The impact of high and low levels of state anxiety on attentional bias and implicit memory

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ABSTRACT

It has been suggested that anxious individuals who show an attentional bias to threat related stimuli would also demonstrate a memory bias for the same material. However evidence is not consistent and often research has examined attentional bias and memory bias across different studies. Therefore the aim of this study is to examine attention and memory biases within one study. N=40 non-clinical anxiety sample drawn from the normal population. SAI was used to measure state anxiety and SuperLab tasks to measure attention and memory, which included images of neutral, happy and angry facial expressions. A 2x3 split plot ANOVA was used to analyse the data. Results of the attention task revealed a significant interaction between state anxiety levels and the type of face shown. Further simple effect analysis revealed that the difference was significant when shown angry faces but not when shown neutral or happy faces. The correlation analysis revealed there was a significant positive relationship between state anxiety and recall of angry faces, but not happy faces. Therefore this study shows support for an attentional and memory bias in those with higher levels of anxiety in a single study. Limitations and directions for future research will be discussed.

KEY WORDS:	ATTENTION	IMPLICIT MEMORY	STATE ANXIETY	BIAS	SAI

Introduction

There is an extensive amount of research indicating that individuals with higher levels of anxiety have a tendency to pay particular attention to threat related stimuli rather than neutral or positive stimuli, therefore showing an attentional bias towards potential threats in the environment (Beck, 1976; Beck & Clark, 1997; Macleod & Mathews, 1988; Broadbent & Broadbent, 1988). In addition to this attentional bias, it has been suggested that anxious individuals would also demonstrate heightened retention of threat related stimuli, therefore displaying a possible selective memory bias (Becker, Roth, Andrich & Margraf, 1999; Rogers, Kuiper & Kirker, 1977, Breck & Smith, 1983; Kennedy & Craighead, 1988).

Two cognitive theories have been influential in the suggestion that individuals who display an attentional bias will also demonstrate a memory bias, Bower's Associative Network Theory (1981, 1987) and Beck's Schema Theory (Beck, 1976; Beck, Emery & Greenberg, 1986). Within Bower's Associative Network Theory (1981, 1987) it is suggested that individuals have a tendency to learn and remember events congruent with their current mood and consequently the persistent negative mood present in those with anxiety would lead to memory biases (Dillon, 2006). Beck's Schema Theory (1976) suggested that when an individual is in a prevailing mood, such as an anxious mood, a schema consistent with that mood predisposes them to attend to, and interpret stimuli as potentially threatening. This bias in attention would therefore result in similar biases in memory (Schacter & Coyle, 1997). In summary, both theories of Bower (1981, 1987) and Beck (1976) predict that individuals who are high in anxiety will display an attentional bias for threat related stimuli and also show a memory bias for the same kind of material (Beck et al., 1986).

Evolutionary psychologists, such as Tooby and Cosmides (2005) propose that cognitive biases have been shaped by evolutionary adaptive processes and Mogg and Bradley (1998) suggest that these processes have led to an attentional bias to threat in order to facilitate the unconscious and rapid detection of danger. This theory is supported by Ohman's Feature Detection Model (1996, 2005; Ohman & Wiens, 2004) which states that attention to threat is unconscious and high intense stimuli are analysed in a Feature Detection System which influences the arousal system and results in an attentional bias to threat (Cisler & Koster, 2010). Following this reasoning the evolutionary concepts of attentional bias by Mogg and Bradley (1998) and Ohman (1996, 2005) can be extended and applied to memory bias (Mitte, 2008). A memory bias may be evolutionary adaptive because it would assist learning in the detection of potential threats resulting in the ability to avoid danger and promote survival (Baumeister, Vohs, DeWall & Zhang, 2007). A remarkable study by Nairne, Thompson and Pandeirada (2007) found that participants that were faced with an imaginary scenario which was potentially threatening to their survival demonstrated enhanced memory for survival related stimuli both in recall and in recognition. This suggests that there may be an evolutionary based explanation for a memory bias in those with an attentional bias.

However despite the theories of Bower (1981, 1987) and Beck (1976), and in contrast to findings on attentional bias, the predicted memory bias in those who show an attentional bias for threat related stimuli has not been found consistently in research (Williams, Watts, MacLeod, & Mathews, 1988, 1997). Much of the evidence appears to be contradictory, with a considerable number of studies showing support for a memory bias in those with attentional bias (Becker et al., 1999; Rogers, Kuiper & Kirker, 1977, Breck & Smith, 1983, Kennedy & Craighead, 1988) but in contrast an equal amount of research which challenge these findings (Lundh & Ost, 1997; Wenzel & Holt, 2002; Rapee, McCallum, Melville, Ravenscroft & Rodney, 1994). As Coles and Heimberg (2002) noted in their review of memory biases in anxiety disorders, it's impossible to draw satisfactory conclusions from contradictory findings. Moreover recent evidence confirms that these contradictory findings are still occurring. A study by Cheie and Visu-Petra (2012) showed that children with high levels of anxiety displayed a tendency to better recall angry expressions, compared to neutral and positive. Kircanski, Craske and Bjork (2008) found an enhanced overall memory bias for threat related words in individuals with higher anxiety, therefore showing support for a memory bias. In contrast only limited support for memory bias in individuals with higher anxiety was found by Watts and Weems (2006) and no evidence was found by Thomas and Hasher (2006).

It is important to recognise the consistent discrepancies that relate to previous studies investigating cognitive biases in attention and memory. The majority of the research has not measured attention and memory biases in the same study within the same individuals (Mitte, 2008). A meta-analysis conducted by Mitte (2008) of 165 studies of memory biases in anxiety which included a total of 9,046 participants (clinical and nonclinical samples) found a large amount of support for an attentional bias to threat in highly anxious individuals but no evidence was found for a memory bias. Overall Mitte's (2008) meta-analysis found there was no difference in recall between individuals with high and low anxiety. However a critical point is that this meta-analysis focused exclusively on between group comparisons and therefore it still remains unclear whether the same anxious individuals who demonstrate an attentional bias would also demonstrate a memory bias (Schacter & Coyle, 1997). Drawing conclusions based on comparisons across studies conducted with different methodologies is dangerous and will lead to ambiguity (Schacter & Coyle, 1997). Therefore a within subjects design would be more appropriate and this will also control for differences between individuals which could act as confounding variables, such as age or existing memory ability.

Equally important to any study involving threat related attentional bias is the difference between state anxiety and trait anxiety. State anxiety refers to a temporary anxious mood state, whereas trait anxiety is more stable over time and refers to an aspect of personality (Speilberger & Sarason, 1990). Many studies which have found an attentional bias and a memory bias in those with higher anxiety have not been able to establish whether state or trait anxiety was more important (Becker et al., 1999; Coles & Heimberg, 2002). The meta-analysis by Mitte (2008) highlighted the relevance of state anxiety because it has been shown to increase the effects of trait anxiety (Mitte, 2008). Mathews and Mackintosh (1998) found that an attentional vigilance will only be present in those who are experiencing high levels of state anxiety. Both Williams et al. (1988, 1997) and Mogg and Bradley (1998) suggested that state anxiety is involved in the appraisal of new stimuli. Furthermore both Bower's Associative Network Theory (1981,

1987) and Beck's Schema Theory (Beck, 1976; Beck et al., 1986) focus on state anxiety when suggesting that individuals who display an attentional bias will also demonstrate a memory bias, as they both focus on negative mood states. Research from Fox, Russo, Bowles and Dutton (2001) show that state anxiety is a direct result of activation in the brains fear detection system, and therefore contributes to a threat related attentional bias. Given these results this study will focus on state anxiety.

Some researchers have attributed the inconsistent results related to attentional bias and memory bias to the type of threat related stimuli used (Reidy & Richards, 1997). Many studies into attention and memory biases have used words as the threat stimulus (Denny & Hunt, 1992; Koster, Raedt, Leyman, & Lissnyder, 2010; Kircanski, Craske & Bjork, 2008), however memory biases for threatening information using words as the stimuli has received little support (Coles & Heimberg, 2002). For example a study by Rapee et al. (1994) investigating a memory bias in anxious individuals involved presenting participants with positive, neutral and negative words. However across three studies Rapee et al. (1994) was not able to show any differences between anxious and non-anxious individuals' ability to recall positive, neutral or negative words, thus showing no support for a memory bias. There are a number of factors that influence the ability to recall words and sometimes this may be individual. Particular words can be familiar to certain individuals for various reasons, whether they are negative or not, and there is evidence to suggest that more commonly used, high frequency words are better recalled than low frequency words (Eysenck, 1997; Harley, 2010). If these words are also irregular it will lead to slower reading resulting in decreased ability to recall the word (Harley, 2010). In addition to frequency and regularity, image-ability, concreteness, age of acquisition and part of speech are all known to effect word retention (Harley, 2010). Additionally particular words may be more salient to certain individuals and it has been suggested that the more meaning that is attached to stimuli as it is processed, the better it will be recalled (Craik & Lockhart, 1972).

Human faces are more appropriate when investigating possible attention and memory biases because the human face is a unique stimulus and one of the most frequent and meaningful stimuli that a person experiences from birth (Bradley et al., 1997). A threatening face or an angry expression staring directly at someone is a clear indication of hostility towards the individual, whereas a threat word is an arbitrary symbol (Bradley et al., 1997). Studies have also argued that adaptive evolutionarily processes result in being more able to rapidly detect threatening expressions compared to neutral or positive expressions (Hansen & Hansen, 1988). As it has been suggested that attentional bias to threat and a memory bias are evolutionary adaptive processes (Mogg & Bradley, 1998; Ohman, 1996, 2005; Ohman & Wiens, 2004) then biases to pictorial stimuli are more likely to occur than to threat related words, which do not have any biologically relevant features (Cisley & Koster, 2010). Thus overall angry faces represent a more effective and ecologically valid type of threat than words (Bradley et al., 1997, Bar-Haim, Lamy & Glickman, 2005, Fox et al., 2001) and it has been suggested that future studies of memory biases in anxiety may benefit from using images of facial expressions as the stimuli (Rinck & Becker, 2006). However it is important to use unfamiliar faces and exclude recognisable faces from studies, for example a face from television or film, as research suggests that familiar faces may be easier to recall (Shapiro & Penrod, 1986).

Another point, which further questions current research regarding attentional bias and memory bias, is that researchers do not consistently distinguish between implicit and explicit memory. Implicit memory is where previous knowledge and experience is used unconsciously for recall. A memory test that does not involve conscious recollection would demonstrate an implicit memory bias (Eysenck & Keane, 2005). Explicit memory involves a conscious effort recall of previous experience, knowledge and learned information. A memory test that does involve conscious recollection would demonstrate an explicit memory bias (Eysenck & Keane, 2005). It is important to distinguish between implicit and explicit memory because different outcomes have been found depending on the type of memory investigated (Coles & Heimberg, 2002). Furthermore Bower (1981, 1987) and Beck (1976; Beck et al., 1986) both assume the existence of a memory bias for threatening information in anxious individuals, however neither distinguishes between implicit and explicit memory (Mitte, 2008).

Much of the research which has specified the type of memory examined in anxiety has investigated explicit memory, but there has appeared to be more support for implicit memory biases in anxious individuals (Williams et al.,1997; Amir, Foa & Coles, 2000; Coles & Heimberg, 2002). Williams et al. (1997) suggested that individuals with higher levels of anxiety process threatening stimuli perceptually rather than conceptually and therefore are characterised by an implicit memory bias rather than an explicit memory bias. Consequently anxiety should be linked to implicit memory tasks that are dependent on perceptual subsystems (Johnson & Hirst, 1993) and support for this has been found in a number of studies (Amir et al., 2000; Richards, French, Adams, Eldridge & Papadopolou, 1999; Coles & Heimberg, 2002). Williams et al.'s (1988, 1997) theory of an implicit memory in anxious individuals also addresses the debate amongst researchers of whether depression or anxiety has the greater impact on memory bias. It has been assumed that individuals with depression elaborate and ruminate on negative events or themes and therefore have a higher ability to recall them (Becker et al., 1999). In contrast individuals with anxiety presumably pay attention to negative stimuli, however they do not elaborate on these stimuli as it would be frightening for them, thus showing no memory bias (Becker et al., 1999). Williams et al. (1988, 1997) support this view and suggest that anxiety is related to the former stages of information processing, whereas depression is related to later stages of processing (the elaboration stage). Therefore those with anxiety would be categorised by an implicit memory bias, whereas those with depression would be categorised by an explicit memory bias. Furthermore, in their review of memory biases in the anxiety disorders, Coles and Heimberg (2002) concluded that the empirical evidence for implicit memory biases in anxiety is more homogeneous and shows support for memory biases in various anxiety disorders. Therefore Coles and Heimberg (2002) suggest it will be worthwhile for future research to investigate influences of attentional biases in implicit memory tests. The state component of the Spielberger State-Trait Anxiety Inventory (1983) will be used in the present study as it has been suggested it can distinguish anxiety from depressive syndromes (American Psychological Association (APA), 2012), thus ensuring depression is not a confounding variable.

Recent advances have enabled researchers to utilise neuroimaging techniques to further understand and investigate brain activity involved in attention and memory biases, and the existence of a memory bias in individuals with anxiety has received

some neurobiological support (Etkin et al., 2004). A study by Etkin et al. (2004) utilised functional MRI and found that the processing of angry faces triggers activation of the basolateral amygdala area in the brain, which has shown to be involved in the formation of memory in accordance with the emotional significance of events (Behrendt, 2011; Pare, 2003). Moreover, Etkin et al. (2004) also found that the level of activation in this area can be predicted by individual differences in anxiety.

There are several areas where the presence of a memory bias in anxious individuals could have important implications, one such area is Eye Witness Testimony (EWT). Shapiro and Penrod's (1986) meta-analysis of eye witness and facial identification studies found that distinctive faces or expressions, such as angry faces, are more likely to be remembered in EWT, resulting in more positive identifications and less false identifications. In support of this a study by Mogg, Garner and Bradley (2007) used an eye tracking camera and showed that individuals with higher anxiety were more likely to direct their gaze at negative facial expressions, than individuals with low anxiety (Mogg et al., 2007). This is in line with a study by Yuille, Davies, Gibling, Marxsen and Porter (1994) that used stressful simulated situations and provided evidence to show that higher anxiety improved eyewitness recall. However, in contrast, some previous studies have shown that higher levels of anxiety or stress can lead to impaired memory in EWT (Loftus & Burns, 1982; Peters, 1988). Valentine and Mesout (2008) attached a wireless heart rate monitor to participants as they walked around the Horror Labyrinth of the London Dungeons, and also gathered self-reported state anxiety levels. They found that witnesses who experienced higher levels of state anxiety were less able to correctly recall faces of target horror actors. They also gave more incorrect details and made less correct identification from a lineup than those with lower levels of state anxiety. Due to the conflicting findings from these studies evidence of a memory bias for angry faces in those with higher levels of state anxiety could provide critical insights in the case of EWT and may establish new directions into future research for those interested in this area.

Another area where the presence of a memory bias in anxious individuals could have important implications is in the study of anxiety disorders. Cognitive processes such as memory and attention have been recognised as crucial factors in the etiology and maintenance of anxiety disorders (Williams et al., 1988, 1997; Eysenck, 1992). Mathews (1990) suggested that attentional bias to threat related stimuli will result in a heightened awareness of potential danger in the environment, and therefore lead to more frequent or intense experiences of anxiety. Also a common symptom of several anxiety disorders is intrusive negative memories (Coles & Heimberg, 2002). For example individuals with Post Traumatic Stress Disorder (PTSD) often experience unwanted memories through flashbacks, nightmares and intrusive recollections of a traumatic event. Individuals with Social Phobia (SP) can often easily recall vivid details of certain self-perceived humiliating behaviour. Individuals with Panic Disorder (PD) frequently experience terrifying thoughts of heart attacks, or even death, which may be fueled by prominent memories of a previous related experience, such as heart palpitations. These examples suggest that anxiety disorders tend to be associated with a memory bias, or preferential memory, for threatening material (Coles & Heimberg, 2002) which results in major distress for those with anxiety disorders. These biases contribute to the maintenance of an anxious and fearful state because they intensify the negative mood, and lead to further activation of danger schemata (Calabrese & Leugebauer, 2002). This may lead to

future deterioration of mental health and may result in the individual avoiding any new situations because of assumed threats (Williams et al., 1988, 1997). Therefore the study of attention and memory biases is a highly important area and if a memory bias for negative stimuli does exist then there may be a major breakthrough in providing new directions for the treatment of anxiety (Rinck & Becker, 2006).

Therefore the aim of the present study is to examine if further evidence can be provided to suggest that individuals with higher levels of state anxiety who show an attentional bias towards negative threat related stimuli would also show an implicit memory bias for the same material. This study will incorporate the same materials, the same subjects as well as the same attention and memory tasks within one study. This will eliminate having to speculate across studies and will allow a closer investigation into this important area. In the present study attention to certain facial expressions will be measured by a SuperLab dot probe computer task. This task will measure the time taken to press a key which indicates the correct location of a dot on the screen. The amount of time taken to locate the dot will be used as an index of whether attention was directed to the right or the left of the screen, and therefore to the angry, neutral or happy facial expression. For example, a subject who attends to the left image should be relatively faster to detect a dot probe that subsequently appears on the left, as in the study by Bradley et al. (1997). To ensure implicit memory is examined participants will not be told in advance of the subsequent SuperLab free recall memory task that follows immediately after the attention task. This will ensure unconscious recall and examine implicit memory as in the study by Mogg, Bradley, Williams and Mathews (1993). Implicit memory tasks contain no specific instructions to intentionally recall memories (Mitte, 2008). Finally any limitations within the present study will be addressed and directions for future research will be discussed.

Experiment. Phase One Hypotheses

H_1 There will be a significant difference in reaction time depending on whether an individual is high or low in state anxiety levels.

H_2 There will be a significant difference in reaction time depending on whether a happy, neutral or angry face is shown.

H_3 There will be a significant interaction between state anxiety levels and type of face shown.

Experiment. Phase Two Hypotheses

H_1 There will be a significant difference in implicit memory score depending on whether an individual is high or low in state anxiety levels.

H_2 There will be a significant difference in implicit memory score depending on whether a happy, neutral or angry face is shown.

H_3 There will be a significant interaction between state anxiety levels and type of face shown.

Correlation Hypotheses

H_1 There will be a significant positive relationship between state anxiety score and the number of angry faces correctly recalled.

H_2 There will be not a significant positive relationship between state anxiety score and the number of happy faces correctly recalled.

H_3 There will not be a significant positive relationship between state anxiety score and the number of neutral faces correctly recalled.

Method

Design

Experiment
Phase one uses a 2x3 mixed subjects design. IV1 was state anxiety (2 conditions: high state anxiety, low state anxiety - between subjects factor). IV2 is type of face (3 conditions: happy, neutral, angry - within subjects factor). The DV is the reaction time on the dot probe task.

Phase two uses a 2x3 mixed subjects design. IV1 was state anxiety (2 conditions: high state anxiety, low state anxiety - between subjects factor). IV2 is type of face (3 conditions: happy, neutral, angry - within subjects factor). The DV is the number of faces correctly recalled in the implicit memory task.

Correlation
This consists of a correlation to test if there is a relationship between state anxiety score and implicit memory score.

Participants
N=40. Participants were a non-clinical anxiety sample drawn from the normal population. The study included 14 male and 26 female undergraduate students from the University of West London (UWL) and who were above the age of 18. The age range of participants was between 19 and 42, with a mean age of 25.43 years (SD = 5.65). All the participants had self-reported normal or corrected to normal eyesight.

Materials and Equipment
State anxiety in the undergraduate population was measured using the Speilberger's State Anxiety Inventory (SAI, Appendix A) which is the state anxiety component of Spielberger's State-Trait Anxiety Inventory (STAI, Speilberger, Gorsuch, Lushene, Vagg & Jacobs, 1983). The SAI consists of 20 items created to provide a uni-dimensional measure of state anxiety. State anxiety items include 'I am tense', 'I am worried', 'I feel at ease' and 'I feel secure'. All twenty items are rated on a four point scale, one being 'Not at All' and four being 'Very Much'. The lowest possible state anxiety score is 20 and the highest is 80. The higher the score on the SAI the higher the level of state anxiety. The SAI is a widely used measure of state anxiety and can be used to distinguish from depressive syndromes (APA, 2012). The operational definition of state anxiety is an above average mean score on the SAI. Those below mean state anxiety score were considered to have low state anxiety, and those above the mean were considered to have high state anxiety. Internal consistency coefficients for the SAI have ranged from 0.86 to 0.95. Test-retest reliability coefficients have ranged from 0.65 to 0.75 over a two-month period (Spielberger et al., 1983). Considerable evidence confirms the construct and concurrent validity of the scale (Spielberger et al., 1983).

SuperLab was used for the attention task and the memory task for the present study. The stimuli for these tasks consisted of 54 colour photographic images which were drawn from a set of faces from the Psychological Image Collection (2012) at Stirling

University and The Center For Vital Longevity Face Database (Minear & Park, 2004). 36 main images (18 men and 18 women) were included in the attention task (12 neutral, 12 happy and 12 angry) and an additional 18 distraction faces (9 men and 9 women) were included in the memory task (6 neutral, 6 happy and 6 angry). All images displayed the frontal view of the face with the person in the image looking into the camera. Faces were against a white or blue background. Viewing size for each image was 350 (x) x 500 (y) pixels. The SuperLab tasks were presented on a laptop with a fifteen-inch screen (1366 x 768 resolution) and at a viewing distance of approximately sixty-five centimetres. The databases consisted of Caucasian faces; therefore the images included in this study were of Caucasian men and women. Examples of images can be found at Appendix B. A brief piloting study was carried out with 5 undergraduate students of UWL who were not participating in the study to ensure the SuperLab tasks ran smoothly and the instructions were clear and understandable. No problems were reported.

Procedure

The computer tasks and completion of questionnaires were conducted in quiet classrooms within UWL. Participants were tested individually. They were asked to read and complete the consent form (Appendix C) and then asked if they have any questions. They were asked to complete the SAI questionnaire and were instructed to circle the answer which best described how they were feeling at that time. After completion of the questionnaire they were asked to move onto the computer task.

Procedure for Attention task

A set of instructions appeared on the screen (Appendix D) outlining the attention task, when participants had finished reading the instructions they were prompted to press any key to begin the experiment. Participants were initially instructed to focus their attention on the fixation point in the middle of the screen, which remained for 1500ms (Koster, Verschuere, Crombez & Van Damme, 2005). They were then presented with two faces at the same time, one to the left of the screen and one to the right for 500 milliseconds. This length of time assured the stimuli were subliminal and therefore participants were less able to cognitively process the faces, as in the study by Mogg, Bradley, Williams and Matthews (1993). Immediately after the faces were cleared from view a dot appeared either to the left or the right of the screen and the participant was required to press the appropriate response button as quickly as possible to indicate the location of the dot probe. This dot remained until the participant gave a response.

The faces presented were equally distributed between the left and the right of the screen. For example neutral, happy and angry facial expressions were all displayed to the left of the screen 6 times and to the right of the screen 6 times. The faces were presented in an equal number of combinations. For example the combinations happy and neutral, angry and neutral and happy and angry were displayed 6 times each. The face and dot probes were counterbalanced and appeared in either location with equal frequency, so the dot appeared behind a happy face 3 times, behind a neutral face 3 times and behind an angry face 3 times. Faces in the attention task were displayed in the same order for each participant.

Procedure for Memory task

Immediately after the attention task participants were presented with a second set of on screen instructions (Appendix E) outlining a free recall memory task. Participants were not informed of this memory task prior to beginning the computer tasks to insure that implicit memory would be tested (Mitte, 2008) however they were fully debriefed after. Participants were shown a series of faces that were presented in the attention task (36 images). Images were displayed one at a time, along with the additional distraction faces (18 images), and participants were asked to identify which ones they remember by pressing the appropriate response key. If there was not a response after 3000ms the task would automatically move onto the next image and a 'no response' was recorded, as in the study by Majerus et al. (2011). Faces appeared randomly in the memory task and not in the same order as the attention task.

Ethics

Participants were asked to sign a consent form (Appendix E). They were advised that taking part in the study was voluntary and they could withdraw at any time without any questions asked. It was explained that participants would be required to complete a questionnaire and complete a short computer task and they were given an estimation of the time needed to complete the study. Participants were assured that information gained from the questionnaire and the computer tasks would be kept anonymous and no names will be used on the report. Furthermore names and email addresses of the researcher and supervisor were provided. This study used a standardised questionnaire and SuperLab attention and memory tasks which are not known to cause any harm, offense or distress. Furthermore as this type of study could be stressful for individuals with clinical levels of anxiety this study was intended to only look at relative levels of high and low anxiety that can be found in the general public. All participants were debriefed after the experiment was completed. Ethics approval for this study was obtained from the UWL Psychology Research Ethics Committee.

Results

The data were collected and entered into SPSS and the results can be found below.

Experiment. Phase One Results – Attention Task

Before the analysis any data with errors within the attention tasks were discarded as in studies by Rinck and Becker (2006) and Bradley et al. (1997). Therefore N=36 and these remaining data were subjected to analysis reported below.

Table 1
Descriptive statistics showing the mean scores of reaction times for facial expressions in state anxiety

	Happy		Neutral		Angry	
State Anxiety	*M*	*SD*	*M*	*SD*	*M*	*SD*
High	619.00	161.12	514.89	137.00	459.56	125.55
Low	642.39	470.32	560.61	231.46	677.80	539.63
Total	630.70	346.69	537.75	188.88	568.68	399.22

Inspection of the means show that for the happy faces the quickest mean reaction time was for those with high anxiety. For the neutral faces the quickest reaction time was for those with high anxiety. For the angry faces the quickest reaction time was also for those with high anxiety. Overall the quickest reaction time for all faces was for those with high anxiety when they saw the angry faces. This suggests that people with higher levels of anxiety directed their attention to the angry faces, compared to the neutral or happy faces.

The means also show that those with high anxiety, as well as those with low anxiety, were slower to react to happy faces than neutral faces. The difference in the mean reaction times between high and low anxiety for happy and neutral are not great, however the difference in the mean reaction time for angry faces shows the biggest difference.

Table 2
Split plot ANOVA summary table

	SS	df	Mean square	F	Sig
Facial expression	161407.63	1.54	104818.49	3.80	0.04
Error (facial expression)	1445042.30	52.36	27600.41	-	-
State anxiety	217172.68	1.00	217172.68	0.80	0.38
Error (state anxiety)	9205000.98	34.00	270735.32	-	-
Facial expression*state anxiety	166365.41	1.54	108038.08	3.91	0.04

N.B. Mauchley's Test of Sphericity is significant (0.701, df = 2, p<.01) therefore the sphericity assumption is not met, consequently data from the correction model Greenhouse-Geisser was reported for within subject effects.

To test for differences in Reaction Time these data were analysed using a split plot ANOVA with facial expression (Happy, Neutral, Angry) as the within subjects factor and state anxiety (high/low) as the between subjects factor. The analysis reveals the main effect of the facial expression condition was significant, $F(1.54, 52.36) = 3.8$; $p = .04$. The main effect of the state anxiety condition was not significant, $F(1,34) = 0.8$; $p = .38$. The interaction between facial expression and state anxiety was significant, $F(1.54, 52.36) = 3.91$; $p = .04$.

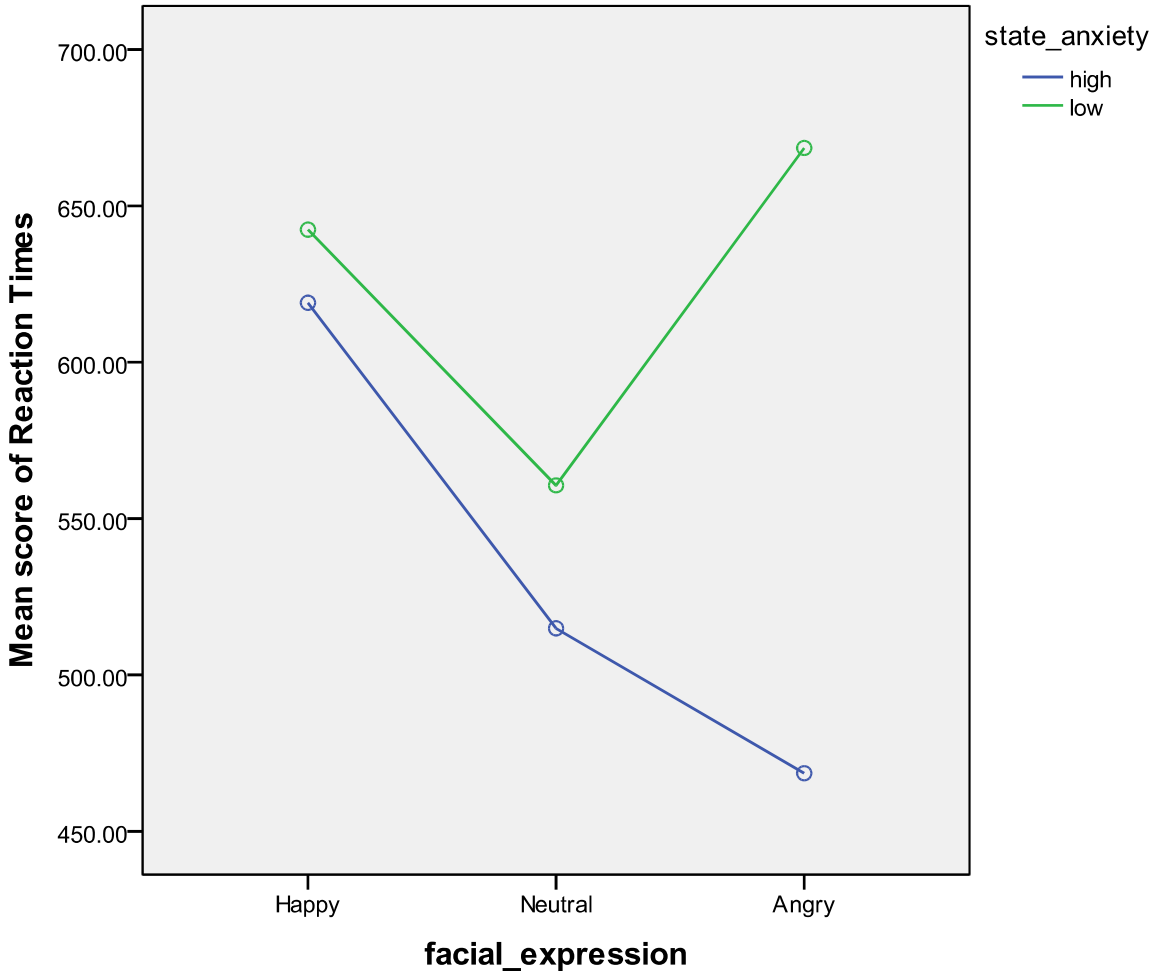

Figure 1: Line graph showing the mean scores of reaction times for facial expressions in state anxiety

As there is a significant interaction between facial expression and state anxiety this was further investigated using simple effect analysis. Bonferroni adjustment was made for multiple comparisons (Hinton, Brownlow, McMurray & Cozens, 2004).

Table 3
Descriptive statistics showing the paired difference in the means for reaction times in high and low anxiety for happy, neutral and angry faces

Facial expression	State anxiety	Mean difference	Std Error	Sig
Happy	Low - High	23.39	117.18	0.84
Neutral	Low - High	45.72	63.40	0.48
Angry	Low - High	218.24	135.61	0.04

Table 4
Table to show the simple effects of high and low state anxiety on happy, neutral and angry faces

Facial Expression	State Anxiety	Sum of Squares	df	Mean Square	F	Sig
Happy	Contrast	4923.36	1	4923.36	0.40	0.84
	Error	4201792.28	34	123582.13		
Neutral	Contrast	18814.69	1	18812.69	0.52	0.48
	Error	1229820.06	34	36171.18		
Angry	Contrast	787360.44	1	787360.44	4.76	0.04
	Error	5626930.11	34	165497.94		

This simple effect analysis reveals that the difference in reaction time between high and low state anxiety levels when shown a happy face was not significant, $F(1,34) = 0.40$, $p = .84$). The difference in reaction time between high and low state anxiety levels when shown a neutral face was not significant, $F(1,34) = 0.52$, $p = .48$). The difference in reaction time between high and low state anxiety levels when shown an angry face was significant, $F(1,34) = 4.76$, $p = .04$).

Experiment. Phase Two Results – Memory Task

Before the data were analysed any data from participants who selected 'do not remember' on certain images were discarded as in the study by Majerus et al. (2011).

Table 1

Descriptive statistics showing the mean scores of recall for facial expressions in state anxiety

	Happy		Neutral		Angry	
State Anxiety	*M*	*SD*	*M*	*SD*	*M*	*SD*
High	5.41	3.02	4.23	2.52	6.72	3.27
Low	5.83	3.03	3.61	2.17	5.33	3.22
Total	5.60	2.99	3.95	2.36	6.10	3.28

Inspection of the means show that for the happy faces the highest recall mean was for those with low anxiety. For the neutral faces the highest recall mean was for those with high anxiety. For the angry faces the highest recall mean was also for those with high anxiety. Overall the highest recall mean for all faces was for the angry faces for those with high anxiety. This suggests that people with higher levels of anxiety remembered more of the angry faces, compared to the neutral or happy faces.

The means also show that those with high anxiety, as well as those with low anxiety, recalled less of the neutral faces than happy faces. The difference in the mean recall between high and low anxiety for happy and neutral are not great, however the difference in the mean recall for angry faces shows the biggest difference.

Table 2

Split plot ANOVA summary table

	SS	df	Mean square	F	Sig
Facial expression	99.28	2	49.64	10.40	0.00
Error (facial expression)	362.92	76	4.78	-	-
State anxiety	8.30	1	8.30	0.53	0.47
Error (state anxiety)	599.40	38	15.77	-	-
Facial expression*state anxiety	16.48	2	8.24	1.73	0.19

To test for differences in Recall these data were analysed using a split plot ANOVA with facial expression (Happy, Neutral, Angry) as the within subjects factor and state anxiety (High/Low) as the between subjects factor. The analysis reveals that the main effect of the facial expression condition was significant, $F(2, 76) = 10.40$; $p<.001$. The main effect of the state anxiety condition was not significant, $F(1,38) = 0.53$; $p = .47$. The interaction between facial expression and state anxiety was not significant, $F(2, 76) = 1.73$; $p = .19$.

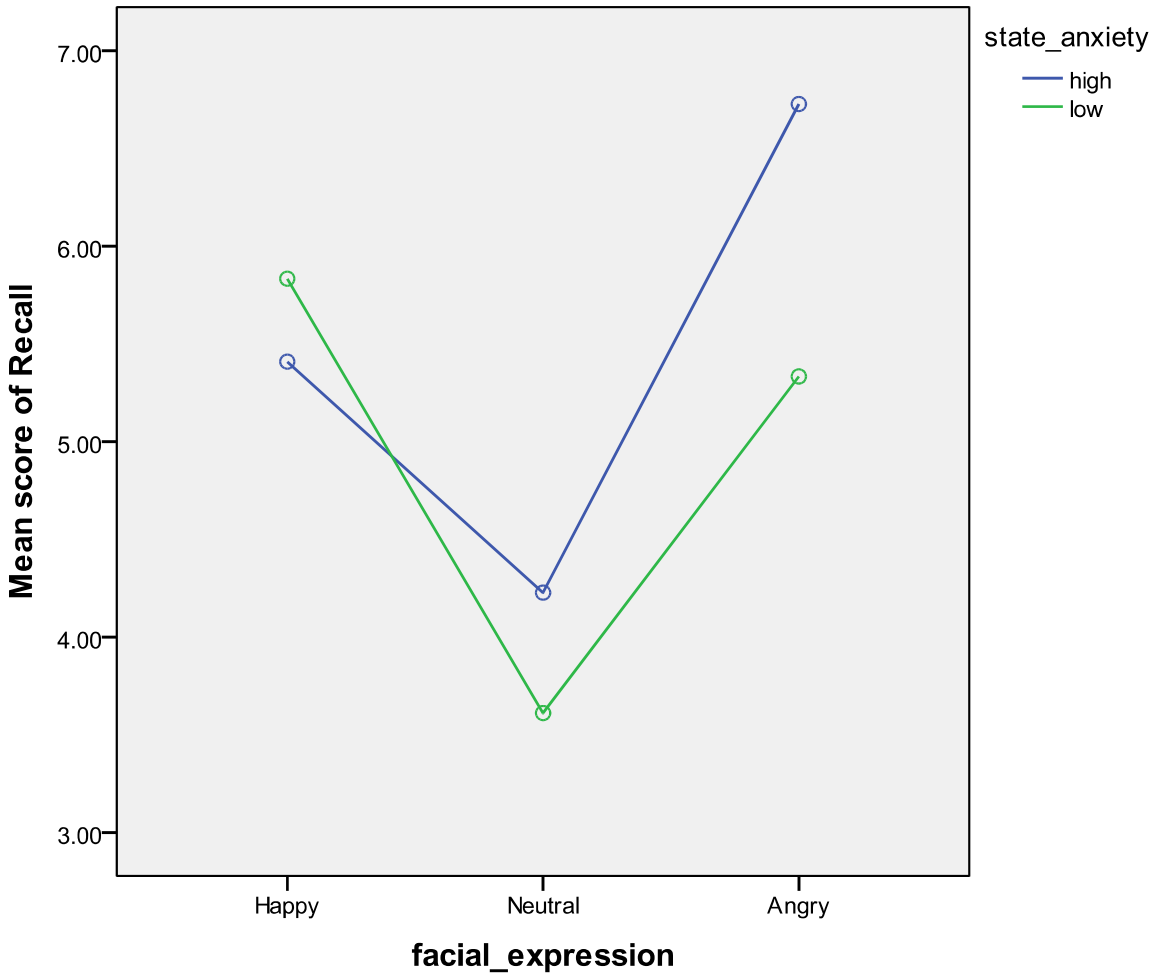

Figure 1: Line graph showing the mean scores of recall for facial expressions in state anxiety

Correlation Results - Correlation of state anxiety and implicit memory

Table 1
Descriptive statistics showing the mean state anxiety score

	M	*SD*
State Anxiety score	39.38	10.09

Table 2
Correlation between state anxiety score and recall score for happy, neutral and angry faces

	State Anxiety score
Recall for Happy faces	-0.23 (p = 0.16)
Recall for Neutral faces	0.35 (p = 0.03)
Recall for Angry faces	0.34 (p = 0.03)

The correlation analysis reveal there was not a significant positive correlation between state anxiety score and the number of happy faces recalled, $r(38) = -0.23$, $p = .16$, one-tailed. There was a significant positive correlation between state anxiety score and the number of neutral faces recalled, $r(38) = 0.35$, $p = .03$, one-tailed. Finally, there was a significant positive correlation between state anxiety score and the number of angry faces recalled, $r(38)= 0.34$, $p = .03$, one-tailed.

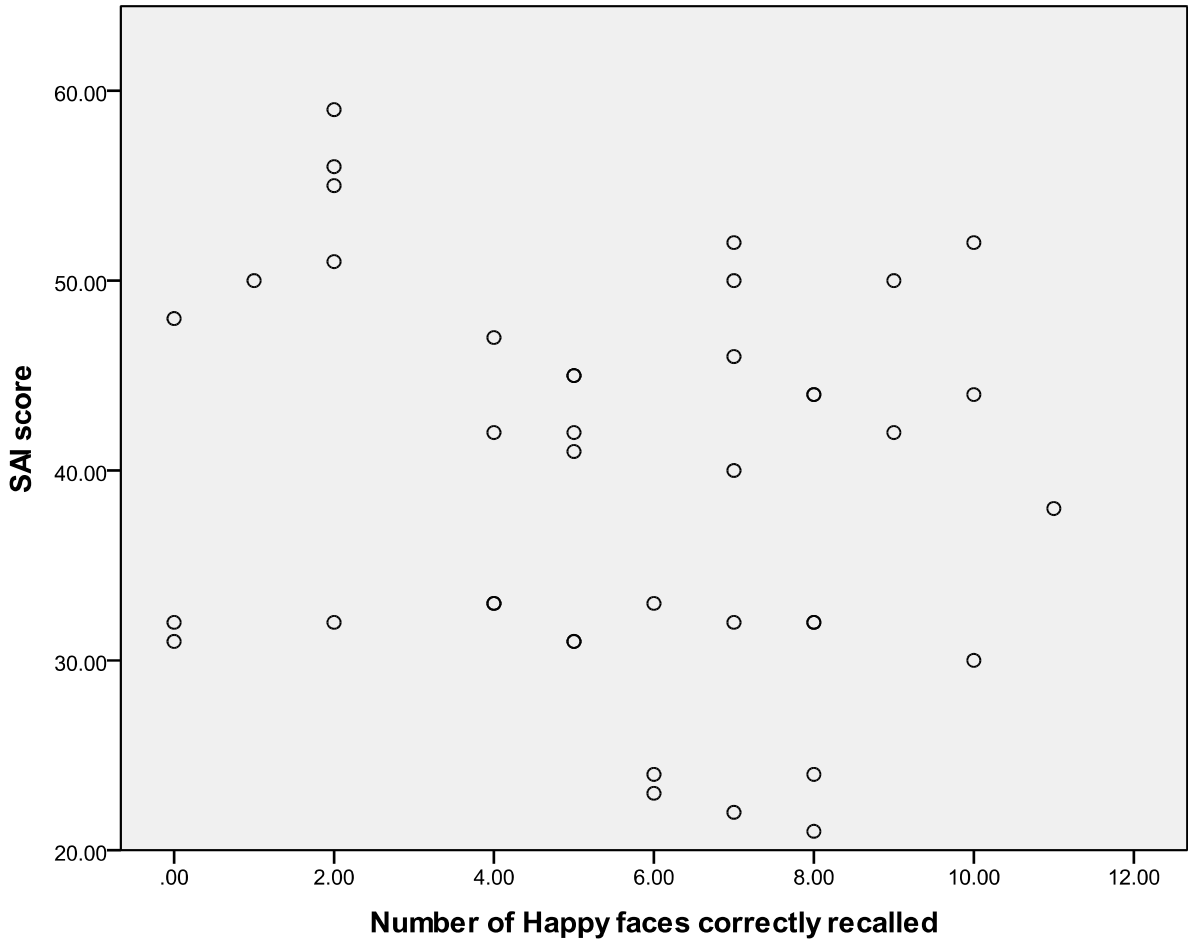

Figure 1: Scattergram to show state anxiety score and the number of Happy faces recalled

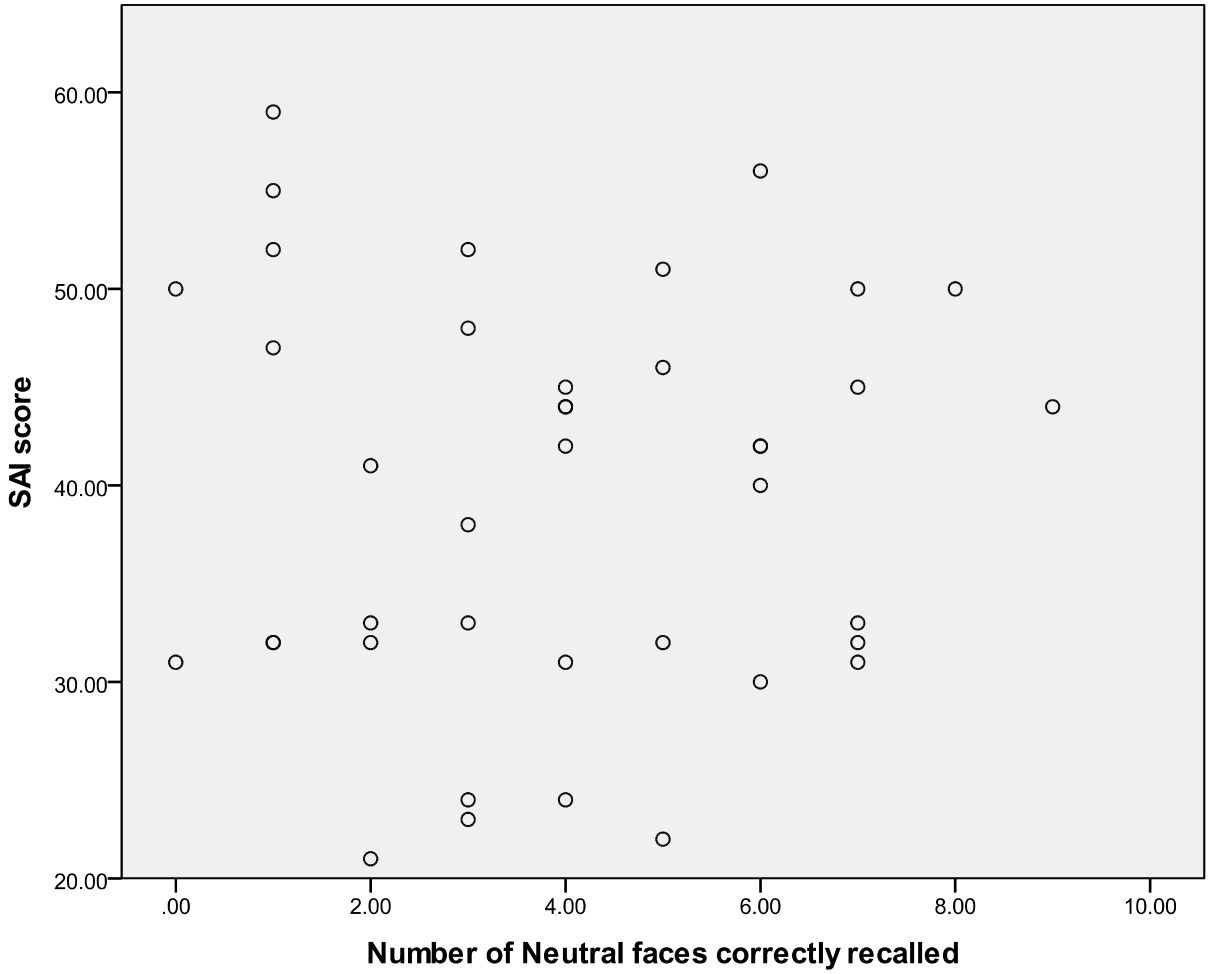

Figure 2: Scattergram to show the positive relationship between state anxiety score and the number of Neutral faces recalled

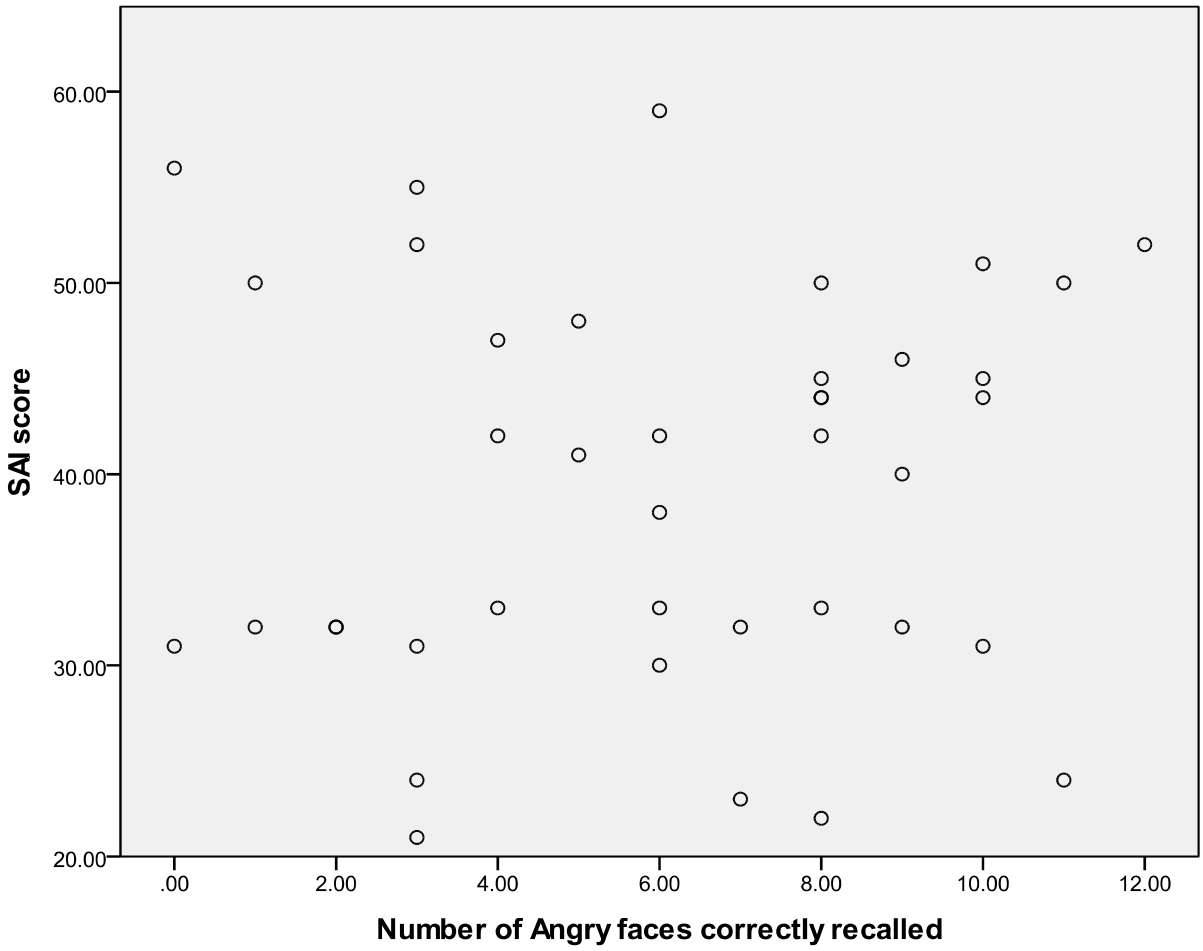

Figure 3: Scattergram to show the positive relationship between state anxiety score and the number of Angry faces recalled

Discussion

The results of the attention task (Phase one of the experiment) show there was not a significant main effect on reaction time depending on whether an individual had high or low state anxiety levels, thus the null hypothesis can be accepted. This is surprising, however see below the interaction. There was a significant main effect on reaction time depending on whether a happy, neutral or angry face was shown, thus H2 can be accepted. Finally, and most importantly, there was a significant interaction between state anxiety levels and the type of face shown, thus H3 can be accepted. The interaction was investigated further with simple effect analysis and the results show that the difference in reaction time between those with high and low state anxiety when shown angry faces was significant. Differences in reaction time between those with high and low state anxiety when a shown happy or neutral face was not significant. These differences can also be seen in inspection of Figure 1 of Phase one. These results provide evidence for an attentional bias in those with higher levels of state anxiety. This is in line with evidence from Beck (1976), Beck and Clark (1997), Macleod and Mathews (1988), Broadbent and Broadbent (1988).

The results for the memory task (Phase two of the experiment) show there was not a significant difference in implicit memory score depending on whether an individual had high or low state anxiety levels, thus the null hypothesis can be accepted. There was a significant difference in implicit memory score depending on whether a happy, neutral or angry face was shown, thus H2 can be accepted. Finally there was not a significant interaction between state anxiety levels and type of face shown, thus the null hypothesis can be accepted. Therefore the type of face shown did have an impact on memory, but state anxiety did not and there was no interaction. Interestingly the results were in the predicted direction and inspection of the descriptive statistics and Figure 2 in Phase two does show that those with higher levels of state anxiety were able to recall more of the angry faces, however it remains that the split plot ANOVA analysis did not provide significant results.

The results of the correlation show that there was a significant positive relationship between state anxiety score and the number of angry faces correctly recalled, therefore H1 can be accepted. Furthermore there was not a significant positive relationship between state anxiety score and the number of happy faces correctly recalled, therefore H2 can be accepted. However there was a significant positive relationship between state anxiety score and the number of neutral faces correctly recalled, thus the null can be accepted. This suggests that, as predicted, the higher the level of state anxiety the higher the levels of recall for angry faces. This provides evidence to suggest that those with higher levels of anxiety show a memory bias for threat related stimuli and is in line with the studies of Becker et al. (1999), Rogers et al. (1977), Breck and Smith (1983), Kennedy and Craighead (1988), Etkin et al. (2004).

Overall the present study provides evidence to show that those with higher levels of state anxiety tend to show an attentional bias towards angry faces. Furthermore, the correlation also provides evidence to show that those same individuals with higher levels of state anxiety also tend to remember more of the angry faces, compared to happy faces. Therefore the present study provides new and recent support for an implicit

memory bias for threat related stimuli in those with an attentional bias. A further important aspect of this research is that these biases were observed simultaneously in a single study.

This new evidence of a memory bias in those with attentional bias could provide vital insights into investigations relating to EWT. The study by Mogg et al. (2007) showed that individuals with higher anxiety were more likely to direct their gaze at negative facial expressions, than individuals with low anxiety, and the evidence of a memory bias in those with higher anxiety in the present study is in line with research from Yuille et al. (1994) who showed that high anxiety leads to improved memory in EWT. However the studies of Loftus and Burns (1982), Peters (1988) and Valentine and Mesout (2008) contrast with the results of this study and show that higher levels of anxiety impair memory in EWT and these conflicting findings may be related to differences in the time periods between encoding and recall within these studies. For example in the study of Valentine and Mesout (2008) the time between encoding and recall was forty five minutes, in contrast to the present study which was approximately one minute. Individuals may initially direct their attention to angry faces (as shown in the present study), but it is unclear if they maintain focus and elaborate or if they avoid due to emotion regulation processes (Bradley et al., 1997). Elaboration during encoding provides a richer memory trace (Shapiro & Penrod, 1986), therefore if they avoid this would result in a weaker memory trace leading to impairments in facial recognition over time. This may explain the evidence showing memory impairments in EWT for those with high anxiety (Loftus & Burns, 1982; Peters, 1988; Valentine & Mesout, 2008).

A hypothesis of how long attention is directed to angry faces for future studies could be addressed by eye tracking studies, as in the study by Mogg et al. (2007) and Rinck and Becker (2006). Also to further the study of Etkin et al. (2004) neuroimaging studies could examine whether the activation of the basolateral amygdala in response to angry faces is positively associated with subsequent attentional avoidance or elaboration. If studies show subsequent avoidance as suggested by Williams et al. (1988, 1997) and Becker et al. (1999) the theory of emotion regulation processes (Bradley et al., 1997) could be tested by further neuroimaging studies to examine the possible involvement of the pre frontal cortex. It has been suggested that the pre frontal cortex may suppress amygdala activity in order to mediate emotion regularity processes including the control of attention (Nomura et al, 2004; Ochsner & Gross, 2005). In addition future research could incorporate additional memory tasks at later stages to examine accuracy of recall at various time intervals, and correct recognition of a face could be compared to the length of time attention was directed at that face. These are important considerations into future developments related to EWT.

Cognitive biases such as attention and memory have been recognised as crucial factors in the etiology and maintenance of anxiety disorders (Williams et al., 1988, 1997; Eysenck, 1992). Mathews (1990) suggested that attentional bias to threat related stimuli will result in a heightened awareness of potential danger in the environment, and therefore lead to more frequent or intense experiences of anxiety. Furthermore, as well as maintaining anxiety disorders, a memory bias can also lead to further activation of danger schemata (Calabrese & Leugebauer, 2002). The evidence of a memory bias in the present study should encourage future research into new directions and

developments regarding the treatment of intrusive negative memories in anxiety disorders such as PTSD, SP and PD (Coles & Heimberg, 2002). However because anxiety disorders such as PTSD and PD have exhibited varying cognitive biases and different patterns of a memory bias in previous studies (Cole & Heimberg, 2002), it is important not to generalise the results of this study to all types of anxiety and anxiety disorders. Consequently future research into clinical anxiety and the various anxiety disorders is encouraged. Further to the role of cognitive biases in the etiology of anxiety disorders, the correlation results of the present study show a relationship between state anxiety score and implicit memory score for angry faces, however this does not mean that high state anxiety causes higher recall of angry faces. For these reasons it would be beneficial for future studies to determine whether cognitive biases, such as memory, play a causal role in the etiology of anxiety. This hypothesis could be tested by conducting longitudinal studies. There has been a relatively small number of longitudinal studies of anxiety disorders, and a minor amount of published studies have examined whether cognitive processes predict the onset of any anxiety disorder (Steinman & Teachman, 2010). Experimental manipulation of biases is sometimes used to establish a causal role of cognitive bias in anxiety, to test if these manipulations influence anxiety and emotional vulnerability (Hirsch, Clark, Mathew & Williams, 2003). However this technique has many ethical implications, therefore longitudinal studies are preferred and should include structured ratings, a naturalistic setting and multiple assessments over a significant time period.

It is important to recognise that there was not a significant interaction between state anxiety levels and the type of face shown in the memory task, and evidence of a memory bias for angry faces was only provided by the positive relationship between state anxiety score and implicit memory score. Therefore it is important to consider the possible reasons for this non-significant interaction and to discuss the limitations of this study for the benefit of future research. Due to the difficulty in attaining the fifty four images used in this study that matched in terms of background colour and content, position of head, image quality, size and sharpness of image, there was no choice but to compromise on background colour and the overall colour strength of the image. Hence some of the background colours of the photos were blue and some were white, and some of the images contained sharper and stronger colours and some had more grey overtones (as shown in Appendix B). It is important to acknowledge that these variations in colour sharpness and strength could have acted as a distraction in the attention task, where two images appeared on the screen simultaneously. This could have led to a participant's attention being drawn automatically to the picture which contained the stronger, more prominent colours, when compared to a plain white background or greyscale colours, rather than being drawn because of the facial expression. Therefore it is important for future research to use images that match in every aspect and that they are taken from a single database which has a large selection and availability of images.

With further reference to the images used in this study, it is important to recognise that as well as a significant positive correlation between state anxiety score and recall of angry faces, there was also a positive correlation between state anxiety score and recall of neutral faces. Even though this study conducted piloting for the SuperLab tasks it is also important for future research to have the images independently rated by individuals not participating in the study to ensure that there is agreement as to the emotion

displayed by each face. This would eliminate the chances of the image being misinterpreted. Research by Yoon and Zinbarg (2008) suggests that anxious individuals often interpret neutral faces as threatening, which is known as interpretive bias. This could explain the correlation between state anxiety score and recall of neutral faces. An independent rating of images should involve individuals deciding which facial expression they consider the person in the image to be displaying, either happy, neutral or angry. A inter rater agreement percentage would then be provided in the study. Using consistent images and including an independent rating would provide a more robust study and enhance the external validity of the stimulus materials.

The last point to consider in relation to the facial images is that they consisted of entirely Caucasian faces simply because the faces available in the databases used in this study were Caucasian. However this study included participants with a variety of racial and ethnic identities. These factors are relevant because a meta-analysis by Elfenbein and Ambidi (2002) on several studies relating to recognition of facial expressions revealed that people are faster and better at recognising and interpreting a facial expression of a person from their own race than of a person from other races. The different details within a facial expression across a variety of races can make it difficult for members of different races to decode emotional expressions (Sporer, 2001). Therefore these issues could have had an effect on the recognition of certain facial expressions, possibly effecting results. This further highlights the importance of independently rated images for future studies, and it is also necessary to collect details of ethnicity and race in the early stages of the study in order for this to be measured.

Another limitation to the present study was realised during a debriefing session where a participant admitted to guessing that when seeing the faces in the attention task she would be required to recall these faces. This may be due to the participant being a psychology student, as often students and who have a higher level of education can be more aware of the hypothesis of a research project, as they have experience of, or have been involved in similar projects. There is also a danger that guessing the purpose of the research could have led to a response bias, where participants respond in a way they think will be favorable to the researcher. It may have also had an impact on the type of memory involved in recall, and explicit memory may have been tested due to conscious recall. Therefore for future research it may be beneficial to include a variety of participants from the general public, and not target only university students. This will ensure the findings generalise to a more heterogeneous group, with a variety of education levels and a varying knowledge of psychological research, resulting in a more diverse sample of people.

In relation to the SuperLab experiments used within this study, incorrect responses within the attention task were discarded as in the studies of Rinck and Becker (2006) and Bradley et al. (1997). However it may have been beneficial to analyse these incorrect responses as they could have provided further insights. Similarly with the memory task, data from participants who selected 'do not remember' on certain images were discarded as in the study by Majerus et al. (2011). However because the participant was given an option of 'do not remember' then these responses could have also been analysed. Investigation of these discarded results could have provided observations into the role of implicit memory in people with lower levels of anxiety. As

this research reveals that anxious individuals display an attentional bias and memory bias towards threat related stimuli, it could have also investigated whether those with low anxiety do not show an attention and memory bias. This would have provided a double dissociation, thus substantially strengthening the evidence of this study. For future research all participant responses should be analysed in order to make the most of the study and to establish if they contribute to the findings, or provide new insights to the experiment.

Future research is recommended as even though this study did provide evidence for an attentional bias and a memory bias in those with higher levels of anxiety, some of the significance levels were quite weak. Future studies need to consider the nature of the attention task and the memory task, and ensure the external validity of the stimuli. Future research could investigate the time interval between encoding and retrieval, and also assess whether initial orientation is followed by elaboration or avoidance. Attention and memory biases are an important and exciting area of study. The hypothesis that anxious individuals show an attentional bias and implicit memory bias for angry faces is supported. However the question of causation awaits answers from future research using longitudinal studies. Future research incorporating valid materials, along with a larger number of participants, may provide additional current evidence and would be beneficial for future developments into the treatment and prevention of anxiety disorders.

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