression are different in their emotional processing, the former emphasizing threat-related information and the later self-relevant linguistic material concerning loss and failure. In this present study, attentional bias was found towards faces in subjects with comorbid depressive symptoms, rather than words, however additional depression specific measures would be required to compare these findings to those with clinical depression. These results are closer in kind to Bar-Haim et al. (2007) that controlled for depression when assessing the attentional bias effect, and did not discern any difference between anxious individuals and those with comorbid depressive symptoms.

There are studies that previously failed to produce positive effects when Internet-based training for attentional bias was used. One explanation that is offered is that in a laboratory setting the expectation of a positive result is fostered in the participant which in turn might be a promoting factor in self-rated improvement (Boettcher et al., 2012; Neubauer et al., 2013). How clinical researchers recruit participants, whether at a clinic or online, and expectations regarding the task (e.g., whether it is a powerful new treatment) may similarly moderate treatment effects (Enock et al., 2014). This could explain the positive findings of studies that measured the change in attentional bias in participants that underwent some form of treatment. Similarly the lack of correlations between the self-report scales and the Internet-based attentional bias measurement may be explained by the lack of laboratory setting and online recruitment in this study. Future studies may benefit from evaluation of nonspecific factors such as expectations (Enock et al., 2014) and other moderators that could affect cognitive bias (Hayes et al., 2010).

It is important to note that one limitation common to all the Internet-based studies that are refereed here, including this study, is the impossibility to control for variables such as the distance of the user to the computer monitor, the resolution and size of the monitor, interruptions and so forth. Neubauer et al. (2013) mention that the probability to be interrupted when at home while participating in various bias measuring tasks is considerably higher than when in a laboratory setting. However,

Table 4
Results from correlation analysis of attentional bias to specific stimuli.

		Word bias	Image bias	Words pos–neu	Words pos–neg	Words neu–neg	Images pos–neu	Images pos–neg	Images neu–neg
LSAS-SR	Correlation coefficient (r)	.130	.068	.046	.057	.140	.000	.065	.058
	Significance (p)	.110	.402	.570	.486	.085	.998	.427	.479
Mini SPIN	Correlation coefficient (r)	.120	−.020	.104	.108	−.008	−.125	.057	.035
	Significance (p)	.139	.808	.202	.183	.919	.122	.482	.668
GAD 7	Correlation coefficient (r)	.045	.097	.072	−.076	.099	−.092	.060	.182*
	Significance (p)	.582	.235	.380	.348	.221	.257	.462	.024
PHQ 9	Correlation coefficient (r)	−.046	.119	−.118	−.092	.140	−.107	.159*	.139
	Significance (p)	.571	.142	.148	.256	.084	.190	.049	.088
Quality of	Correlation coefficient (r)	−.052	−.037	−.058	.014	−.034	.154	−.124	−.081
Life Index	Significance (p)	.524	.646	.478	.866	.677	.057	.126	.317

Table 5
Results from the correlation analysis of relative attentional bias and questionnaires.

		LSAS-SR	Mini-SPIN	GAD-7	PHQ-9	QOLI
Relative positive bias	Correlation coefficient (r)	.089	.072	.012	.003	.046
	Significance (p)	.424	.523	.913	.976	.682
Relative negative bias	Correlation coefficient (r)	.138	.095	.169	.180	.075
	Significance (p)	.252	.429	.159	.134	.534

they report no difference in completion times or error rates from comparison of laboratory participants and home ones. Their data on pre-training response times (between 700 and 792 ms) is equivalent to this study indicating a level of reliability in online reaction time measurement. Another element of relevance to studies undertaken at home may be the stimulation level of participants during the dot-probe or other tasks. Specifically the arousal levels of participants and how seriously they undertake the task may be lower when at home compared to when in a laboratory setting or outpatient clinic. (Boettcher et al., 2012; Neubauer et al., 2013).

The measurement of bias may also be influenced by mood state (Bar-Haim et al., 2007). Amir et al. (2009) undertook an ABM training regime with a pool of 400 students with obsessive–compulsive disorder and found significant attentional bias effects in an initial block of training but attenuated effects in the second block. The authors concluded that habituation of the threatening stimuli may have occurred indicating the need for emotional affect in order to produce an attentional bias. Another ABM study required one group of socially anxious students to undertake an anxiety provoking exposure (such as making a difficult phone call or walking past a crowded room) prior to attentional bias assessment (Kuckertz et al., 2014). These subjects did not have statistically different pre-treatment attentional bias, however, following ABM they experienced greater anxiety reduction and reduction in attentional bias, indicating a possible relationship with emotional activation. Some authors who have carried out Internet-based studies (Boettcher et al., 2012; Carlbring et al., 2012) have suggested that fear activation is an important component of the attention bias effect being successfully shown in the laboratory. Bar-Haim et al. (2007) suggests that this relationship may be mediated by an interaction effect between state anxiety and some aspect of trait anxiety endogenous to the individual.

Another possible explanation for the lack of correlations in this study could be related to the dot-probe paradigm. Previous studies making use of the dot-probe task have questioned its reliability. Price et al. (2014) provided an array of examples of studies that failed to achieve positive results using the dot-probe task. These studies had participants from multiple backgrounds ranging from — among others: healthy users (Schmukle, 2005; Staugaard, 2009), substance users (Ataya et al., 2012) and participants with both high and low scores on SAD scales (Waechter et al., 2014). Only one study (Price et al., 2014), has evaluated test–retest reliability in a clinically anxious population, finding moderate reliability in the dot-probe task. The study suggests that repeated assessments (equal to or over five trials) may potentially enhance reliability, however, no participant in the present study did the task over five times. An alternative explanation for lack of relationship with attentional bias may be low variability in clinical indicators restricting the possible range of results, particularly when no healthy control group is available for comparison. In this study, controls were absent and LSAS-SR scores were high, however standard deviation was also moderate (19.18) reducing the likelihood of this type of error. Future studies using a within-group design will benefit from selecting subjects with a wider range in their primary outcome measure.

The possibility of using alternative calculations in the dot-probe paradigm exists as well. Research could revolve around the concept of disengagement from cues instead of attention towards or away from threatening stimuli. Evidence indicates that results may vary when disengagement versus attention towards stimuli are compared (Neubauer et al., 2013). Most calculations of attentional bias measure the difference in reaction time during presentation of neutral/non-neutral stimuli between: a) threat incongruent trials in which a probe follows the neutral item and, b) threat congruent trials in which a probe follows the threatening item. Price et al. (2014) explains that high scores on this measure may either mean the participant's attention was oriented more easily to non-neutral stimuli or that disengagement from non-neutral stimuli was more difficult. Another method suggests that reaction times be measured between neutral/non-neutral valence combinations and trials presenting neutral/neutral combinations (Koster et al., 2004). Price et al. (2014) argue that this alternate method might address the difficulty with disengagement from non-neutral stimulus, which is required for the incongruent trial calculation, unlike neutral/neutral combinations.

The measuring of attentional bias via reaction time may be problematic. Assessing visual and cognitive processing of threatening stimuli according to allocation of attention instead of speed of reacting (as discussed below using eye tracking technology) could offer an alternative. The problem with reaction time based measurements are their weakness to irrelevant factors such as the time to select a response or the delay in registration of a response due to inhibition in pressing the relevant button (Price et al., 2014). It should be noted that there is no significant difference in effect size and direction from studies that used alternatives to the dot-probe task such as the emotional Stroop task in regard to moderation of bias specificity, despite being thought to affect alternative cognitive processes, i.e., the dot-probe relates to spatial–visual attention whereas the Stroop effect relates to threat-relevant interference (Pergamin-Hight et al., 2014).

Data suggesting low retest-reliability of the dot-probe during repeated assessments (Schmukle, 2005) has led some researchers to consider other mechanisms that could confound results. Mogg et al. (2008) have suggested reaction slowing of some individuals in the presence of threatening stimuli could be a contributing factor. Reaction slowing was found to affect highly anxious individuals not low anxious individuals, with the result that data gathered by self-report in Internet-based studies might be inadequate (lack sufficient objectivity) to accurately distinguish these groups. Furthermore, since reliability of Internet- based attentional bias assessment renders problematic the interpretation of the results, one might even argue that the failure to demonstrate a correlation between attention bias and SAD or results from any other scale might be due to failure to assess attention bias correctly. Future studies should continue to identify challenges to reliability of Internet-based dot-probe paradigm as previous studies recommend (Boettcher et al., 2014).

Future studies may want to employ eye tracking as an alternative to reaction time measurement, as the movement and pattern of gaze away from and towards stimuli could provide attentional bias data. Eye tracking could also be used alongside dot-probe paradigms over the Internet using a computer webcam to provide supplemental evidence. According to some (Price et al., 2014), even with efforts to resolve problems with the dot-probe such as issues of repeated measurement, location of dot probe to the bottom and calculation of congruent and incongruent reaction times, the dot-probe paradigm may still remain problematic and its reliability insufficient for psychometric studies. Attentional bias is also understood not to be exclusive to problems in reaction time or mechanisms of attention; Pergamin-Hight et al. (2014) add that relationships exist with content themes unique to the individual and disorder, such as social and physical concerns or trauma related content, which may influence attentional bias towards threats.

To conclude, no relationship could be determined in this study between social anxiety and attentional bias. There appears however, to be a correlation between attentional bias towards negative (threatening) cues and generalized anxiety and depression; this is in turn explained by the concept that individuals suffering from anxiety or depression are prone to orient towards the negative or threatening. The dot-probe paradigm is not problem free, and if the above concerns are addressed, additional measures may be needed to ensure a reliable tool, particularly when completed at home over the Internet. Improvements might lie in combining it with other methods such as eye tracking, for example. Finally, Internet-based detection of attentional bias in individuals with SAD using the dot-probe task and other technologies may hold potential as a step towards the detection and treatment of anxiety disorders.

6. Conflict of interest

The authors have no conflict of interest to report.

Acknowledgments

The current study was made possible in part by a grant from the Swedish Research Council (2011-38394-87877-7) to the last author. The authors would like to thank Sarah Heinrich for the valuable comments she made to a previous version of this manuscript.

References

American Psychiatric Association, 2000. Diagnostic and statistical manual of mental disorders DSM (4th ed., text revision, 2003).
Amir, N., Najmi, S., Morrison, A.S., 2009. Attenuation of attention bias in obsessive–compulsive disorder. Behav. Res. Ther. 47 (2), 153–157. http://dx.doi.org/10.1016/j.brat.2008.10.020.
Andersson, G., et al., 2005. Stroop facilitation in tinnitus patients: an experiment conducted via the world wide web. Cyberpsychol. Behav. 8 (1), 32–38.
Andersson, G., et al., 2006. Cognitive bias via the internet: a comparison of web-based and standard emotional Stroop tasks in social phobia. Cogn. Behav. Ther. 35 (1), 55–62.
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. J. Anxiety Disord. 8 (2), 107–117.
Ataya, A.F., et al., 2012. Internal reliability of measures of substance-related cognitive bias. Drug Alcohol Depend. 121 (1–2), 148–151. http://dx.doi.org/10.1016/j.drugalcdep.2011.08.023.
Baker, S.L., et al., 2002. The Liebowitz social anxiety scale as a self-report instrument: a preliminary psychometric analysis. Behav. Res. Ther. 40, 701–715.
Bar-Haim, Y., et al., 2007. Threat-related attentional bias in anxious and nonanxious individuals: a meta-analytic study. Psychol. Bull. 133 (1), 1–24.
Beard, C., Sawyer, A.T., Hofmann, S.G., 2012. Efficacy of attention bias modification using threat and appetitive stimuli: a meta-analytic review. Behav. Ther. 43 (4), 724–740. http://dx.doi.org/10.1016/j.beth.2012.01.002.
Beck, A.T., Clark, D.A., 1997. An information processing model of anxiety: automatic and strategic processes. Behav. Res. Ther. 35 (I), 49–58.
Boettcher, J., Berger, T., Renneberg, B., 2012. Internet-based attention training for social anxiety: a randomized controlled trial. Cogn. Ther. Res. 36, 522–536.
Boettcher, J., Leek, L., et al., 2013a. Internet-based attention bias modification for social anxiety: a randomised controlled comparison of training towards negative and training towards positive cues. PLoS ONE 8 (9), 1–14.
Boettcher, J., Andersson, G., Carlbring, P., 2013b. Combining attention training with cognitive-behavior therapy in internet-based self-help for social anxiety: study protocol for a randomized controlled trial. Trials 14 (1), 68 (Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3618238&tool=pmcentrez&rendertype=abstract).
Boettcher, J., Carlbring, P., Renneberg, B., Berger, T., 2013c. Internet-based interventions for social anxiety disorder — an overview. Verhaltenstherapie 23, 160–168. http://dx.doi.org/10.1159/000354747.
Boettcher, J., et al., 2014. Combining attention training with internet-based cognitive–behavioural self-help for social anxiety: a randomised controlled trial. Cogn. Behav. Ther. 43 (1), 34–48 (Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3869050&tool=pmcentrez&rendertype=abstract).
Carlbring, P., et al., 2007. Internet vs. paper and pencil administration of questionnaires commonly used in panic/agoraphobia research. Comput. Hum. Behav. 23, 1421–1434.
Carlbring, P., 2012. Internet-delivered attention bias modification training in individuals with social anxiety disorder-a double blind randomized controlled trial. BMC psychiatry 12 (1), 66.
Chen, Y.P., et al., 2002. Patients with generalized social phobia direct their attention away from faces. Behav. Res. Ther. 40, 677–687.
Cisler, J.M., Koster, E.H.W., 2010. Mechanisms of attentional biases towards threat in anxiety disorders: an integrative review. Clin. Psychol. Rev. 30 (2), 203–216. http://dx.doi.org/10.1016/j.cpr.2009.11.003.
Clarke, P.J.F., Notebaert, L., MacLeod, C., 2014. Absence of evidence or evidence of absence: reflecting on therapeutic implementations of attentional bias modification. BMC Psychiatry 14, 8 (Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3899426&tool=pmcentrez&rendertype=abstract).
Connor, K.M., et al., 2000. Psychometric properties of the Social Phobia Inventory (SPIN): new self-rating scale psychometric properties of the Social Phobia Inventory (SPIN) New self-rating scale. Br. J. Psychiatry 176, 379–386.
Connor, K.M., et al., 2001. Mini-SPIN: a brief screening assessment for generalized social anxiety disorder. Depress. Anxiety 14 (April 2000), 137–140.
De Lima Osório, F., Crippa, J.A., Loureiro, S.R., 2007. A study of the discriminative validity of a screening tool (MINI-SPIN) for social anxiety disorder applied to Brazilian university students. Eur. Psychol. 22, 239–243.
Emmelkamp, P.M., 2012. Attention bias modification: the Emperor's new suit? BMC Med. 10 (1), 63 (Available at: http://www.biomedcentral.com/1741-7015/10/63).
Enock, P.M., Hofmann, S.G., McNally, R.J., 2014. Attention bias modification training via smartphone to reduce social anxiety: a randomized, controlled, multi-session experiment. Cogn. Ther. Res. 38, 200–216.
Fresco, D.M., et al., 2001. The Liebowitz Social Anxiety Scale: a comparison of the psychometric properties of self-report and clinician-administered formats. Psychol. Med. 31, 1025–1035.
Frewen, P.A., et al., 2008. Selective attention to threat versus reward: meta-analysis and neural-network modeling of the dot-probe task. Clin. Psychol. Rev. 28, 307–337.
Frisch, M.B., et al., 1992. Clinical validation of the Quality of Life Inventory. A measure of life satisfaction for use in treatment planning and outcome assessment. Psychol. Assess. 4 (1), 92–101.
Hakamata, Y., et al., 2010. Attention bias modification treatment: a meta-analysis toward the establishment of novel treatment for anxiety. Biol. Psychiatry 68 (11), 982–990. http://dx.doi.org/10.1016/j.biopsych.2010.07.021.
Hallion, L.S., Ruscio, A.M., 2011. A meta-analysis of the effect of cognitive bias modification on anxiety and depression. Psychol. Bull. 137 (6), 940–958.
Hayes, S., et al., 2010. The effects of modifying interpretation bias on worry in generalized anxiety disorder. Behav. Res. Ther. 48 (3), 171–178. http://dx.doi.org/10.1016/j.brat.2009.10.006.
Hedman, E., et al., 2010. Internet administration of self-report measures commonly used in research on social anxiety disorder: a psychometric evaluation. Comput. Hum. Behav. 26, 736–740.
Heimberg, R.G., et al., 1999. Psychometric properties of the Liebowitz Social Anxiety Scale. Psychol. Med. 29, 199–212.
Helfinstein, S.M., et al., 2008. Affective primes suppress attention bias to threat in socially anxious individuals. Behav. Res. Ther. 46, 799–810.
Juth, P., et al., 2005. Looking for foes and friends: perceptual and emotional factors when finding a face in the crowd. Emotion 5 (4), 379–395 (Washington, D.C.).
Klumpp, H., Amir, N., 2009. Examination of vigilance and disengagement of threat in social anxiety with a probe detection task. Anxiety Stress Coping 22 (February 2015), 283–296.
Koster, E.H.W., et al., 2004. Selective attention to threat in the dot probe paradigm: differentiating vigilance and difficulty to disengage. Behav. Res. Ther. 42, 1183–1192.
Kroenke, K., Spitzer, R.L., Williams, J.B.W., 2001. The PHQ-9: validity of a brief depression severity measure. J. Gen. Intern. Med. 16, 606–613.
Kuckertz, J.M., Amir, N., 2015. Attention bias modification for anxiety and phobias: current status and future directions. Curr. Psychiatry Rep. 17, 1–8.
Kuckertz, J.M., et al., 2014. Moderation and mediation of the effect of attention training in social anxiety disorder. Behav. Res. Ther. 53, 30–40. http://dx.doi.org/10.1016/j.brat.2013.12.003.
Lamers, F., et al., 2011. Comorbidity patterns of anxiety and depressive disorders in a large cohort study: the Netherlands Study of Depression and Anxiety (NESDA). J. Clin. Psychiatry 72, 342–348.
Liebowitz, M.R., 1987. Social phobia. Mod Probl Pharm 22, 141–173.
Lindner, P., et al., 2013. Validation of the internet-administered Quality of Life Inventory (QOLI) in different psychiatric conditions. Cogn. Behav. Ther. 42 (February 2015), 315–327 (Available at: http://www.ncbi.nlm.nih.gov/pubmed/23837710).
Linnman, C., et al., 2006. The Stroop effect on the internet. Comput. Hum. Behav. 22, 448–455.
Löwe, B., et al., 2008. Validation and standardization of the Generalized Anxiety Disorder Screener (GAD-7) in the general population. Med. Care 46 (3), 266–274.
MacLeod, C., et al., 2002. Selective attention and emotional vulnerability: assessing the causal basis of their association through the experimental manipulation of attentional bias. J. Abnorm. Psychol. 111 (1), 107–123.
Martin, A., et al., 2006. Validity of the Brief Patient Health Questionnaire Mood Scale (PHQ-9) in the general population. Gen. Hosp. Psychiatry 28, 71–77.
Mennin, D.S., et al., 2002. Screening for social anxiety disorder in the clinical setting: using the Liebowitz Social Anxiety Scale. J. Anxiety Disord. 16 (March 1999), 661–673.

Mogg, K., Bradley, B.P., 2002. Selective orienting of attention to masked threat faces in social anxiety. Behav. Res. Ther. 40, 1403–1414.

Mogg, K., Philippot, P., Bradley, B.P., 2004. Selective attention to angry faces in clinical social phobia. J. Abnorm. Psychol. 113 (1), 160–165.

Mogg, K., Bradley, B.P., 2005. Attentional bias in generalized anxiety disorder versus depressive disorder. Cognitive Ther Res 29 (1), 29–45.

Mogg, K., et al., 2008. Effects of threat cues on attentional shifting, disengagement and response slowing in anxious individuals. Behav. Res. Ther. 46 (5), 656–667. http://dx.doi.org/10.1016/j.brat.2008.02.011.

Mohlman, J., Price, R.B., Vietri, J., 2013. Attentional bias in older adults: effects of generalized anxiety disorder and cognitive behavior therapy. J. Anxiety Disord. 27 (6), 585–591. http://dx.doi.org/10.1016/j.janxdis.2013.06.005.

Mueller, E.M., et al., 2009. Electrophysiological evidence of attentional biases in social anxiety disorder. Psychol. Med. 39, 1141–1152.

Mühlberger, A., Wieser, M.J., Pauli, P., 2008. Visual attention during virtual social situations depends on social anxiety. Cyberpsychol. Behav. 11 (4), 425–430.

Musa, C., et al., 2003. Selective attention in social phobia and the moderating effect of a concurrent depressive disorder. Behav. Res. Ther. 41, 1043–1054.

Neubauer, K., et al., 2013. Internet-delivered attention modification training as a treatment for social phobia: a randomized controlled trial. Behav. Res. Ther. 51 (2), 87–97. http://dx.doi.org/10.1016/j.brat.2012.10.006.

Pergamin-Hight, L., et al., 2014. Content specificity of attention bias to threat in anxiety disorders: a meta-analysis. Clin. Psychol. Rev. 35, 10–18. http://dx.doi.org/10.1016/j.cpr.2014.10.005.

Price, R.B., et al., 2014. Empirical recommendations for improving the stability of the dot-probe task in clinical research. Psychol. Assess. http://dx.doi.org/10.1037/pas0000036 (Advance online publication).

Roberts, K.E., Hart, T.A., Eastwood, J.D., 2010. Attentional biases to social and health threat words in individuals with and without high social anxiety or depression. Cogn. Ther. Res. 34, 388–399.

Ruiz, M.A., et al., 2011. Validity of the GAD-7 scale as an outcome measure of disability in patients with generalized anxiety disorders in primary care. J. Affect. Disord. 128 (3), 277–286. http://dx.doi.org/10.1016/j.jad.2010.07.010.

Samuelsson, H., et al., 2012. The Umeå University Database of Facial Expressions: a validation study. J. Med. Internet Res. 14 (Available at: 10.2196/jmir.2196).

Schmidt, N.B., et al., 2009. Attention training for generalized social anxiety disorder. J. Abnorm. Psychol. 118 (1), 5–14.

Schmukle, S.C., 2005. Unreliability of the dot probe task. Eur. J. Personal. 19 (August 2004), 595–605.

Schofield, C.A., et al., 2012. Social anxiety and difficulty disengaging threat: evidence from eye-tracking. Cogn. Emot. 26 (2), 300–311.

Spitzer, R.L., et al., 2006. A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch. Intern. Med. 166, 1092–1097.

Staugaard, S.R., 2009. Reliability of two versions of the dot-probe task using photographic faces. Psychol. Sci. Q. 51 (3), 339–350.

Titov, N., et al., 2011. Psychometric comparison of the PHQ-9 and BDI-II for measuring response during treatment of depression. Cogn. Behav. Ther. 40 (February 2015), 126–136.

Vassilopoulos, S.P., 2005. Social anxiety and the vigilance–avoidance pattern of attentional processing. Behav. Cogn. Psychother. 33, 13–24.

Waechter, S., et al., 2014. Measuring attentional bias to threat: reliability of dot probe and eye movement indices. Cogn. Ther. Res. 38, 313–333.

Waters, A.M., Lipp, O.V., Spence, S.H., 2004. Attentional bias toward fear-related stimuli: an investigation with nonselected children and adults children with anxiety disorders. J. Exp. Child Psychol. 89, 320–337.

Waters, A.M., et al., 2012. Attention Bias for Angry Faces in Children With Social Phobia. 2(4) pp. 475–489 (Available at: http://eprints.soton.ac.uk/184437/).

Wieser, M.J., et al., 2009. Fear of negative evaluation and the hypervigilance–avoidance hypothesis: an eye-tracking study. J. Neural Transm. 116, 717–723.