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HÁSKÓLI ÍSLANDS

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Lokaverkefni til BS-gráðu í sálfræði
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Sálfræðideild Heilbrigðisvísindasvið
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Contents

Abstract

Background and objectives: Socially anxious individuals have been found to have an attentional bias towards threats. It is hoped that computerized tasks can be used in attention bias modification (ABM) as a treatment resources for socially anxious people. In recent years computerized tasks have been used to assess attentional bias toward threats. But the tasks most used heretofore have been criticized for being unreliable. Therefore it is important to investigate the ability of these tasks to identify attentional bias towards threats further.

Methods: Researchers compared the sensitivity of four tasks: The dot-probe task, the visual cueing task, the visual search task and the attentional blink task. These tasks were tested on 31 healthy individuals. A counterbalanced within-subject design was used.

Results: The attentional blink proved to be the most sensitive task to assess attentional bias towards threat, whereas the other tasks did not find any difference in performance due to difference in facial expression on the stimuli that were used. In the attentional blink task the attentional blink was reduced when T2 was a threatening facial expression, in comparison to when the expression was neutral.

Limitations: The main limitation of this study was a small sample. With a larger sample size more reliable results would have been found.

Conclusions: Results indicate that the attentional blink task could be more useful than the computerized tasks that are currently used, both in measuring attention bias and in developing of ABM as a potential treatment resource for socially anxious people.

Keywords: Attentional bias, attention bias modification, cognitive bias modification, social anxiety, attentional blink.

1. Introduction

Social anxiety disorder is characterized by anxiety in social circumstances. The anxiety stems from the reason that people worry about making a fool of themselves in front of others or that others will notice how anxious they really are. Socially anxious individuals are also afraid that they will act stupid in social circumstances and worry that others will see them in a negative light and refuse to accept them (Heimberg, Hope, Rapee & Bruch, 1988).

Studies have indicated that socially anxious people expect negative events in the future (Foa, Franklin, Perry & Herbert, 1996; Teglasi & Fagin, 1984) and that they interpret social events and social communication that they participate in, in a negative manner (Amir, Foa & Coles, 1998; Musa & Lépine, 2000; Rapee & Lim, 1992; Voncken, Bögels & de Vries, 2004). No matter if the communication turns out in a positive or a negative way (see Wallace and Alden, 1997).

Cognitive theories of social anxiety address that attention, memory and information processing of socially anxious people is biased toward negative items, especially in social circumstances (Musa & Lépine, 2000). A vicious cycle is created and maintained where selective attention (attentional bias) and interpretation (interpretation bias) of ambiguous information is experienced as threatening (Beard, 2011). In fact, studies suggest that attentional bias toward negative, threatening and disgusting stimuli in the environment affect the formation and maintenance of social anxiety disorder (Clark & McManus, 2002; Dalgleish & Watts, 1990). Healthy individuals have also been found to direct their attention to a greater degree to threatening stimuli (Fox et al., 2000; Hansen & Hansen, 1988) and can thus also be said to have some kind of an attentional bias toward threat. Admittedly it may have come in handy for our ancestors in evolutionary history to be quick to identify threats and escape danger (Öhman, 1996).

Beck, Emery and Greenberg´s model (1985) was one of the first theories to speculate about the role of attentional bias in social anxiety disorder. The model states that people with social anxiety disorder direct their attention toward threatening cues in other people´s and their own behaviour and interpret these cues as a negative evaluation by others of their social performance.

Clark and Wells' (1995) model of social anxiety disorder highlights the point that attentional bias contributes to the maintenance of social anxiety. According to the model, socially anxious people direct their attention inward in social circumstances and that makes them more self-conscious and aware of their own anxiety responses. The model states that people with social anxiety disorder keep a negative self-image in mind, before and after they participate in social interactions. A priori they make a negative prediction about their performance and both beforehand and afterwards they think about their past mistakes in social interactions. Studies on attentional- and judgement biases support Clark and Well's model regarding the negative processing of information both before and after social situations take place (Clark & McManus, 2002; Dodge, Hope, Heimberg & Becker, 1988; Fairbrother, Rachman & Mitchell, 1998; Heinrichs & Hofman, 2001; Hinrichsen & Clark, 2003).

Another influential model that focuses on the role of attentional bias in social anxiety disorder is the model formulized by Rapee and Heimberg (1997). Rapee and Heimberg's model states that when socially anxious people participate in social situations, they imagine how they will appear to others. Then they compare their perceived performance to the high standards they expect others to have of them. This comparison is unfavorable, especially since people with social anxiety disorder look for cues in their environment that confirm the negative evaluation that they think others have of them. This results in an anxiety that maintains the social anxiety.

It is fairly well established that people with social anxiety disorder or other anxiety disorders have got a specific attentional bias towards threatening stimuli, relevant to their anxiety disorder (Pergamin-High, Naim, Bakermans-Kranenburg, van Ijzendoorn & Bar-Haim, 2015). Still it is uncertain what contributes to the attentional bias. It is unclear whether the attentional bias can be attributed to improved recognition and processing of threatening stimuli, or whether it arises from difficulties to break away attention from threatening stimuli (Cisler & Koster, 2010). One study supported the latter explanation in patients with PTSD (Schönenberg & Abdelrahman, 2013).

Cognitive Bias Modification (CBM) is an intervention that is aimed to alter cognitive biases through implicit process (Beard, 2011). Studies targeted to determine whether cognitive bias precedes and predicts negative emotional symptoms show that in general the assumption of a causal relationship is valid (Koster, Fox, & McLeod, 2009). For example, Eldar, Ricon & Bar-Haim (2008) tested the causal relation by inducing attentional bias toward threat in healthy children. The study yielded results showing of elevations in stress reactivity and emotional vulnerability. The same results have been found in healthy adults (see Mathews & MacLeod, 2002).

In recent years, the number of studies aimed to test the causal relation of cognitive biases and social anxiety symptoms in a clinical population and thereby assess the potential clinical use of CBM, has increased (Hallion & Ruscio, 2011). For example a study on clinically anxious individuals showed positive results, where a reduction was found in state and trait anxiety symptoms after a four week period of CBM training (Brosnan, Hoppitt, Shelfer, Sillence & Mackintosh, 2011).

Researchers have modified CBM interventions so repeated application activates a desired cognitive change, such as cognitive bias modification for attention (CBM-A, attention bias modification) or cognitive bias modification for interpretation (CBM-I) (Enock, Hofmann & McNally, 2014; Koster et al. 2009). The most used tasks in ABM are the dot-probe task, the visual cueing task and the visual search task. These tasks all have that in common that with repeated training they are designed to reduce selective attention to threatening stimuli (Mogoase, David & Koster, 2014).

To illustrate, in the dot-probe task (MacLeod, Mathews & Tata, 1986), participants are exposed to two stimuli that appear simultaneously on a computer screen. One stimulus is threatening and one is neutral or positive. After a short interval the stimuli disappear and a visual probe appears on either location of one of the two stimuli. Participants are supposed to identify the probe as quickly as possible. A faster response to a threatening stimulus indicates a stronger reaction of the individual and therefore a selective attention towards threatening information.

By modifying the appearance of the probe on the location of the positive or neutral stimulus, implicit attention can be trained (MacLeod, 1995). Anxious individuals typically respond faster to probes appearing in locations where a threatening stimulus has previously appeared rather than neutral stimulus, compared to non-anxious control-group participants that show the opposite behavior (MacLeod et al., 1986). Thereby such repeated attention training might help anxious individuals to attend to neutral or positive information instead of threatening information.

It is worth noting that performance may vary depending on what kind of stimuli is used in the task of ABM, such as words (threatening or neutral) or facial images (threatening or neutral). A number of meta-analysis have addressed the issue by comparing effect sizes by using image stimuli and word stimuli (see Bar-Haim, Lamy & Pergamin, 2007; Hakamata et al., 2010; Hallion & Ruscio, 2011; Mogoase et al., 2014). It is also worth mentioning that the tasks that are commonly used for assessing attentional bias have had their share of criticism for insufficient detection of attentional bias for threat (McNally, Enock, Tsai & Toisian, 2013; Schmukle, 2005). For example, the dot-probe task has been criticized for poor reliability (Cisler, Bacon, & Williams, 2009; Schmukle, 2005).

The attentional blink (AB) paradigm is a task that has been used to assess attentional bias (Fox, Russo & Dutton, 2002; Reinecke, Rinck & Becker, 2008; Trippe, Hewig, Heydel, Hecht & Miltner, 2007). Attentional blink is a term that is used to describe a phenomenon that occurs in visual search tasks, when the task is to identify two targets (T1 and T2) in a stream of stimuli with short time interval between the targets. If there is only a 200-500 ms interval between the appearance of T1 and T2 and if people correctly identify T1, it is very likely that they will miss T2. Then it is said that attentional blink has occurred. Because T1 captures people's attention, it seems to be the case that less attention is left to provide T2 attention (Broadbent & Broadbent, 1987; Raymond, Shapiro & Arnell, 1992).

The attentional blink seems to vary to a great degree if the task contains emotional targets (Anderson, 2005). Generally people show stronger attentional blink if T1 is an emotional target. After an emotional T1 has captured people's attention, people seem to find it more difficult to focus their attention immediately on T2 – regardless of whether it is neutral or emotional. If T2 is in turn emotional when T1 is neutral, the attentional blink will be reduced (Müsch, Engel & Schneider, 2012; Schwabe et al., 2011). The attentional blink may be governed more by emotional strength of T2, then by type of emotional response (positive or negative) that the stimulus triggers (Keil & Ihssen, 2004).

It may matter whether a target stimulus contains a frightened or a disgust facial expression. In one study frightening T1 inhibited attention to T2 and distractors to a greater degree than a disgusting T1 (Vermeulen, Godefroid & Mermillod, 2009). Recent studies indicate that people who have an anxiety disorder, show less AB if T2 is a frightening stimulus in line with the relevant anxiety disorder (Fox, Russo & Georgiou, 2005; see also Reinecke et al., 2008; Trippe et al., 2007).

Research findings indicate that attention bias modification (ABM) could be used in a clinical setting to reduce anxiety symptoms to a significant degree (Beard, Sawyer & Hofmann, 2012; Hakamata et al., 2010; Hallion & Ruscio, 2011; Mogoase et al., 2014). In order to test the efficacy of using ABM to reduce anxiety symptoms, various randomized controlled trials (RCT's) have been conducted. Several studies have shown positive results (Amir, Beard, Cobb & Bomyea, 2009a; Amir et al., 2009b; Amir, Weber, Beard, Bomyea & Taylor, 2008; Li, Tan, Quian & Liu, 2008). A study on patients with generalized social anxiety suggests that attention bias modification was effective; attention training two times per week in four weeks revealed at four month follow-up a significant reduction in anxiety symptoms for clinical patients compared to participants in a placebo condition (Schmidt, Richey, Buckner & Timpano, 2009). Other studies do not give as promising results (Boettcher, Hasselrot, Sund, Anderson & Carlbring, 2014; Bunnel, Beidel & Mesa, 2013; Carlbring et al., 2012).

A recent meta-analysis by Mogoase et al. (2014) indicates that ABM successfully reduces attentional bias symptoms and emotional vulnerability in anxious and healthy individuals. Among results obtained by the meta-analysis, was that younger participants compared to older showed more benefits of training. Several studies have shown good results of ABM for children and adolescents in terms of anxiety (see Bechor et al., 2014; Bar-Haim, Morag & Glickman, 2011; Rozenmann, Weersing & Amir, 2011).

Attention bias modification training is in general administered in research laboratories but it has been of much interest whether a delivery through a web-based method could increase efficiency (MacLeod, Soong, Rutherford, & Campbell, 2007). Many studies have been targeted to test this different administration of ABM but have not shown positive results on reduction on social anxiety (see Boettcher et al., 2013; Carlbring et al., 2012; Neubauer et al., 2013; Enock et al., 2014). The same results were found in a meta-analysis of Mogoase et al. (2014).

The results of web-based studies in ABM training could be in line with the diathesis-stress model of cognitive biases. It demonstrates that an individual has to encounter a stressor to activate the cognitive bias. Therefore the cognitive bias is latent and should influence symptoms only in situations that the cognitive bias has vulnerability for (Beck, 1987; MacLeod, Campbell, Rutherford & Wilson, 2004). For socially anxious individuals, it could explain the absence of an effect of ABM on symptoms in web-based methods whereas the effect is larger in studies where ABM is administered in a research laboratory.

The aim of this study is to compare the efficacy of different computerized tasks that have been used to assess attentional bias in individuals with social anxiety. As the discussion above indicates, attentional bias toward negative social stimuli is considered to play an important role in maintaining social anxiety. As more studies are conducted on attentional bias and attentional bias modification the hope for developing various, effective treatments for individuals with social anxiety disorder, increases. Therefore it is important to evaluate the sensitivity of the tasks that are used in assessing attentional bias. In this study four tasks were tested on healthy individuals. The tasks were the probe task (MacLeod et al., 1986), the attentional cueing task (Posner, 1980; Kristjánsson, Mackeben & Nakayama, 2001), the irrelevant distractor task (Theeuwes, 1992; Yantis & Jonides, 1990) and the attentional blink task (Raymond et al., 1992; Kristjánsson & Nakayama, 2002). This study is a replication of the study *Barking up the wrong tree in attentional bias modification* by Sigurjónsdóttir, Sigurðardóttir, Björnsson and Kristjánsson (2015). It is expected that the attentional blink task will be the most sensitive task in assessing attentional bias, as prior findings of Sigurjónsdóttir et al. (2015) indicated.

2. Method

2.1. Participants

31 individuals (17 women, 14 men, Mage = 27.7 years, age range: 18 – 56 years) participated in the study (Fig. 1 shows a consort diagram of the progress of enrollment in the study). The sample of the study was from a general population and was meant to represent a control group that was matched (in terms of age, gender and level of education) to a clinical experimental group. Participants were recruited with advertisements on social media, in several high schools in the Reykjavík area, on the University of Iceland campus and in various public places in Reykjavík. Sample size goal was 30 participants. All participants signed a consent form for participation in the study. All participants were screened for mental disorders in an interview, except for one participant that was unable to finish the interview because of language difficulties. All participants had normal orcorrected-to-normal visual acuity and normal color vision. Participants got a gift certificate for participating in the study.

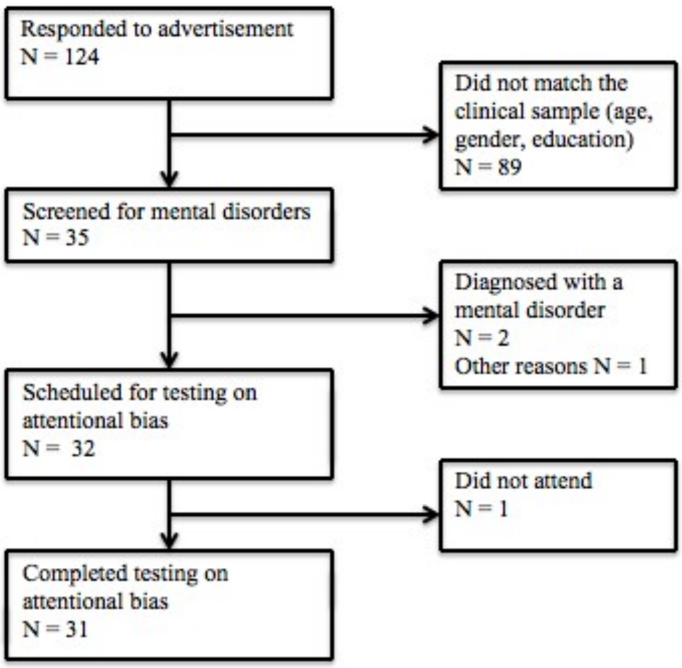

Figure 1. Consort diagram of the progress of enrollment in the study.

2.2. Equipment

The experimental displays were programmed in C using the VisionShell software library on a 75-Hz screen in a 400-MHz G4 Apple computer.

2.3. Stimuli and procedure

All four tasks contained grey scale facial images of 39 Caucasian Dutch people, both men and women, from the *Radboud Faces Database* (Langner et al., 2010). The faces showed either neutral expressions or expressions of disgust (see Fig. 2). The neutral images were meant to represent non-threatening stimuli and the disgust images were meant to represent threatening stimuli. All the tasks except for the attention blink task started with a white fixation cross in the center of a dark screen. Following a variable interval (1100 to 1500 ms, randomly determined for each trial) the experimental stimuli appeared. Different auditory feedback was given after each trial on whether the answer was correct or incorrect. The main measure of interest in all the four tasks was whether the facial expression would affect performance.

Each participant finished all the four tasks in a randomized order to prevent any sequence effects, a counterbalanced within-subject design was used. All participants received the same instructions for each task. Before starting each task participants completed three practice trials. The attentional blink task, the cueing task and the irrelevant distractor task included 180 trials. But the probe task included 160 trials. Over all participation took about one hour.

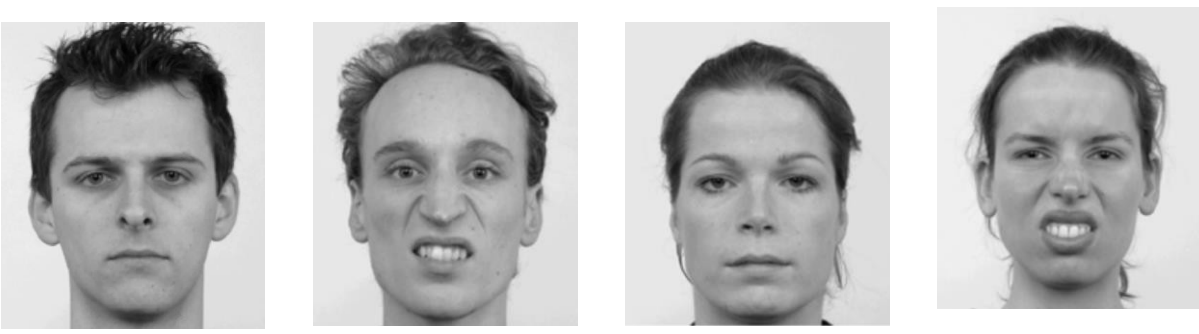

Figure 2. Four examples of faces from the tasks, two of each gender and two with each expression (neutral or disgust).

2.3.1. Probe task

Each trial started with a presentation of two facial images of the same individual, one above and the other below the white fixation cross in the center of the screen (5.24° x 5.57°). When the upper image showed a threatening facial expression, the lower image showed a neutral facial expression (see Fig. 3) and vice versa. The images were presented on the screen for 146 ms. Thereafter a white arrow appeared at the location of either the neutral or threatening image. Participants were supposed to determine, by keypress, whether the arrow pointed to left or wright. The main interest was to observe whether performance would differ on the task, depending on whether the arrow appeared on the location of the neutral or threatening facial image.

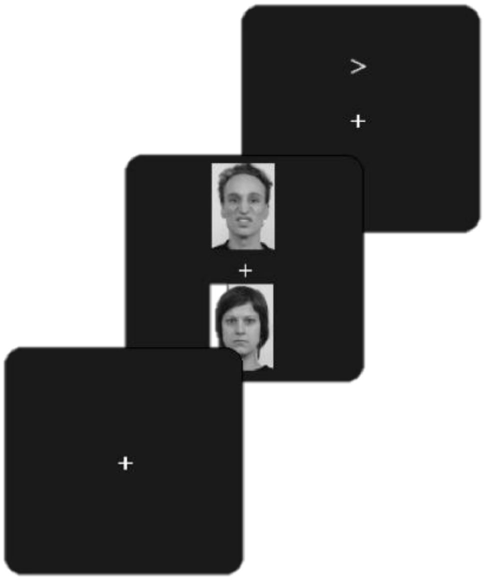

Figure 3. An example of the probe task. Two faces were presented for 146 ms after presentation of a fixation cross. An arrow followed on either of the location of the two facial images.

2.3.2. Cueing task

Each trial started with a presentation of two white frames (4.95° x 4.95°) at each side of the screen, with a white fixation cross in the center of the screen (4.5°). Then in either one of the frame a neutral or threatening image appeared (see Fig. 4). The image was a cue for the target stimuli that followed 1100-1500 ms later. The target stimulus in this task was a small white square (30° x 30°). The cue could either be valid, if the square appeared in the same frame as the image, or invalid, if the square appeared in the opposite frame as the image. Participants were supposed to determine whether the square appeared on the left or right frame by keypress. The main interest was to observe whether the cue type (neutral or threatening facial expression) would affect performance on the task.

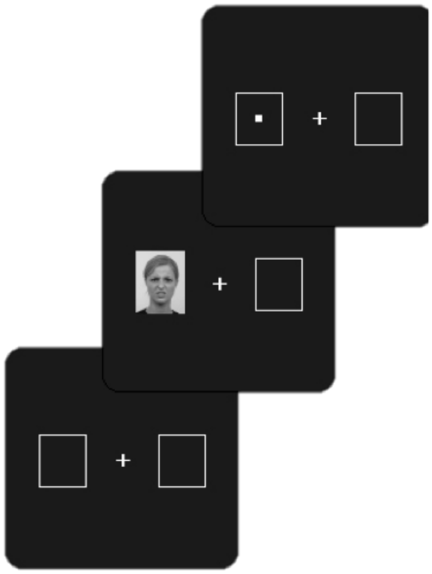

Figure 4. An example of the cueing task. A cue (the facial image) was presented for 146 ms followed by a target stimulus on either of the cued or uncued location.

2.3.3. Irrelevant distractor task

Each trial started with a presentation of four facial images (5.71° x 4.57°) around the white fixation cross in the center of the screen. Three of them were of the same individual, but one was an image of the opposite gender. Participants were supposed to find the image that mismatched the others and determine its gender by keypress. On ⅓ of trials an irrelevant distracting facial image appeared in the center of the screen (see Fig. 5). Participants were instructed to ignore that image. The facial expression (threatening or neutral) was random on every image on the task. The main interest was to observe whether the expression of the irrelevant distracting image would affect performance on the task.

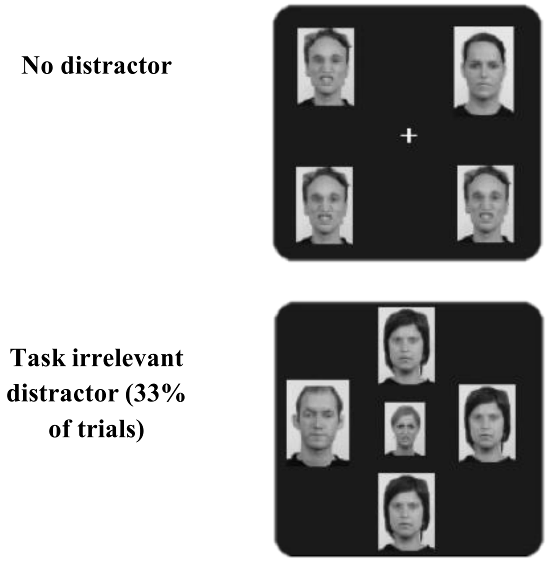

Figure 5. An example of irrelevant distractor task. Participants searched for the image that mismatched others and judged its gender. On 33% of trials an irrelevant distractor facial image appeared in the center.

2.3.4. Attentional blink task

Each trial contained 30 facial images (5.24° x 5.90°) that were presented in a fast sequence, one by one, at the center of the screen on a dark background. Each face was presented for 67 ms with a 40 ms blank screen in between. There were two target images. Target 1 (T1) was a face marked with a dot either on the left or right cheek. T1 could be any image on the range from five to 15 in the fast sequence. Target 2 (T2) was a face with a green hue. T2 could be the first to seventh image following T1 (see Fig. 6). The location of and lag between T1 and T2 in the sequence was randomly determined on each trial. The remaining images worked as distractors and were presented in a gray scale. In each sequence they had either neutral facial expression or expression of disgust. It was randomized whether each target image was neutral or threatening. Participants were supposed to judge after each trial whether the dot was on the left or right cheek on T1 and whether T2 was a male or a female. Answers were given by keypress. The main interest was to observe whether any difference in detection of T2 would depend on whether T2 was neutral or threatening, or whether T1 was neutral or threatening.

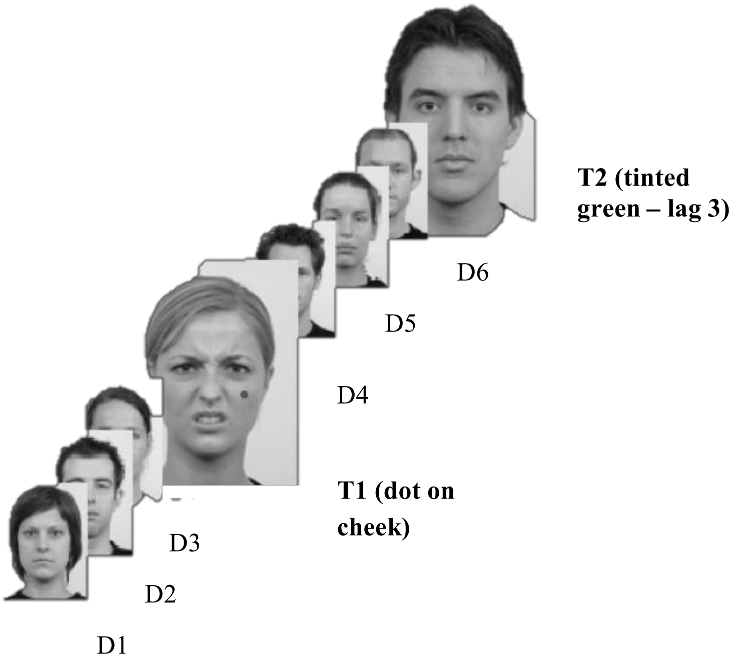

Figure 6. An example of attentional blink task. Participants were supposed to detect the facial image with a dot on either cheek (target 1, T1) and the facial image that was tinted green (target 2, T2). Answers to T1 were indicated on which cheek the dot was located (left or right) and answers to T2 were which gender the green tinted image was of. Target 2 appeared 1-7 presentations after target 1 (T1 and T2 are expanded in size for demonstration purposes, all images in the task were the same size).

3. Results

For the probe, cueing and irrelevant distractor tasks, trials with response times ± 3 SDs for each participant (0.19% of their responses) were excluded from analyses, along with error trials for the probe (2%) and the cueing tasks (1%). Effect sizes (Cohen´s d) were calculated for each task to provide a standardized measure of the differential sensitivity of attentional processing of facial expression on performance.

3.1. Probe task

The results for the probe task are presented in Fig. 7. Mean RT on the probe task was 491.4 ms (s.d. = 156.0, range = 173 – 1727 ms) and accuracy was 98%. RTs on trials where targets appeared in the location of threatening face did not differ significantly from RTs on trials where the arrow appeared in the location of a neutral face (threat trials M = 488.9 ms, s.d. = 151.3: neutral trials M = 493.9, s.d. = 160.4), $t(30) = 0.81$; $p = 0.425$; $d = 0.03$, indicating no effect (Cohen, 1977). In other words, facial expression had no influence on performance on the probe task.

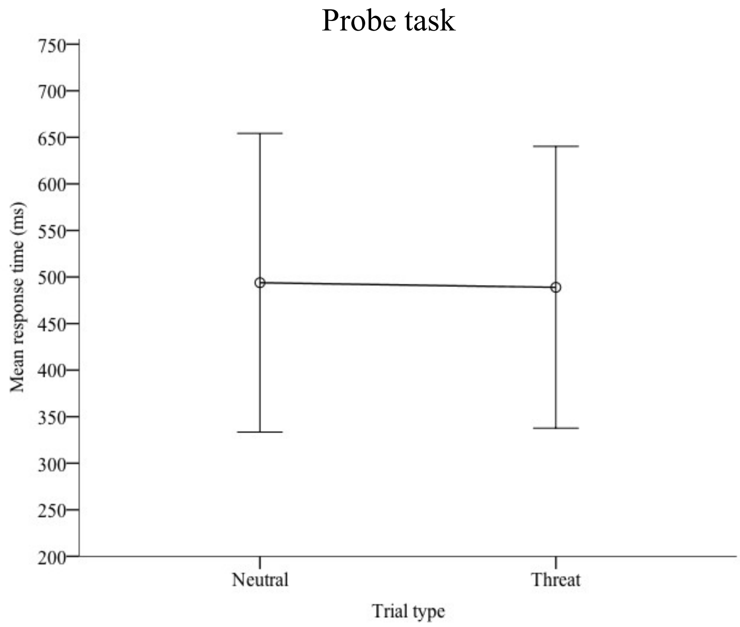

Figure 7. Mean response times on the probe task, as a function of facial expression where the target stimuli appeared. Error bars represent standard deviations.

3.2. Cueing task

The results for the cueing task are shown in Fig. 8. Mean RT was 400.6 ms (s.d. = 124.6, range = 121 – 1578 ms) and accuracy was 99%. A 2 x 2 (Cue Validity x Cue Type [threat, neutral]) repeated-measures ANOVA revealed main effects of cue validity, $F(1, 30) = 8.93$, $p = 0.006$, but no main effect was found for cue type, $F(1, 30) = 0.01$, $p = 0.917$. There was a Cue Validity x Cue Type interaction $F(1, 30) = 5.73$, $p = 0.023$. Cue Validity had influence on response time, but facial expression had no influence on performance on the cueing task. Still there was some difference on performance depending on whether the cue was valid or invalid and whether the cue was a threatening or neutral facial expression. Cohen's d for the effect size for the differences of the means on valid threatening trials and valid neutral trials was 0.04, indicating no effect (Cohen, 1977). Cohen's d for the effect size for the differences of the means on invalid threatening trials and invalid neutral trials was 0.02, indicating no effect (Cohen, 1977).

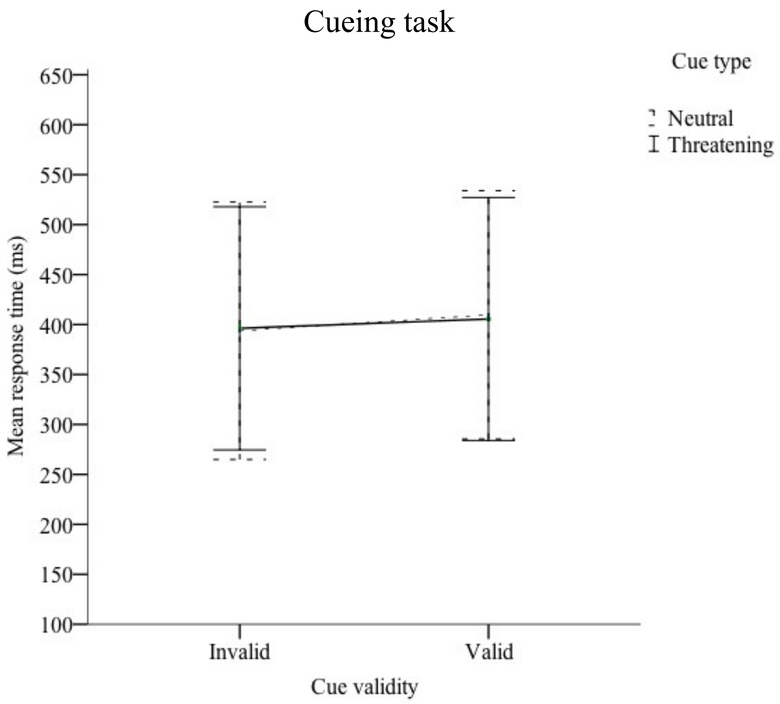

Figure 8. Mean response times on the spatial cueing task as a function of whether the cue was invalid or valid and whether the cue was with a threatening or neutral facial expression. Error bars represent standard deviations.

3.3. Irrelevant distractor task

The results for the irrelevant distractor task are shown in Fig. 9. Overall mean RT was 1540.9 ms (s.d. = 683.5, range = 165 – 6942 ms) and accuracy was 91.1%. RTs on trials with an irrelevant distractor were significantly longer (M = 1652 ms, s.d. = 761.3) than RTs on trials without a distractor (1487 ms, s.d. = 635.9), $t(30) = 4.03$, $p < 0.001$; $d = 0.24$. A 2 x 2 (Distractor Type [threat, neutral] x Target Type [threat, neutral]) repeated-measures ANOVA showed no main effect of distractor type, $F(1, 30) = 0.001$, $p = 0.971$, nor target type, $F(1, 30) = 1.89$, $p = 0.18$, nor was there a distractor type by target type interaction; $F(1, 30) = 3.33$, $p = 0.078$. There was no influence of distractor type on response time on the irrelevant distractor task. But it had a small effect (Cohen, 1977) on performance to present a distractor.

There was a significant differences in accuracy between trials with or without a distractor, $t(30) = 2.14$, $p = 0.04$, reflecting slightly higher accuracy (3%) on trials without a distractor. Therefore a presentation of a distractor had an overall influence on accuracy. A 2 x 2 (Distractor Type [threat, neutral] x Target Type [threat, neutral]) repeated-measures ANOVA showed no main effect of distractor type on accuracy, $F(1, 30) = 2.37$, $p = 0.134$, nor target type, $F(1, 30) = 0.22$, $p = 0.643$. The distractor type by target type interaction was also not significant, $F(1, 30) = 0.15$, $p = 0.699$. Thus presentation of a distractor had influence, both on response time and accuracy. But neither distractor type nor target type had any effect on performance.

Irrelevant distractor task

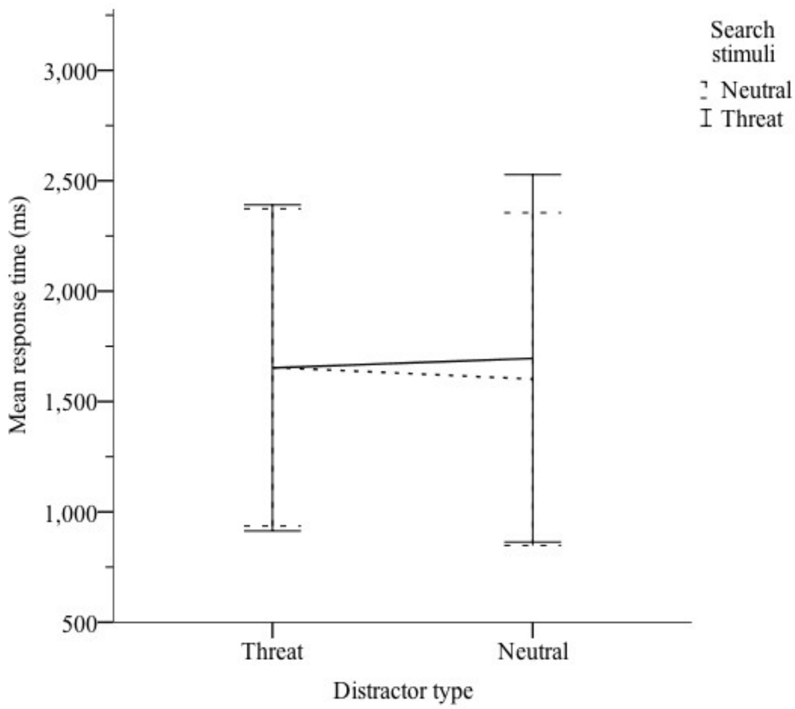

Figure 9. Mean response times on the irrelevant distractor task as a function of facial expression of the irrelevant distractor and whether it appeared among search stimuli with threatening or neutral facial expression. Error bars represent standard deviations.

3.4. Attentional blink task

Average percent correct for threatening and neutral T2 is shown in Fig. 10 and Fig. 11 as a function of whether T1 was threatening or neutral and as a function of lags between T1 and T2. Overall accuracy for T1 was 97% and 78.4% for T2. We initially ran a 2 x 2 x 2 x 7 (T1-type [threat, neutral] x T2-type [threat, neutral] x Distractor Type [threat, neutral] x Lag

Between Targets [1, 2, 3, 4, 5, 6, 7] repeated measures ANOVA. This analysis gave unreliable results, because the data showed many missing values. Therefore we ran a 2 x 2 x 2 x 3 (T1-type [threat, neutral] x T2-type [threat, neutral] x Distractor Type [threat, neutral] x Lag Between Targets [1-2, 3-4, 5-7] repeated measures ANOVA. This analysis showed a main effect of T2-type, $F(1, 28) = 22.88$, $p < 0.001$, reflecting higher accuracy on trials where T2 was threatening. Thus images with a threatening facial expression were less affected by the attentional blink than images with a neutral facial expression. The main effect of distractor type was also significant, $F(1, 28) = 4.96$, $p = 0.034$, reflecting slightly higher accuracy on trials where distractors were neutral. A main effect of lag between targets was also significant, $F(2, 56) = 13.01$, $p < 0.001$, reflecting an attentional blink where accuracy for T2 increased with lag from T1 (see Fig. 10 and 11). No interaction was found significant in this analysis. A possible reason could be the grouping of seven lags into three for the ANOVA.

Fig. 10 shows the accuracy on T2 when T1 is neutral and T2 is neutral or threatening, as a function of lags between targets. The figure shows that in every lag, the accuracy is greater (on average 6% higher) when T2 is threatening. This indicates that when T1 is neutral the attentional blink is reduced when T2 is threatening, compared to when T2 is neutral. The figure shows that overall the accuracy becomes greater as number of lags between targets increases. This applies both when T2 is threatening and neutral. It is worth noting that the increasing accuracy is more noticeable when T2 is neutral, except for lag 6. This shows that the attentional blink is stronger when T1 is neutral and T2 is neutral, but it seems to recover faster when T2 is threatening. The accuracy on threatening T2 is not under as much influence of the number of lags between targets. Thus the attentional blink is weaker.

Fig. 11 shows the accuracy on T2, when T1 is threatening and T2 is neutral or threatening, as a function of lags between targets. The accuracy is greater (on average 7% higher) when T2 is threatening as number of lags increases. This indicates that a presentation of a threatening stimulus (T1) causes an attentional blink, but the blink is reduced when T2 is also threatening. The figure also shows that accuracy is higher on lag 7 than on lag 1, both when T2 is threatening and also when T2 is neutral, indicating that the attentional blink recovers as the number of images between T1 and T2 increases.

The effect size of facial expression on performance on the attentional blink task was calculated to give a standardized measure of its differential sensitivity. When T1 was neutral, the mean accuracy across all lags when T2 was threatening was 81.84% and 76% when T2 was neutral. Cohen's d for T2 type was 0.23, indicating a small effect (Cohen, 1977). When T1 was threatening, the mean accuracy across all lags when T2 was also threatening was 82.31% and 74.9% when T2 was neutral. The effect size for T2 type was *d* = 0.28, indicating a small effect (Cohen, 1977).

T1 Neutral

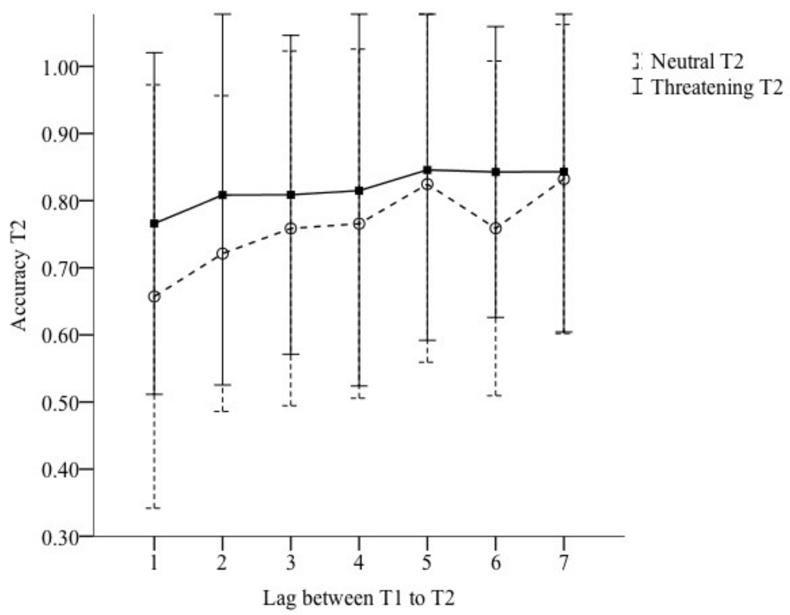

Figure 10. Mean accuracy for identification of threatening and neutral T2 for seven lags between T1 and T2 when T1 was neutral. Error bars represent standard deviations.

T1 Threatening

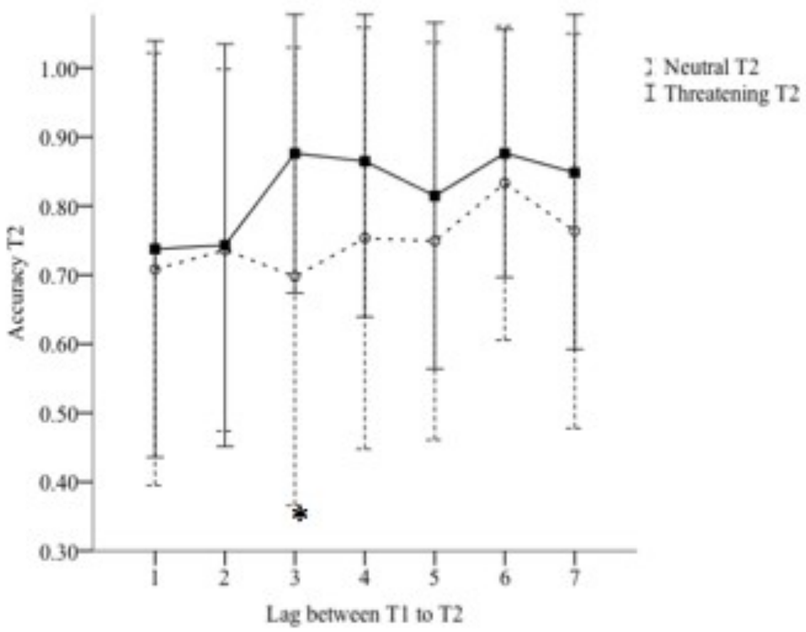

Figure 11. Mean accuracy for identification of threatening and neutral T2 for seven lags between T1 and T2 when T1 was threatening. Error bars represent standard deviations. The star denotes that a t-value for mean difference was significant at $\alpha = .05$.

4. Discussion

The results support the hypothesis. Of the four tasks that were compared in this study, the attentional blink task proved to be the most sensitive task to identify difference in performance, depending on whether a facial expression was threatening or neutral. Facial expression on T2 in the attentional blink task had influence on accuracy, more precisely on identification of gender on the second target (T2) in the task. Threatening T2 resulted in higher accuracy and thus a reduced attentional blink, in comparison of neutral T2. These results are in line with previous results (Müsch et al., 2012; Schwabe et al., 2011) that have found a reduced attentional blink to emotional stimuli in comparison with neutral stimuli. Results also revealed that threatening T2 resulted in a weakened attentional blink, independent of the number of images between the targets. According to these results it might not matter how many images are between the targets: Threatening T2 simply grabs peoples attention. Still it is uncertain whether this increased attention by participants toward threatening stimuli, can be traced to improved recognition of threatening stimuli or whether they had difficulties in breaking away their attention from the threatening stimuli (Cisler & Koster, 2010).

The probe, cueing and irrelevant distractor tasks did not fulfill their purpose. No difference was found in performance with respect to response time or accuracy in the tasks, depending on whether the facial expression on the relevant stimuli were threatening or neutral. Participants did not direct more attention to threatening targets or to threatening distractors on the tasks.

These results are consistent with the research findings of Sigurjónsdóttir et al. (2015). The probe task might have poor reliability as Cisler et al. (2009) and Schmukle (2005) have claimed. Criticism of the cueing and the search tasks (McNally et al., 2013; Schmukle, 2005), also seem to be justifiable. According to these results, the tasks that have been most widely used in ABM (Mogoase et al., 2014), do not seem to be effective. At least they did not find "attentional bias" toward threat in participants from a general sample in this research. But according to evolutionary theories, there should be some kind of "attentional bias" toward threats in healthy individuals, whereas it might have come in handy for our ancestors in the evolutionary history to be quick to identify threats and escape from dangers (Öhman, 1996). In addition, studies suggest that people in general direct their attention to threatening stimuli, to a greater degree than to neutral stimuli (Fox et al., 2000; Hansen & Hansen, 1988). It can be assumed that the "attentional bias" that was found in this study in healthy participants toward threat in the attentional blink task, is even greater in socially anxious people (Clark & McManus, 2002; Dalgleish & Watts, 1990). Assuming this, the attentional blink task should be particularly useful to assess attentional bias in socially anxious people.

According to these results, it should be more effective to use the attentional blink task, rather than the dot probe, cueing or irrelevant distractor task, in ABM for socially anxious individuals. The results give hope to usefulness of the attentional blink task in development of ABM, which studies have shown to have positive effect in reducing anxiety symptoms (Amir et al., 2008; Amir et al., 2009a; Amir et al., 2009b; Li et al., 2008; Schmidt et al., 2009). Hopefully the results of this study will be advantageous in the development of treatment resources for socially anxious individuals in the future, by using the attentional blink task in attention training.

The main limitation of this study was a small sample. It would be necessary to repeat this study on a larger sample. With a larger sample the results would be more reliable and could therefore be more useful in the development of ABM and moreover in the development of treatment resources for socially anxious people. It could also be interesting to repeat the study by using another kind of negative facial images. In the study of Vermeulen et al. (2009) a frightening T1 inhibited attention to T2 and distractors, to a greater degree than a disgusting T1. Therefore it could be worth to repeat this study by using other kinds of facial expression stimuli, as for example fearful facial expression image.

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