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Interpretative Biases in Socially Anxious Adults

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By

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Abstract

Social phobia is a highly prevalent and debilitating anxiety disorder that can significantly impact quality of life and produce extreme distress in social situations. Cognitive models of social phobia suggest that information-processing biases are involved in the maintenance of social anxiety. Treatment typically involves a course of Cognitive Behavioural Therapy (CBT). Recent advancements in the understanding of the mechanisms underlying social anxiety have led to specific adjunctive treatments that target processing biases. The current literature review explores the efficacy of training programs designed to modify interpretative biases. Training programs typically involve repeated exposure to positive resolutions of ambiguous lexical social stimuli. Results suggest that current techniques are able to modify interpretative biases in non-anxious, socially anxious and clinical samples of social phobia. Multi-session programs have also been shown to reduce trait anxiety and social anxiety symptoms. Evidence for the generalisability of training to subsequent socially stressful situations remains mixed and requires further research. In the present study, the validity of a novel cognitive bias modification of interpretation (CBM-I) technique using ambiguous facial stimuli was examined in an unselected sample of 65 undergraduate students. Participants were randomly allocated to receive CBM-I-threat (n=31) or CBM-I-non-threat (n=34) training. The number of angry responses in a forced alternative (angry, neutral) choice was compared at pre and post assessment to determine the efficacy of training. Participants completed a subsequent social stressor task (impromptu speech). Measures of state anxiety, physiological measures of arousal, and judgements of speech performance were taken to examine the effects of training on emotional vulnerability. Results showed that the training program successfully induced a bias towards threat in the CBM-I-threat trained group. There was also some evidence that it was able to reduce the number of threat interpretations in CBM-I-non-threat trained individuals, however this was only when facial expressions were ambiguous. Early results suggest

CBM-I training may also effect anticipated and retrospective negative evaluations of social performance.

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Declaration of Authorship

I, Ross Craig Patrick Godfree declare that the thesis entitled

……
Interpretative Biases in Adults with Social Anxiety Disorder
……

and the work presented in the thesis are both my own, and have been generated by me as the result of my own original research. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
- where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
- where I have consulted the published work of others, this is always clearly attributed;
- where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
- I have acknowledged all main sources of help;
- where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
- none of this work has been published before submission, **or** [delete as appropriate] parts of this work have been published as: [please list references]

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Literature Review

Does Modification of Interpretative Biases in Socially Anxious Adults Produce Symptom Improvement

Ross Godfree

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Does Modification of Interpretative Biases in Socially Anxious Adults Produce Symptom Improvement

Overview of Social Phobia

Social phobia is an anxiety disorder characterised by the Diagnostic and Statistical Manual of Mental Health Disorders (fourth edition: DSM-IV) as a marked and persistent fear of social situations in which embarrassment may occur (American Psychiatric Association, 2000, p. 450). Social phobia can be subcategorised into (a) Generalised type; in which fears are related to a wide range of social concerns (such as going to parties, using public toilets, or dating) and (b) Non Generalised; in which individuals may fear a specific performance or social situation (e.g. public speaking). In order to warrant a diagnosis, the DSM-IV requires that individuals fears, avoidance or anxiety must interfere significantly with the persons daily routine, occupational functioning or social life, or lead to marked distress (American Psychiatric Association, 2000). This distinction is important as it suggests that Social Phobia may be conceptualised as part of a continuum across the population (See Figure 1: Heiser, Turner, Beidel, & Roberson-Nay, 2009). This implies research using non-anxious and analogue samples is merited because the processes operating across the continuum should only be quantitatively different.

However, viewing social anxiety on a continuum means that there has been considerable debate surrounding acceptable inclusion criteria for studies and treatment with a lack of consensus in the field. This has also led to a lack of diagnostic and terminological clarity (See McNeil, 2001). This may account for the wide variation in estimates of prevalence rates in the general population. Kessler et al (2005) used national comorbidity survey data to generate an estimated lifetime prevalence rate of 12%. Whereas Fehm et al. (2005) reviewed 21 European epidemiological studies and found a median lifetime prevalence rate of 6.65%. Most research on prevalence rates indicate that social phobia is

highly prevalent marked by significant impairment, with typical onset during late adolescence, and is highly comorbid with other psychiatric disorders, most notably depression and other anxiety disorders (Kessler, Stang, Wittchen, Stein, & Walters, 1999).

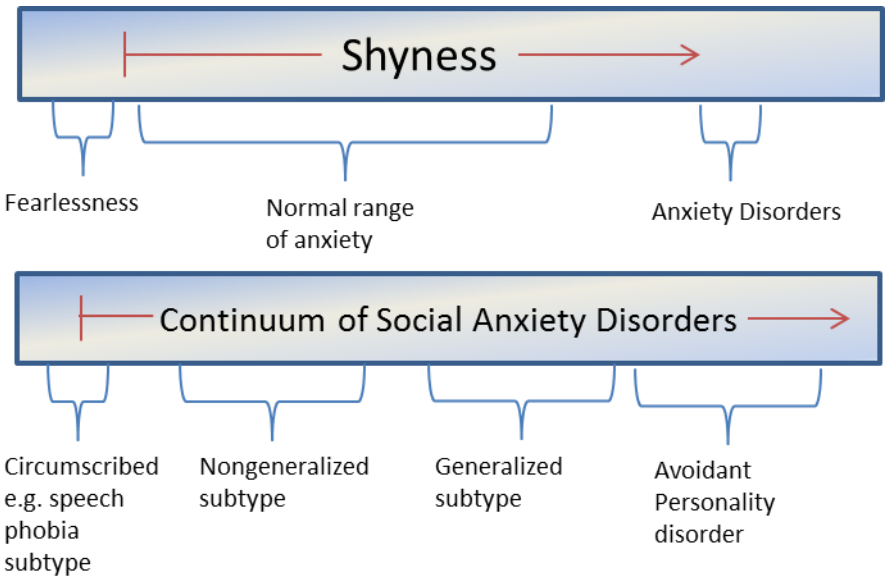

Figure 1. Continuum of shyness and social anxiety disorders. modified from Heiser, Turner, Beidel, & Roberson-Nay (2009).

Current Treatment Options

As a current first line treatment, draft guidance from the National Institute of Clinical Excellence recommends a course of CBT based on the Clark and Wells model or Heimberg model (NICE, 2012). In a study by Clark et al.(2003) 60 individuals with a diagnosis of social phobia randomly allocated to cognitive therapy, fluoxetine plus self-exposure, or placebo plus self-exposure, produced significant reductions on most measures regardless of treatment group at 16 week follow-up. However, when comparing the treatments, CBT was shown to be superior to fluoxetine plus self- exposure and placebo plus self-exposure. It is widely accepted that CBT is the preferred treatment option for individuals with social phobia (NICE, 2012). Manualised approaches typically involve psycho-education, graded exposure to feared situations, cognitive restructuring

and relapse prevention. Within the Clark and Wells model, cognitive restructuring encompasses identifying and challenging negative core beliefs, modification of dysfunctional pre and post event processing, and guided discovery to elucidate the effects of self-focussed attention and safety behaviours during social encounters.

There has been a drive to develop treatments that target specific processes underlying social phobia such as cognitive processing biases, social skills deficits (See Stravynski, Arbel, Lachance, & Todorov, 2000) and behavioural avoidance. The evidence for the use of social skills training in isolation is limited (Ponniah & Hollon, 2008). Treatments designed to modify cognitive processing biases are showing more promise and can be equally as effective as computerised CBT (Bowler et al., 2012). Such disorder specific treatments are easy to administer and could be used as an adjunctive treatment, cutting down the number of individual therapy sessions required. However, research is still in its infancy. This review aims to examine the current literature on the cognitive modification of biases in interpretation (CBM-I) and provides recommendations for future directions.

Cognitive Theories of Social Phobia

The following chapter will present several key theories of social phobia with the intention of introducing the reader to the wider context of the role of interpretative biases. It is beyond the scope of this review to provide an exhaustive or critical account of cognitive, neurobiological, evolutionary and behavioural theories of social phobia (however, see Crozier & Alden, 2001; Heimberg, Liebowitz, Hope, & Schneier, 1995; Hofmann & DiBartolo, 2001).

Beck, Emery and Greenberg's (1985) model of social phobia. One of the earliest models of anxiety that exerted influence over our understanding of social phobia was Beck, Emery and Greenberg's (1985) cognitive model. It suggested distortions in thinking maintain emotional

disorders. The distortions are content specific[1] and in the case of anxiety disorders, people have a schema for potential threat. In social phobia, the threat centres on fears of negative evaluation. Three categories of negative beliefs can be distinguished (a) excessively high standards for social performance *"I must not show any signs of weakness"* (b) conditional beliefs concerning social evaluation *"If I make mistakes others will reject me"* and (c) unconditional beliefs about the self *"I am inadequate"*. Schemas were thought to equally bias an individual's attention to threat, appraisal and memory (Beck, et al., 1985).

Clark and Wells (1995) cognitive model. Clark and Wells (1995) produced the first disorder specific cognitive model of social phobia (see Figure 2). This delineates the information processing biases suggested by Beck and places greater emphasis on the attentional system that is postulated to maintain fears of negative evaluation. Clark and Wells suggest that when an individual encounters a social situation they have a strong desire to convey a favourable impression to others and marked insecurity about their ability to do so. This activates an anxiety program, which prompts a number of changes in behavioural, somatic, and affective responses to the social situation compared to a non-anxious person, and which maintains their fears. For example, the person will switch their attention to detailed self-monitoring which creates a heightened awareness of their anxiety response and confirm both their negative beliefs that the situation is something to be afraid of and their distorted beliefs that they are likely to perform badly. Individuals use this information to construct an impression of how they appear to others. Individuals with a diagnosis of social phobia are more likely to view themselves as a social object from an "observer perspective"

[1] According to Beck, the schemata of anxiety-disordered individuals are dysfunctional. They are hypersensitive to threat cues. Importantly, schemata are specific to the feared stimulus. For example, the model predicts that for socially anxious individuals, the vulnerability mode is only activated in social situations, or when the threat is specific to social stimuli.

and imagining that others are observing them in a negative light (based on their felt internal sense) only serves to maintain anxiety (Spurr & Stopa, 2003).

Another key feature of the model is the use of safety behaviours in order to reduce anxiety. However, these behaviours (such as avoiding eye contact or rehearsing a speech) prevent individuals from disconfirming their negative thoughts and may increase the likelihood of poor social performance, (others may see avoiding eye contact as cold and unwelcoming). Finally the model suggests that individuals also engage in post event processing whereby they may conduct a *"post mortem"* of the social event, selectively attending to negative aspects thus maintaining their anxiety program and encoding the event strongly in memory with a negative interpretative style which they may later draw upon in future social situations (Clark & Wells, 1995).

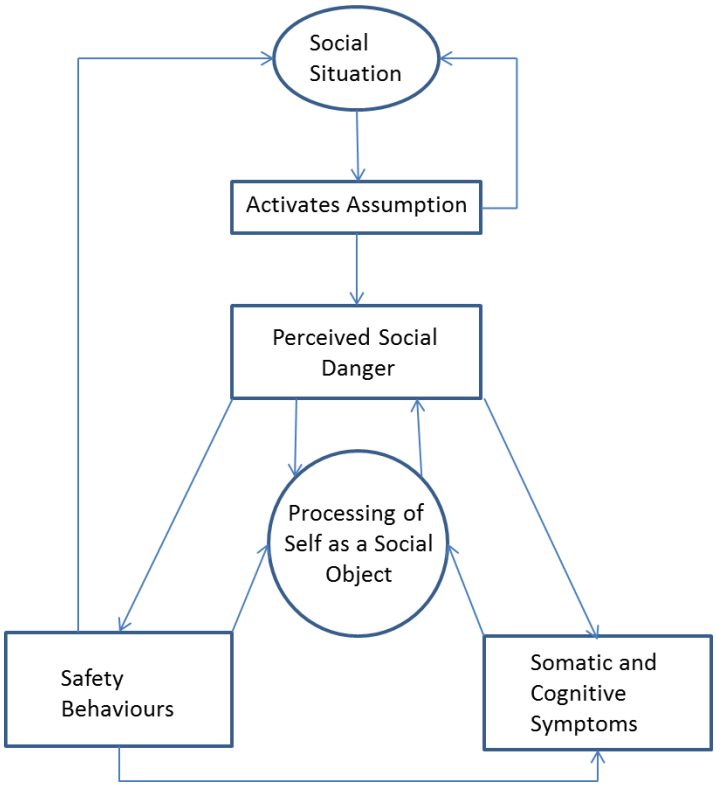

Figure 2. The processes that occur when a socially anxious person encounters a social situation. Adapted from Clark and Wells (1995) Model of Social Phobia.

Rapee and Heimberg's (1997) cognitive model. This model of social phobia begins with the basic premise that socially anxious individuals believe other people are inherently critical and likely to evaluate them in a negative light. The model posits that on encountering a social situation, individuals form a mental representation of their behaviour and appearance based on what they think the "audience" (real or imagined) will see. This representation is constructed from a variety of sources such as memory (of past and similar encounters), physiological indicators, and judgements/interpretations of the perceived standards the audience expects. The individual may then make a judgement on the outcome of the social situation and the likelihood of receiving negative evaluation from others. This then leads to the behavioural (avoidance, diminishment of social skills) physiological (blushing, sweating, heart racing etc.) and cognitive signs of anxiety. Within the cognitive domain, individuals may reallocate attentional resources to look for negative signs within the situation/interaction. They may also be prone to view ambiguous information in a negative light. The cognitive behavioural and physiological signs of fear and anxiety interact with one another and ultimately confirm the person's fears and keep them trapped in a vicious cycle. This theory closely resembles Foa, Franklin and Kozak's (2001) Information Processing model which proposes a fear network of information stored in memory about the feared stimulus, information about the verbal, physiological and behavioural responses, and interpretative information about the meaning of the feared stimulus. The theory proposes that cognitive biases play a major role in maintaining social phobia, and correction of these biases is essential in reducing fear, however, it places a greater emphasis on the role of social skills deficits in the maintenance of social phobia.

Fear of positive evaluation. So far, cognitive models have all placed emphasis on fear of negative evaluation. Recent research has led to the theory that individuals with social phobia may fear evaluation in general (Weeks, Heimberg, Rodebaugh, & Norton, 2008). Weeks et al. demonstrated that individuals with social phobia also fear positive evaluation, which is associated

with increased discomfort and a discrepancy with the perceived genuineness of feedback from others in a social situation. Their idea draws heavily upon Trower and Gilbert's (1989) evolutionary/psychobiological theory of social phobia. Trower and Gilbert argue a competitive schema drives socially anxious individuals (activating a defence network upon encountering social situations) whereas a co-operative schema (which drives a cooperative biological system) guides non-anxious individuals. These systems then dictate how a person appraises and responds in social situations (Walters & Hope, 1998). The defensive system is associated with threat and therefore the person employs defensive or submissive strategies in order to inhibit perceived threats (for a full exposition see Trower & Gilbert, 1989).

In summary, the models presented all emphasise the role of information processing biases in the maintenance of social phobia. Early models of emotional disorders gave equal weight to the role of attention, interpretation and memory biases, whereas later disorder specific models (e.g. Clark and Wells, 1995: Rapee and Heimberg, 1997) have placed greater importance on the role of attention and interpretation. There has been a growing interest to enhance our understanding of maladaptive cognitive processes in social anxiety so that biases can be specifically targeted in future refined evidence based interventions for social phobia. It is beyond the scope of the review to examine the role of attention or memory biases within social phobia, however the reader is directed toward (Amir & Bomyea, 2010; Heinrichs & Hofmann, 2001). The following section will review the evidence for the existence of interpretative biases in social phobia.

Interpretative Biases[2]

Consider this example: a socially anxious person is on a first date and having a meal. Towards the end of the meal, their partner yawns. The socially anxious person interprets this as a

[2] Recent research has examined brain mechanisms associated with differences in interpretative style between socially anxious and non-anxious individuals, however it is beyond the scope of this review to include these studies here (see Hallion & Ruscio, 2011for a review).

sign that *"they are boring the other person,"* and *"the date has been a disaster"* (a negative interpretation). Social situations are inherently ambiguous whereby one needs to judge ones performance and judge the approval/disapproval of others (Amir & Bomyea, 2010). The yawn could also have been interpreted as neutral/benign (the person was tired and may have stayed up late the night before). Socially anxious individuals have a tendency to interpret socially ambiguous information in a negative light.

One of the first paradigms used to experimentally test the role of interpretation bias in anxious individuals used homographs (words that have identical spelling but different meanings) and homophones (words that can be pronounced identically but have different meanings). Words were selected in which meanings typically represented a threat and a non-threat/benign meaning. Within this review the terms threat, non-threat, benign and positive are used to describe the distinction between training groups or training items. Threat refers to items that hold a socially threatening outcome. Non-threat can be further sub-divided into benign and positive. Benign items are items that convey a neutral interpretation can be resolved in a neutral manner. 'Positive' refers to social items that convey a positive interpretation or can be resolved in a consistently positive way. For example after reading the following scenario "at your new computer class you have finished the assigned task and the lecturer gives you a new assignment to work on. You don't understand and you ask your lecturer for advice" the following critical sentences could be presented:

The lecturer says that asking for help is a sign of incompetence (threat)

The lecturer says that asking for help is a not a sign of incompetence (non-threat/benign)

The lecturer says that asking for help is a sign of competence (positive)

Mathews, Richards, and Eysenck (1989) auditorally presented clinically anxious, recovered anxious patients and control (non-anxious) participants with either unambiguous threat words, unambiguous neutral words or homophones (e.g. die/dye) and asked them to spell the word they

heard. They found that clinically anxious patients tended to interpret the critical homophones in the more threatening way, suggesting they were more likely to interpret ambiguous information negatively.

Another procedure commonly used is the presentation of ambiguous sentences (Constans, Penn, Ihen, & Hope, 1999; Foa, Franklin, Perry, & Herbert, 1996; Hirsch & Mathews, 1997; Stopa & Clark, 2000). Hirsch et al. presented high and low anxious participants with descriptions of job interviews and measured the time taken to decide if a threat or non-threat word probe was a real English word or not (speeded lexical decision). Non-anxious individuals were quicker to identify non-threat probes compared to anxious individuals, suggesting that non-anxious individuals may hold a positive interpretative bias. That is, the default position for non-anxious individuals is to interpret ambiguous information in a positive light. The ambiguous sentence paradigm has shown that when presented with mildly negative social events, individuals with social phobia tend to interpret them in catastrophic terms compared to individuals with other anxiety disorders (Stopa et al, 2000) and as more costly (Foa, et al., 1996), which provides support for Beck's content specificity hypothesis.

Investigators have also found that interpretative biases are detectable in more realistic social encounters and using more ecologically valid stimuli (such as video clips of real life scenes: Amir, Beard, & Bower, 2005). Wallace and Alden (1997) found that after experiencing a successful social interaction, individuals with a diagnosis of social phobia display increased negative emotional states, and predictions that others would expect more of them in the future compared to non-anxious controls. Similarly, when experiencing a mildly socially stressful situation (such as delivering a speech) socially phobic individuals are more likely to interpret an audience's behaviour as negative (Kanai, Sasagawa, Chen, Shimada, & Sakano, 2010) and rate their performance as significantly worse than non-anxious individuals (Rapee & Lim, 1992).

In addition to lexical tasks, other paradigms have examined the extent to which social anxiety is characterised by a bias in the interpretation of emotionally ambiguous facial expressions (Garner, Baldwin, Bradley, & Mogg, 2009; Heuer, Lange, Isaac, Rinck, & Becker, 2010; Joormann & Gotlib, 2006; Montagne et al., 2006; Philippot & Douilliez, 2005; Richards et al., 2002; Schofield, Coles, & Gibb, 2007; Yoon & Zinbarg, 2007). By using morphed prototypical images of facial expressions that are blended together, it has been shown that high socially anxious individuals have an increased sensitivity for detecting fearful expressions compared to those low in trait social anxiety (Richards, et al., 2002). However, Garner et al. (2006) found that patients with generalised social phobia were significantly poorer at discriminating fear expressions compared to healthy controls. Whilst the majority of studies have identified a bias for socially ambiguous pictorial stimuli in either sensitivity (the ability to correctly detect the correct facial expression at varying levels of emotional intensity) classification, (the ability to correctly identify an emotional expression when given a choice of differing emotions to pick from) or reaction times, not all studies have found a difference. There is still some disagreement whether socially anxious individuals demonstrate a negative response bias (tendency to misperceive emotions in a negative light) or whether they have an enhanced ability to discriminate negative emotions (see Philippot & Douilliez, 2005). Methodological differences between the studies reviewed may account for this. It may be that the amount of time a person has to make their decision could account for the discrepancies observed in the literature: Heuer *et al.* (2010) found that only under conditions of restricted viewing was an interpretative bias apparent.

In summary, results suggest that socially anxious individuals are characterised by a tendency to interpret socially ambiguous information in a threatening manner. Moreover, interpretative biases are specific to social information in individuals with generalised social phobia and can distinguish individuals with social phobia from other anxiety disorders. The interpretative bias for socially ambiguous information has also been implicated with increased negative emotional

states, distorted views of self-performance and exaggerated appraisals of the cost of interacting with others (Foa, et al., 1996).

The majority of research examining interpretative biases in social anxiety has used cross-sectional designs, which can only determine an association between interpretation bias and emotional vulnerability. However, recent advancements in experimental techniques have allowed for modification of interpretative biases in order to establish if a causal role exists. The following systematic review will critically evaluate Interpretative Cognitive Bias Modification (CBM-I) procedures and their efficacy in producing symptom improvement.

Search Strategy

Studies were collected using the EBSCOhost server and simultaneously searching the PsychINFO, PubMed, Medline, and PsycARTICLES databases using the search terms *social phobia* or *social anxiety disorder* or *anxiety* intersected with *information processing* or *cognitive* and bias and *interpret** (interpretative) and *modif** (modification). The search was conducted in December 2012. The reference lists of articles that met inclusion criteria (see below) were scanned to identify further studies. Relevant journal publications were also scanned after the search date to ensure the most current and up-to-date literature was included in the search.

Inclusion criteria.

1. The article must be an original study published in the English Language before December 2012.
2. The study must include adult participants (aged $\geq 18\ years$).
3. The study must aim to examine CBM-I techniques in populations of either unselected (participants not pre-selected based on levels of social anxiety), socially anxious (individuals scoring high on a measure of social anxiety), or individuals with a diagnosis of social phobia.

4. The study must aim to experimentally modify interpretative bias.

After discarding studies that did not meet inclusion criteria (see Appendix A) 29 articles were included in the review.

Systematic Review

Review of training paradigms used. The 29 studies reviewed (see Table 1) employed similar methods to modify interpretative bias. Mathews and Mackintosh's (2000) training procedure was widely used. The procedure involves the presentation of a number of social descriptions that remain ambiguous until the final word. Participants are asked to use their understanding of the description to solve the word fragment. For example:

> *Your partner asks you to go to an anniversary dinner that their company is holding. You have not met any of their work colleagues before. Getting ready to go, you think that the new people you will meet will find you [bo _ _ _g (boring)/ fri_ _ _ly (Friendly)].*

Participants typically received blocks of training materials that included eight induction-training trials, (final word fragment is the same valence as the group they were assigned to positive/negative training). Training also includes three filler trials, (in which the valence of the intended training procedure is reversed in order to make the aim of the training less conspicuous) and two probe trials (where the final word fragment is the same regardless which training group participants were assigned to). The aim of the procedure is to either train participants to interpret ambiguous social descriptions in a consistently negative or positive way. The success of the training procedure is measured both by an online measure of response latency (how fast participants solved positive and negative probe items) and by a later recognition test. During the recognition phase participants see 10 new critical ambiguous social descriptions, however this time the meaning of the scenario is left ambiguous. They are then given a subsequent recognition test booklet

followed by four possible versions of the final sentence of the scenario) possible positive interpretation, ii) A possible negative interpretation, iii) A positive foil sentence (that cannot be deduced from recollection of the story), iv) A negative foil sentence. This yields an outcome measure of number of positive and negative trials endorsed/rejected and provides a control measure (foil sentences) to ensure and changes are not the result of a response bias.

The Word Sentence Association Paradigm (WSAP: Beard & Amir, 2008) is another recent technique to modify interpretative biases that uses corrective feedback in order to train socially anxious individuals to interpret socially ambiguous information in more benign or positive ways. During the training procedure, participants are shown a word (either a threat interpretation relating to a sentence to be seen, or a benign interpretation word of the sentence). They are then shown an ambiguous sentence. Participants are asked to indicate if they thought the word and sentence were related or not. In the training condition [referred by the authors and henceforth as the Interpretation Modification Program (IMP) group], the participants receive positive feedback (you are correct) if they reject threat interpretations and endorse benign interpretations. In the control group [referred by the authors as the Interpretation Control Condition (ICC) group], the contingency of feedback is set at 50% i.e. not designed to train participants in a certain way (see Figure 3 for an example).

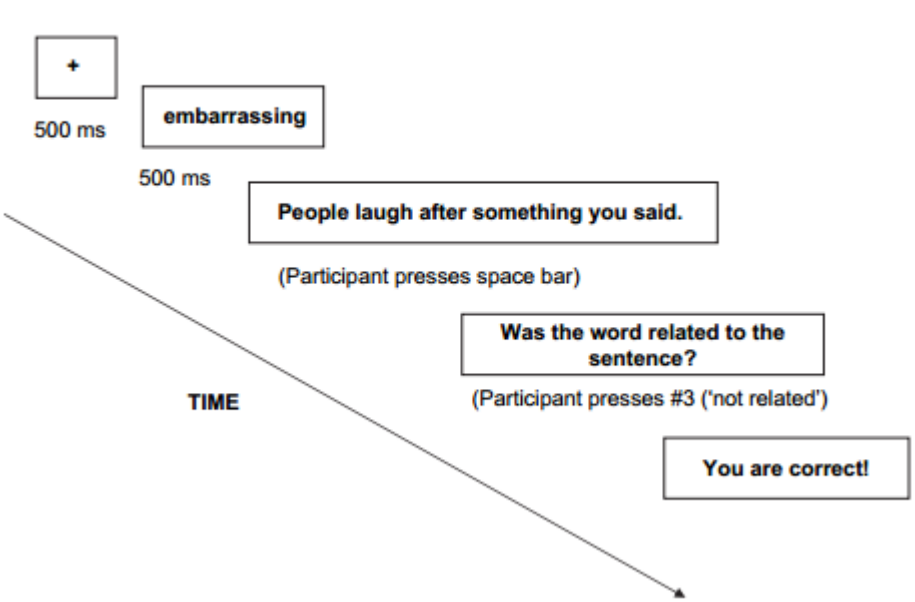

Figure 3. An example 'benign-training' trial using the WSAP. Borrowed from Beard and Amir (2008, p. 1137).

Table 1
Study Characteristics

Study	Aim	Sample	N	Groups	SA Measure	Primary Outcome Measure	Method of Training IB	Method of quantifying bias	No of sessions	Results
Grey *et al.* (2000)	To train Pts to interpret ambiguous emotional words in either a threat or non-threat direction	Unselected	40	Threat Non-threat	No	Response latency	Homographs	Post training check	1	Pts were quicker to solve previously seen word fragments that matched the valence of their training
Grey *et al.(2000) EXT 2*	To replicate findings of EXT 1 using more items and a different outcome measure	Unselected	40	Threat Non-threat	No	Lexical decision response latency	Homographs	Post training check	1	TT group showed faster response times for homographs that matched the valence of training for both old and new homographs. There were no effects of training in NTT group
Grey *et al.(2000) EXT 3*	To test whether active generation of meanings was critical to modifying IB	Unselected	40	Threat Non-threat	No	Lexical decision response latency	Homographs	Post training check	1	TT group produced speeded lexical decisions for threat targets compared to non-threat targets for both old and new homograph primes. The opposite pattern appeared for NTT group
Grey *et al.(2000) EXT 4*	To establish a baseline of IB in sample	Unselected	20	No training baseline	No	Lexical decision response latency	Homographs	Baseline	1	Pts did not differ from NTT Pts
Mathews *et al. (2000) EXT 1*	To test a paradigm that used ambiguous descriptions as training items	Unselected	20	Positive Negative	No	Recognition rating, response latency, STAI-S	Social scenarios	Post training check	1	Probe Latency- negatively trained Pts were quicker to respond to negative critical items and vice versa for positively trained Pts Recognition Task- Training led to significantly different interpretations of ambiguous scenarios
Mathews *et al. (2000) EXT 2*	To replicate results of EXT 1 using passive exposure to training items	Unselected	20	Positive Negative	No	Recognition rating, response latency, STAI-S	Social scenarios	Post training check	1	Similar to those of EXT 1
Mathews *et al. (2000) EXT 3*	To obtain a baseline condition from which to interpret previous results from.	Unselected	12	No training baseline	No	Recognition rating	No modification	Baseline	0	In the absence of any training Pts employ a positive response bias to novel ambiguous stimuli
Mathews *et al. (2000) EXT 4*	To test durability of IB	Unselected	54	Positive Negative	No	Recognition rating, STAI-S	Social scenarios	Post training check	1	IB survived a 10 min delay. The effects of state anxiety were present when Pts had to actively generating meanings
Mathews *et al. (2000) EXT 5*	To test if the active generation of meanings is necessary to affect state mood	Unselected	56	Positive + active generation, positive + passive exposure, negative + active generation, negative + passive exposure	No	Recognition rating, STAI-S	Social scenarios	Post training check	1	Different interpretative biases were induced across groups. This effect did not differ according to generation condition. State anxiety was only altered for those in the active generation condition

Study	Aim	Sample	N	Groups	SA Measure	Primary Outcome Measure	Method of Training IB	Method of quantifying bias	No of sessions	Results
Hertel *et al. (2003)*	To see if CBM-I training would transfer to another task (constructing mental images of words)	Healthy students	54	Threat, non-threat, no training control	No	Mean number of interpretations	Homographs	Control group	1	In the transfer phase, mean number of threat unrelated interpretations were higher for NT group
Amir *et al. (2005)*	To see if groups differed in response latency to homograph primes	Clinical GSP	58	GSP NAC	Yes	Response latency	Homographs	Post training check	1	GSP's and NAC's showed similar response latencies to threat meanings. Training in non-threat targets only produced speeded response latencies for NAC's
Yiend *et al.(2005)*	To examine the temporal effects of training IB	healthy community volunteers	20	Positive, negative	No	Recognition rating, response latency	Mathews and Mackintosh (2000) word sentences	Post training check	1	Prior training in a particular valence of interpretation led pts to interpret new ambiguous material with the same bias. This effect was still present after a 20-minute period and a 24-hour delay
Holmes *et al.*(2006)	To see if different modes of presenting ambiguous info effected the strength of training effects or state mood.	Unselected	26	Auditory vs. visual presentation	No	STAI-S, PANAS	Descriptions of ambiguous situations with positive or benign resolutions	Post training check	1	The imagery condition produced greater increases in positive affect and greater decreases in state anxiety relative to the auditory condition
Mackintosh & Mathews (2006)	To see if training effects would survive a change of context	Unselected	48	Positive same context, negative same context, positive different context, negative different context	No	Recognition rating, STAI-S	Mathews and Mackintosh (2000) word sentences	Post training check	2	The effects of training survived a 24-hour period. Critically there was still a significant difference between training groups despite a change of context. Groups displayed sig differences in state anxiety when shown a mildly stressful video
Wilson *et al.*(2006)	To see if CBM-I can have a causal effect on subsequent emotional vulnerability	Unselected	48	Threat, non-threat	No	Response latency	Homographs and unambiguous primes	Post training check	1	CBM-I led to successful induction of benign and threat related biases. The TT group showed elevated state anxiety scores whilst the NTT group reported no significant changes in response to a mildly stressful video clip
Hirsch *et al.*(2007)	To see if inducing an IB can influence imagery for subsequent ambiguous social stimuli	Unselected	24	Positive, Negative	FNE	Image rating	Mathews and Mackintosh (2000) training procedure	Post training check	1	CBM-I led to greater negative imagery scores for socially ambiguous situations for the negatively trained group. Pts in the negatively trained group also anticipated more self-reported anxiety during an imaginal social stressor task
Mathews *et al.*(2007)	To see if CBM training could reduce vulnerability in high trait anxious individuals	High TA	40	Positive, test-retest control		STAI-T, reasons for ambiguous events, recognition rating	Mathews and Mackintosh (2000) word sentences	Control	4	In both tests of IB, positive training increased the likelihood for positive ambiguous events and enhanced positive images of outcome. Training also reduced trait anxiety scores for those in the training condition one week after testing
Murphy *et al.*(2007)	To facilitate a benign IB using benign or positive training materials. To see if training effects would generalise to an anticipated social stressor	Analogue	66	Benign positive, benign non-negative, control	FNE	Recognition rating	Mathews and Mackintosh (2000) word sentences	Control	1	Training with either positive or benign materials led to a positive IB compared to a control group. Pts in training groups reported significantly less anxiety than a control group in response to an imaginal social stressor

Study	Aim	Sample	N	Groups	SA Measure	Primary Outcome Measure	Method of Training IB	Method of quantifying bias	No of sessions	Results
Salemink *et al.*(2007)	To replicate Mathews and Mackintosh (2000) study and to see if the results would remain if a different type of IB check was used	Unselected	81	Positive, Negative	No	Recognition rating, EAST, ASSIQ	Mathews and Mackintosh (2000) word sentences	Post training check	1	Replication successfully modified IB using recognition rating task. However, other measures of interpretations bias (EAST and ASSIQ) could not distinguish between groups
Beard & Amir (2008)	To examine use of a new CBM-I procedure that gives corrective feedback. To see if extended training would have effects on trait measures of social anxiety	Analogue	27	IMP, ICC	SPAI	Mean no of threat and non-threat items endorsed, SPAI	WSAP	Pre –Post check	8	At post-assessment, the IMP group endorsed significantly fewer threat interpretations and endorsed more benign interpretations than the ICC group. The IMP group also reported significantly less social anxiety symptoms
Grey & Mathews (2009)	To see if there needs to be some level of emotional ambiguity for CBM-I training effects to occur	Unselected	37	Threat, Non-Threat	No	Lexical decision response latency	Homographs	Post training check	1	There were no differences between groups on a speeded lexical decision task that did not involve the priming of an ambiguous homograph. When a prime was ambiguous, groups significantly differed in response to threat and non-threat items
Salemink *et al.* (2009)	To replicate and improve Mathews (2007) by increasing the amount of trials and training sessions. They also examined how CBM-I affected emotional vulnerability	High TA	34	Positive, Placebo control	FNE	Recognition rating, STAI-S, STAI-T, FNE SCL-90	Social stories	Control	8	The CBM-I group gave more positive interpretations than the control group. The CBM-I group improved on measures of trait anxiety and general psychosocial functioning. CBM-I did not appear to moderate state anxiety during a stress vulnerability task
Standage *et al.* (2009)	To examine the efficacy of CBM-I with visual vs. auditory presentation of training materials	Student medium levels of SA	48	Positive auditory, positive visual, negative auditory, negative visual	No	Recognition rating	Mathews and Macintosh (2000) using updated pool of social scenarios	Post training check	1	Auditory and visual presentation had comparable effects in altering IB. Auditory presentation was associated with increased depression levels during the procedure. CBM-I did not affect emotional vulnerability as measured by behavioural ratings during a speech task
Amir *et al.*(2010)	To see if WSAP produces transfer effects to attentional processing biases	High SA	57	IMP, ICC	LSAS	Response latency to an attentional bias measure	WSAP	Pre – post check	1	CBM-I training successfully reduced endorsement of threat explanations in IMP group. CBM-I also facilitated the IMP group to disengage attention from social threat cues quicker than ICC group
Hoppitt *et al.*(2010)	To differentiate between a true IB and some form of facilitated emotional priming. A second aim was to see if active training would have greater effects on emotional responses to a social stressor task	Average TA	112	Active threat, passive threat, active non-threat, passive non- threat	No	STAI-s, and reaction times to lexical decision task	Homographs with and without ambiguous primes	Post training check	1	Lexical decisions were speeded for cue words that were the same valence as the training group regardless of training procedure. Results disappeared in the absence of a priming cue. State anxiety increased significantly more in the active TT group relative to passive TT group in response to a social stressor
Lange, Wolfe-Gero *et al.* (2010)	To see if modifying IB generalized to effects in a behavioural task	Average TA	68	Positive, Negative	No	Approach avoidance task reaction times, recognition rating	Mathews and Mackintosh (2000) word sentences	Post training check	1	The IB procedure was successful in inducing a positive and negative bias. CBM-I did not have a significant impact on subsequent reflexive behaviours

Study	Aim	Sample	N	Groups	SA Measure	Primary Outcome Measure	Method of Training IB	Method of quantifying bias	No of sessions	Results
Salemink & Van Den Hout (2010)	To see if CBM-I training would survive changes in mood that would run counter to the valence of training received	Moderate TA	82	Positive CBM-I/positive mood induction, positive CBM-I/negative mood induction, negative CBM-I/positive mood induction, negative CBM-I/negative mood induction	No	Mood VAS, recognition rating	Mathews and Mackintosh (2000) word sentences	Post training check	1	CBM-I was successful at training participants to make speeded decisions when completing word fragments that matched their direction of training. The recognition task showed that the mood induction did not affect the later manipulation check of interpretative bias
Salemink, Van Den Hout& Kindt (2010)	To see how CBM-I training effects state and trait anxiety levels	Re analysis of previous studies				STAI-S, STAI-T				Changes in state anxiety are caused by direct effects of the training procedure. Training also modified IB which in turn is causally related to changes in TA
Salemink, Hout & Kindt (2010)	To see if CBM-I generalises to other tasks that measure IB and to other domains	Average anxiety	133	Positive, negative, no training control	No	Ambiguous social vignette scores, video fragments, academic performance recognition task	Replication of Mathews and mackintosh (2000) method	Control	1	Neither of the two other tasks measuring IB detected a change in interpretation bias following training. Group differences did emerge with the academic performance task
Salemink, Mertel & Mackintosh (2010)	To examine if CBM-I training influences memory for ambiguous events	Unselected	77	Positive, Negative	No	The emotional valence of initial and remembered endings, the no of intrusions in scenario recall	Replication of Mathews and mackintosh (2000) method	Post training check	1	CBM-I training successfully modified IB. Positively trained Pts remembered their previous interpretations as being more positive however, groups did not differ with amount of recall or intrusions for the information in the scenario
Salemink & Van Den Hout (2010)	To validate the modified Mathews and Macintosh (2000) procedure and assess discriminant validity	Neuroticism	89	Positive mood induction/ high neuroticism, positive mood/low neuroticism, negative mood /high neuroticism, negative mood/ low neuroticism	No	Recognition scores	Mathews and mackintosh (2000) method	Post training check	1	Pts high in neuroticism interpreted ambiguous info in a more negative way than those low in neuroticism. The differences were unaffected by mood induction condition
Standage *et al.* (2010) EXT 1	To examine if induction of mood was sufficient to cause a change in interpretative bias	Unselected	30	Positive, Negative	No	Number of positive resolutions to the scrambled sentences task	Unambiguously positive or negative social sentences were placed on cards	Post training check	1	The CBM-I procedure of showing unambiguous positive or negative sentences for 5 minutes induced a change in mood state and also changed interpretative bias. In EXT 2, mood induction alone had no effects on Pts interpretative style
Brosan *et al.* (2011)	To investigate the effects of combining CBM-I and CBM-A treatment	GAD and GSAD	13	Positive	No	STAI-S and T	WSAP	Pre Vs. post	4	10\12 patients showed significant changes in their original negative interpretative bias. There were significant reductions in state and trait anxiety over 4 sessions with 4/9 Pts achieving clinically significant change

Study	Aim	Sample	N	Groups	SA Measure	Primary Outcome Measure	Method of Training IB	Method of quantifying bias	No of sessions	Results
Lester *et al.* (2011) EXT 1	To develop a more ecologically valid CBM-I procedure that targets other forms of cognitive errors seen in clinical practice	Unselected	60	Error, Non error	No	Response latency, recognition rating test	Cognitive error modification program	Post training check	1	Training successfully modified IB. The non-error group were faster to respond to non-error probes and rated non-error targets as significantly more similar to new ambiguous passages. Groups also significantly differed in emotional vulnerability to a stressor task
Lester *et al.* (2011) EXT 2	To test the non-error format of training on an analogue sample	Analogue anxiety and depression	70	Non-error, control	No	Response latency, recognition rating test	Error modification program	Control	2	CBM-I led to more benign, error free judgements following training compared to control group. CBM-I Pts reported greater expected performance scores than the control group in response to an imaginal stress task
Amir & Taylor (2012)	To extend WSAP to a clinical population	GSAD	49	IMP, ICC	Yes	LSAS	WSAP	Pre vs. post	12	CBM-I successfully modified Pts interpretative style, The IMP group endorsed significantly more positive interpretations and rejected more threatening interpretations post assessment relative to the ICC. The IMP group were rated by clinicians as displaying significantly less social anxiety symptoms were less avoidant and less functionally impaired compared to the ICC
Beard *et al.* (2011)	To conduct an RCT examining the combined effects of CBM-I & CBM-A	SAD	32	AIM, PC	Yes	LSAS	WSAP	Pre vs. Post	8	The AIM groups self-reported social anxiety had significantly reduced post training relative to PC group. The AIM groups' speech quality was rated better overall (less signs of SA) compared to PC

Note. TT = Threat Trained. NTT = Non-Threat Trained. Pts = Participants. IB = Interpretative Bias. GSP = Generalised social phobia. NAC = Non-anxious controls. GSAD = Generalised social anxiety disorder. EAST = Extrinsic affective Simon task (measure of IB). ASSIQ = Ambiguous social situation interpretation questionnaire. TA = Trait anxiety. CBM-I = Cognitive bias modification of interpretation. IMP = Interpretation Modification Program. ICC = Interpretation Control Condition. AIM = Attention and Interpretation Modification group. PC = Placebo control group. SA = Social anxiety.

1

Efficacy of interpretative bias training. Using the methods outlined above a number of studies reported successfully modifying interpretative biases in unselected samples (Grey & Mathews, 2000; Lester, Mathews, Davison, Burgess, & Yiend, 2011; Mathews & Mackintosh, 2000; Standage, Ashwin, & Fox, 2010). Participants were randomly assigned to receive either threat training (aiming to induce a negative interpretative bias for new socially ambiguous information) or non-threat training (aiming to increase the propensity for individuals to view socially ambiguous information in a positive light). In all studies, participants in threat groups endorsed more threat interpretations during the manipulation checks, however results for the non-threat groups were mixed, with some studies reporting no significant effects for non-threat training groups (Grey & Mathews, 2000). A significant limitation of the majority of studies reviewed is the absence of a within subjects design. This makes it difficult to draw any conclusions about the effect sizes of CBM-I training. However, both Grey *et al*. (EXT 4: 2000) and Mathews *et al*. (EXT 3: 2000) tested participants without any prior training to obtain a baseline. The sample size of the baseline conditions are small, however both studies showed that in the absence of training, unselected participants displayed a general positive interpretation bias for socially ambiguous information. This may explain the mixed findings above as training participants who already hold a positive bias may suffer ceiling effects.

Positive interpretation training has been tested on analogue social phobia samples (Beard & Amir, 2008) and clinical samples of individuals with a diagnosis of social phobia (Amir & Taylor, 2012; Beard, Weisberg, & Amir, 2011; Brosan, Hoppitt, Shelfer, Sillence, & Mackintosh, 2011) using the WSAP. Results suggest that relative to the ICC group, participants in the IMP group are consistently more likely to reject a negative interpretation and endorse positive interpretations of socially ambiguous text. However, the aforementioned studies differed in the number of sessions of training offered to participants (4-12 sessions), the frequency of training (every day- twice weekly), and the intensity of training (number of training trials). In addition, Brosan *et al*. (2011) combined

CBM-I in conjunction with an attention bias modification program (CBM-A), therefore it is difficult to assess the strength of training effects as one training program may have exerted influence over the other. This study used a weak study design with no control group and a small sample size. It therefore remains unclear as to the additive effects of combining different training procedures to target bias modification, or the optimum number of sessions or trials in order to get the best effects.

In order to understand the cognitive mechanisms underlying CBM-I training, Hoppitt *et al.* (2010) employed a post training lexical decision task whereby target words preceded related ambiguous or unambiguously valenced cues. Participants were randomly assigned to four training groups: active threat (participants had to actively generate the meanings of negatively valenced ambiguous information), passive threat (participants were merely exposed to the negative interpretations of ambiguous social information), active non-threat, and passive non-threat. In the test phase participants were either shown an ambiguous cue (homograph: growth) unambiguous cue (cancer) or no cue (string of four x's: xxxx) and were then shown a word that was either real or not. Their task was to identify as quickly as possible if the word was an English word. Results showed that regardless of whether cues were ambiguous or not, those in threat training conditions were faster to identify threat versus non-threat target words, consistent with a negative interpretative bias. Importantly this effect was not apparent for trials where there was no cue (xxxx). It seems therefore that CBM-I training directionally enhances priming of emotional categories, but only in the presence of a priming cue (Hoppitt, Mathews, Yiend, & Mackintosh, 2010). This finding is also supported by Grey and Mathews (2009) who showed priming of homographs is necessary to detect valenced training effects. Similar to Hoppitt *et al.* (2010) they showed when meaningless letter strings preceded a lexical decision task, there were no differences between threat and non-threat trained groups. However, effects were present when a homograph preceded the lexical decision task. This suggests that training effects are a result of processing ambiguous information. Overall,

this would suggest that current cognitive bias modification procedures are able to prime emotional categories and effects should be generalisable.

Task generalisation. One of the main criticisms levied at CBM-I procedures is that the manipulation check (to see if an interpretative bias has been modified from baseline) is often a similar task to the training procedure (Salemink, van den Hout, & Kindt, 2007). Salemink et al. (2007) replicated Mathews and Macintosh (2000) results but also included two further measures of interpretative bias that differed in their relatedness to the interpretation training. One was the Ambiguous Social Situations Interpretation Questionnaire (an open ended questionnaire rated by experimenters: Stopa & Clark, 2000), the other was a modified version of the Extrinsic Affective Simon Task (An implicit learning procedure: De Houwer, 2003). Results showed that the Mathews and Mackintosh manipulation check was successful at distinguishing between positively and negatively trained participants; although there were no differences of interpretative style found between the groups as measured by the AASIQ or the EAST. This suggests that training procedures may simply be teaching participants a "method dependent strategy" as opposed to a fundamental interpretative bias that generalizes across information. However, null results might result from methodological limitations. The study lacked adequate power to detect differences using the EAST task. It may also be that the ASSIQ was not sensitive enough to detect training differences in the unselected sample as it was originally designed for use in the clinical population.

In a follow-up study, Salemink et al. (2010a) examined the extent to which interpretative bias training generalized to other tasks (a social vignette designed for an unselected population, and a video task) as well as to other domains (academic performance). The authors found again that the Mathews and Macintosh (2000) paradigm successfully induced positive and negative interpretative biases when measured by the original online reaction time tests to probes, and later recognition test. However, the additional measures of interpretative bias were unable to detect training effects. Results did however show that interpretative bias transferred to another domain (academic

performance). One would have expected interpretative bias effects to transfer to the social vignette task because it was quite similar to the original training procedure. However, this task focusses on just one scenario (a blind date between students) and the task is presented in the third person. The authors suggest that CBM-I training might not transfer to ambiguity concerning others (Salemink, van den Hout, et al., 2010a). Similarly the academic performance measure was similar to the training procedure therefore it is not clear if participants learnt a task specific technique or if there was genuine transfer of a selective implicit production rule to select positive meanings from ambiguous information to other domains[3].

Other studies provide some support for task generalisation (Hertel, Vasquez, Benbow, & Hughes, 2011; Hirsch, Mathews, & Clark, 2007). Hertel et al. randomly assigned healthy students to threat or non-threat related groups and induced training effects using a homograph procedure. Task transfer was measured by asking participants to generate images of socially ambiguous words displayed on a screen and to describe their images, which were recorded and later scored for meaning (threat related, threat unrelated, not enough information) by independent raters. This task had good construct validity as cognitive models (Clark & Wells, 1995; Rapee & Heimberg, 1997) suggest that imagery and the construction of the self as a social object is a defining feature of social anxiety. Results showed that the mean number of threat unrelated interpretations were higher for the non-threat trained group suggesting that trained interpretative biases can generalise to novel tasks and materials.

As well as task generalisation, studies reviewed suggest that the modification of interpretation can exert influence on attentional (Amir, Bomyea, & Beard, 2010), and memory processing biases (Salemink, Hertel, & Mackintosh, 2010). Amir et al. randomly assigned participants high in social anxiety (score >25 on Liebowitz Social Anxiety Scale: LSAS, Liebowitz,

[3] The authors created 10 critical recognition stories concerning academic performance in the same way as the Mathews and Macleod (2000) recognition test.

1987) to either the ICC or IMP groups of the WSAP training procedure. Importantly, participants completed baseline and post training measures of interpretative bias (using a questionnaire different to the training procedure) and attentional bias (using a modified Posner task with cued word stimuli: an attention disengagement task) in order to check that the IMP effectively modified participants interpretations and to test the effects on attention disengagement respectively. Results showed that the alternative Interpretation Questionnaire (Amir, Foa, & Coles, 1998) successfully distinguished between the two groups, with the ICC group making more threat related interpretations than the IMP group. In addition, results from the Posner task showed that the IMP group were also quicker to disengage their attention away from threat related cues. This provides some support for task generalisation of CBM-I training procedures and highlights the link between cognitive processing biases in the maintenance of social phobia.

Modality and context. A number of studies reviewed, examined the efficacy of CBM-I programs presented using differing modalities (Holmes, Mathews, Dalgleish, & Mackintosh, 2006; Salemink, van den Hout, & Kindt, 2009; Standage, Ashwin, & Fox, 2009). All three studies compared visual versus auditory presentation of training materials. Results showed the mode of presentation did not influence the strength of training effects; however, Standage et al. found that when presented auditorally, the process of training increased self-reported state negative affect. The authors speculated that the lack of control to self-pace the training procedure and the extended time it took to complete training for the auditory group may have led to the increased negative affect. Given the lack of any benefits to strength of training, they suggest that visual presentation of CBM-I training procedures is more effective. A strength of Standage et al. is the inclusion of a baseline measure of interpretative bias allowing for the quantification of the strength of training effects.

Training effects from CBM-I have also been shown to survive changes in context (Mackintosh, Mathews, Yiend, Ridgeway, & Cook, 2006). The authors replicated the Mathews and Mackintosh (2000) training paradigm but also included change of environmental context as a

between subjects factor, yielding four training groups (positively trained/same context, positively trained/different context, negatively trained/same context, negatively trained/different context). The change of environmental context included testing in groups, a change of experimenter between sessions, changes of room, and change of mode of delivery (computerised and pen and paper). Using the Mathews and Mackintosh (2000) recognition test as a manipulation check of interpretative bias after a period of 24 hours, the authors found a significant main effect of training group (those negatively trained endorsed more negative interpretations and vice versa for the positively trained groups). Importantly the result was not qualified by an interaction with context, meaning training effects survived a change of context. However, the study excluded highly anxious participants for ethical reasons therefore it is unclear if the durability of training effects would generalise to socially anxious individuals. Salemink et al. (2009) also demonstrated that CBM-I training could be successfully administered within participants' home environments via online training. Positively trained participants were slower to respond to negative word fragments as opposed to positive fragments. This finding is clinically promising as it suggests that CBM-I training could be easily and readily accessible within a home environment thus targeting the many individuals with social phobia that may be reluctant to seek face-to-face treatment.

Time/enduring effects of bias modification. If CBM-I training programs are to be applied in clinical settings, another important factor to consider is the durability of training effects, both in terms of the change in interpretative style and effects on symptomatology of social phobia such as reductions in physiological and behavioural signs of anxiety. The former will be reviewed here whilst the latter will be discussed in the next section (dedicated to anxiety).

The majority of studies under review used short time delays (2 – 10 minutes) after interpretative bias training before administering manipulation checks (to test the effectiveness of training). However, this was to control for any negative emotional effects of viewing positive and negative training material. The first study to experimentally test the durability of CBM-I techniques

was conducted by Yiend, Mackintosh and Mathews (2005). Using the Mathews and Mackintosh (2000) paradigm, they trained healthy volunteers (10 positive, 10 negative) in one session. Volunteers then completed an unrelated filler task for 20 minutes before completing the Mathews and Mackintosh (2000) recognition test. Results showed that negatively trained participants endorsed negative items at a significantly higher rate than positively trained participants did. Conversely, the positively trained group gave significantly higher ratings for positive items than the negative group. This demonstrated that training effects were still present after a 20-minute delay. In a further experiment, significant differences were found between groups after a 24 hour delay (Yiend, et al., 2005 EXT 3). However, in Yiend et al's. studies, the low sample sizes, absence of a control condition and focus on a non-anxious population limit the generalisability of the findings.

Further evidence for the longevity of training effects comes from more recent studies that use multiple sessions of CBM-I training (Amir & Taylor, 2012; Beard & Amir, 2008; Beard, et al., 2011; Lester, et al., 2011; Mathews, Ridgeway, Cook, & Yiend, 2007; Salemink, et al., 2009). The training programs range from 1-4 weeks in duration and all used high trait anxiety, analogue or clinical samples of social phobia. All studies consistently found that CBM-I training produced significant decreases in threat interpretations and increases in benign interpretations of ambiguous social events compared to test-retest control conditions (Mathews et al, 2007) and interpretation control conditions. Taken together, this suggests CBM-I procedures are successful in modifying interpretative biases and that these biases can have enduring effects. However, in all studies reviewed there is a distinct lack of follow-up data. Most studies did not include a follow-up measure at all. The only exceptions to this were Amir and Taylor (2012) and Mathews et al. (2007) that included 1 week and 12 week follow up data. Both studies reported that participants in the active training condition had maintained treatment gains, indicating that training can have enduring effects on cognitive style and symptoms of social anxiety. However further research will be needed before any firm conclusions can be drawn.

Effects on anxiety. With the development of CBM-I techniques it has become possible to test the causal relationship of cognitive processing biases in the maintenance of social phobia predicted by current disorder specific models. The following section examines the efficacy of modifying interpretative biases on anxiety.

State anxiety. The Mathews and Mackintosh (2000) series of experiments manipulated training materials so that the final word in a socially ambiguous scenario was a word fragment (and thus had to be actively generated by participants) or was simply presented (participants were passively exposed to training materials). As discussed earlier, the differing methods did not affect the magnitude of training effects, however participants that had to actively generate emotional content also had increases/decreases in state anxiety (depending on the valence of training), whereas no differences in state anxiety were observed for passively trained groups. Other studies have also observed significant effects on state anxiety between positively and negatively trained participants (Salemink, et al., 2007; Yiend, et al., 2005). Although, in a re-analysis of previous CBM-I studies using mediation path analysis, Salemink, Van den Hout and Kindt (2010b) found no evidence of a causal relationship between state anxiety and interpretative bias. Instead they found that state anxiety was a product of the CBM-I procedure itself. The authors also found that changes in interpretative bias led to changes in trait anxiety supporting a causal relationship between interpretative bias and anxiety.

In addition, one study investigated the role that imagery during the training procedures had on state mood. Holmes *et al.* (2006) compared visual processing of positive training materials to verbal processing. They found participants in the imagery condition reported greater increases in positive affect and greater decreases in state anxiety. This suggests that the use of imagery may have a greater impact upon emotion.

Overall, results suggest that the active generation of meanings during training procedures may lead to changes in state anxiety. In addition, these effects may be greater if they are processed via the use of imagery. However, these changes to state anxiety are a direct result of the training procedure used and not necessarily causally related to changes in interpretative bias.

*Trait anxiety***.** Three studies (Brosan, et al., 2011; Mathews, et al., 2007; Salemink, et al., 2009) directly examined the effects of training on trait anxiety as measured by the State Trait Anxiety Inventory Trait version (STAI-T: Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Mathews et al. showed that after four sessions of CBM-I, trait anxiety scores were significantly reduced in participants high in trait anxiety, one week after testing compared to participants in a test-retest control condition. However, mere repeated exposure to positive resolutions of ambiguous social events may have reduced trait anxiety rather than the CBM-I training modifying interpretative bias. In addition, the effects observed were relatively small. However, Salemink et al. accounted for this and included a control group that received the same training materials but with a slightly altered procedure so that interpretative bias would be unaffected by procedure in the control group. The latter study design also led to a significant reduction in trait anxiety scores for the positively trained group whereas the control group's scores did not deviate from baseline.

In a pilot study assessing trait anxiety, Brosan et al. assessed the feasibility of delivering CBM-I and CBM-A programs within clinical settings. Although numbers are relatively small and the study design was weak (with an absence of control group), four out of nine participants achieved clinically significant change in trait anxiety scores after four weekly sessions of training. This study also examined the acceptability of the procedure with participants commenting that they found CBM-A training *"boring"*, whilst reporting that they could see the value in CBM-I training. This highlights that CBM-I procedures can also be delivered in clinical settings and that they are accepted by patients.

Current cognitive models predict trait anxiety to be higher in individuals with social phobia; however, it is also important to assess the efficacy of training programs to target disorder specific features of social phobia. Only four of the studies reviewed included a measure of social anxiety as an outcome variable (Amir & Taylor, 2012; Beard & Amir, 2008; Beard, et al., 2011; Salemink, et al., 2009). The earliest study to assess effects of extended training on trait social anxiety symptoms was Beard and Amir (2008). Using the WSAP they found that after eight sessions of training (75 trials per session) the IMP group scored significantly lower on a measure of self-reported social anxiety (Social Phobia and Anxiety Inventory: Turner, Beidel, Dancu, & Stanley, 1989) than the ICC group. However, the study's reliance on self-report data and use of an analogue sample limit the generalisability of the findings. In addition, the authors also found that the ICC group made improvements on the measure of interpretative bias (i.e. their negative interpretative bias was less pronounced following training). Participants in the ICC group already held a negative interpretative bias, therefore when they received biased feedback at a ratio of 50% [4] they may have inadvertently been provided with repeated exposure to alternative positive meanings of socially ambiguous scenarios. It is therefore difficult to assess the full benefits that training can confer. Further studies using this paradigm could benefit from altering the contingency of feedback during training to assess this further.

In order to address these methodological shortcomings, Beard *et al. (*2011) conducted a randomised placebo controlled trial (RCT) to examine the efficacy of combined CBM-I and CBM-A. In this study, the procedure for the control group was modified so that the contingency of feedback was not the independent variable. Instead, the semantic relatedness of words was modified between groups. The participant's task was to judge whether words presented were related or unrelated to the ambiguous sentences. Importantly the words chosen for the ICC group only related to a superficial aspect of the scenario, whereas words chosen for the IMP group referred to

[4] On half the occasions, they were told they were correct to reject a threat interpretation and on the other half, they were told they were incorrect to reject a threat interpretation.

an ambiguous social aspect of the scenario. Results showed that training produced medium to large effects on self-reported social anxiety symptoms as rated by the Liebowitz Social Anxiety Scale-Self Report (LSAS-SR: Liebowitz, 1987).

In another well-designed RCT, Amir *et al* (2012) compared 12 (bi-weekly) sessions of CBM-I using the WSAP in individuals with generalised social anxiety disorder. A strength of this study was the expansion of outcome measures to include clinician rated symptoms of social anxiety (LSAS-CR: considered the gold standard in social phobia research) and measures of functional impairment (Sheehan Disability Scale: Leon, Olfson, Portera, Farber, & Sheehan, 1997). The multi-session program showed participants receiving training were rated by clinicians as displaying significantly fewer social anxiety symptoms, were less avoidant and less functionally impaired compared to the control group. Overall, initial evidence suggests that multi-session CBM-I training is able to reduce trait anxiety and social anxiety symptoms in adults with a diagnosis of social phobia. However, it will be important for future research to establish whether reductions in anxiety constitute clinically significant change.

Social evaluative threat. According to cognitive theories of social phobia, socially anxious individuals will often avoid social situations. If this is not possible, they will employ numerous safety behaviours in order to reduce subjective state anxiety levels (Clark & Wells, 1995). It is therefore important to assess the contribution that CBM-I training programs can have on emotional vulnerability to stress provoking situations. Hirsch et al. (2007) induced a positive and negative inferential bias in an unselected sample. Participants completed an imaginal social stressor task whereby they were asked:

> *"Imagine you are leading a discussion group of 15 people you don't know, for thirty minutes, on a topic which you know a little about but it's not a topic you're very familiar with"*

They used scales from -3 to 3 to rate anticipated anxiety and expected performance. Negatively trained participants anticipated more self-reported anxiety and anticipated poorer performance during the imaginal social stressor task.

Similarly, Murphy, Hirsch, Mathews, Smith, and Clark (2007) investigated imaginal social stress in a highly socially anxious sample. The social stressor task required participants to make anticipated anxiety and performance ratings after being told they would be meeting two people that they did not know and would have to hold a five-minute conversation with them. Participants were allocated to either a benign positive, benign non-negative or control training group. Results showed that participants who received benign training anticipated significantly less anxiety than the control group: however, groups did not differ in their ratings of anticipated performance. These studies provide some support for training effects on emotional vulnerability; however, the tasks were imaginal and relied on self-report, unstandardized measures.

Two studies used a more ecologically valid method of testing for training effects on emotional vulnerability (Hoppitt, et al., 2010; Wilson, MacLeod, Mathews, & Rutherford, 2006). Following training, participants watched stressful video clips depicting real life accidents whose resolution remained ambiguous until the end of the clips. Wilson et al. (2006) found that threat trained participants showed elevated levels of state anxiety in response to the clips compared to baseline; whilst non-threat trained participants reported no change. Hoppitt et al. (2010) also found significant differences in state anxiety between threat and non-threat trained groups. Both groups' state anxiety scores increased from baseline, however anxiety scores increased significantly more in threat trained participants. However, whilst this method may be more ecologically valid it lacks certain controls to infer findings. For example, during video clips, there were unambiguously emotionally positive and negative scenes; it is therefore unclear how this may have affected participants' levels of state anxiety. In addition, Hoppitt et al. excluded data from 16 participants

because they were emotionally desensitised to the video clips. This further limits the generalisability of findings.

Two studies failed to find evidence that interpretative bias training effects subsequent emotional vulnerability (Salemink, et al., 2009; Standage, et al., 2009). After successfully modifying interpretative bias, Salemink et al. exposed participants high in trait anxiety to an anagram stress task. Participants were told, "*The task would be difficult but that intelligent individuals like students usually perform well."* Crucially the difficulty of the task was manipulated so that on half the trials participants had to solve difficult anagrams and the other half ranged from easy to quite difficult. Participants completed visual analogue scales for anxiety and depression ratings before and after the task. One would have expected that CBM-I training to have primed individuals to make less negative interpretations about the task difficulty and their own performance compared to the control group. This would have in turn causally produced less anxiety in the CBM-I group. However, results showed that whilst the task itself was capable of increasing anxiety and depression scores, there was no differentiation in emotional vulnerability between the CBM-I and control group.

Standage et al. (2009) used a speech task as a social stressor. During this task, participants were informed they would have to give a four-minute speech in front of a camera. To increase anxiety further, they were given limited preparation time (1.5 minutes). Visual Analogue Mood Scales (VAMS) were taken pre and post task. In addition, speeches were rated for behavioural signs of anxiety using the timed behavioural checklist (Paul, 1966) by two independent raters. Raters' scores for signs of anxiety were similar regardless of the type of training an individual received, indicating that training did not have any effects on behavioural signs of anxiety displayed during a socially stressful situation. However, previous research has shown that blind assessors find it difficult to distinguish between those high and low in self-reported state anxiety during speech tasks

(Standage, et al., 2009). In addition to behavioural signs, there were also no significant differences between groups on self-reported anxiety during the speech task.

Taken together, the evidence for CBM-I procedures mediating emotional vulnerability in social anxiety seems mixed. It will therefore be important for future research to continue to examine how CBM-I training affects emotional vulnerability: In particular, it may be helpful to include physiological and neurological measures during social stressor tasks.

Clinical Implications

So far this review has considered the efficacy of CBM-I procedures in terms of the reliability of the techniques and the effects on levels of anxiety. We are currently at the stage of trialling CBM-I procedures with clinical populations. Whilst confidence in CBM-I procedures as a plausible treatment option remains to be established, it is clear that CBM-I research has significant clinical implications. Given its clear links to cognitive models of social phobia, it is feasible that CBM-I techniques could be used as an adjunct to a course of CBT. Given its versatility, CBM-I could be used as a homework exercise between sessions. However, it should be noted that CBM-I procedures only target a single cognitive processing bias and whilst there is tentative evidence to suggest that training can also generalise to other cognitive processing biases such as attention (Amir, et al., 2010) and memory (Salemink, Hertel, et al., 2010) this remains to be established.

CBM-I procedures could allow the clinician to target other areas such as graded exposure to threatening situations and the minimisation of safety behaviours. It has also been suggested that CBM-I procedures may be individualised making it more emotionally relevant to treatment seeking individuals (Salemink, et al., 2009). For example, training materials could include the person's name and names of work colleagues or friends in the scenarios. The type of resolution to scenarios could also be graded from non-negative to positive depending upon the extent of the person's

negative interpretation bias and how prepared they are to accept such resolutions (Salemink, et al., 2009).

A final clinical implication worthy of discussion is the finding that passive exposure to positive resolutions of ambiguous social stimuli produces similar changes in interpretative bias compared with active generation. This may have clinical implications as clinicians are taught to use the socratic dialogue in order to allow participants to generate their own meanings and functional resolutions of situations, although this may not be necessary. However further research is required to investigate the role of active versus passive exposure to interpretations of ambiguous social stimuli.

Conclusions and Recommendations

It is well established that non-anxious individuals hold a positive inferential bias for ambiguous social stimuli whereas socially anxious individuals are more likely to make negative inferences of the same information. The research reviewed has shown that several different paradigms have successfully modified interpretative biases in unselected volunteers, medium anxious, analogue and clinical samples of social phobia. However, generalisation to other tasks that also measure interpretative bias has had mixed results which leaves open the question of whether participants are merely learning a task dependent strategy rather than training programs inducing a true interpretative bias. Despite concerns regarding task generalisation, training effects can survive changes in environmental context, changes in mood, endure over a period of 24 hours following a single session and generalise to other domains (academic performance). This suggests that the modification of interpretative bias is a robust finding. However, all studies reviewed used linguistic stimuli. Whilst this has shown to be successful, in real life, individuals with social phobia are often faced with novel stimuli requiring interpretation. For example, an ambiguous facial expression from an audience member whilst you are giving a speech could be interpreted as boredom, that the person is captivated and deep in thought considering your last point, or a number of other

interpretations. Future research should also consider training programs that use different forms of training materials such as facial stimuli. Researchers should also continue to examine and develop other measures of interpretative bias that are significantly different from training procedures but equally, are sensitive enough to detect changes in interpretative bias.

Training effects on anxiety are more complex. The modification of interpretative biases appears to have had mixed results on subsequent emotional vulnerability to social stressors. However, the type of training might mediate this effect: It has been shown that active generation of emotional resolutions of ambiguous social stimuli is necessary to produce changes in state affect (Salemink, van den Hout, et al., 2010b).

Multi-session programs have demonstrated medium to large effects in reducing levels of trait anxiety and self-reported symptoms of social anxiety. In addition, they have also produced significant differences between training and control groups using clinician rated measures of social anxiety symptoms and functional impairment. However, only one study reviewed addressed the wider impacts of training. Future research should also include quality of life measures. Multi-session studies differed in method, frequency, duration and intensity of training. It seems therefore that more research is required to identify if one training procedure significantly outperforms others, the optimum number of sessions, and how many trials should be included in each session in order to achieve beneficial effects.

A further limitation of the studies reviewed is the quality of study design. Only two studies reviewed were RCT's with only two studies reporting follow up data of social anxiety symptoms. Perhaps this reflects the current position of CBM-I research in that we are only now ready to rigorously explore the benefits of CBM-I procedures in clinical samples. It follows that future research should use the RCT format. In addition it will be important to consider how CBM-I procedures perform compared to treatment as usual, and other psychosocial and pharmacological

interventions. Furthermore, more follow-up data is required to ascertain how long benefits can be maintained.

In conclusion this systematic review has explored the progress that has been made since CBM-I procedures were developed. It appears that the modification of interpretative biases is a robust finding that can have effects on trait measures of anxiety that persist for several weeks. This suggests that interpretative biases have a causal role in the maintenance of social phobia. Research reviewed also supports elements of modern cognitive theories of social phobia (e.g. Clark & Wells, 1995; Rapee & Heimberg, 1997) however, this review limited itself to the exploration of interpretative biases. The modification of interpretative biases has seen a surge of interest in the past decade and with many questions still to answer, it is an exciting time to be working in this field.

EMPIRICAL PAPER

The use of Facial Stimuli as a CBM-I Training Procedure: Validity and Effects on Anxiety

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The use of Facial Stimuli as a CBM-I Training Procedure: Validity and Effects on Anxiety

Social Phobia is characterised by an overwhelming and persistent fear of being negatively evaluated in social situations (Diagnostic and Statistical Manual for Mental Health Disorders; American Psychiatric Association, 2000). Social Phobia is the fourth most prevalent psychiatric disorder (Kessler, et al., 2005). It is also highly prevalent amongst other psychiatric disorders, most notably depression (Kessler, et al., 1999). It is a chronic condition with poor rates of spontaneous remission (Bruce et al., 2005) and is characterised by oscillations around the diagnostic threshold (Fehm, et al., 2005).

Cognitive models of anxiety (e.g., Beck, et al., 1985) propose the tendency to interpret ambiguous stimuli as threatening plays a causal role in the maintenance of a broad range of anxiety disorders. A number of models have been suggested to explain the characteristics of social phobia (Clark & Wells, 1995; Hofmann, 2007; Matthews & Mackintosh, 1998; Rapee & Heimberg, 1997). In essence, all models implicate cognitive processing biases of attention, interpretation, and (to a lesser extent) memory. Socially anxious individuals frequently attend to and interpret socially ambiguous information as threatening, causing them to experience more frequent negative affective reactions to social stimuli and to develop maladaptive coping strategies such as avoidance and safety behaviours (Wilson, et al., 2006). Among the various cognitive processing domains of bias, interpretative bias is likely to play a key role in the maintenance of social anxiety because of the inherent ambiguity in social interactions (Amir, Beard, & Przeworski, 2005).

It is well established that anxious individuals display an interpretative bias: that is, anxious individuals will interpret ambiguous information in a threat related manner compared to non-anxious individuals. Investigations have typically used verbal stimuli (e.g. threat-neutral homographs) or ambiguous stories. For example, when hearing sentences such as *"the Doctor examined little Emma's growth,"* individuals with high trait anxiety scores were more likely to

interpret the sentence in a threatening manner (i.e. cancer as opposed to height) than individuals low in trait anxiety (Eysenck, Mogg, May, Richards, & Mathews, 1991). However, these studies were all correlational in nature therefore causality could not be established.

The turn of the century saw the development of procedures allowing the manipulation of interpretative biases in order to further our understanding of the causal role of interpretative biases in emotional vulnerability. In a much cited study, Mathews and Macintosh (2000) presented an unselected sample of 20 individuals with short passages of ambiguous social scenarios whose emotional resolution only became apparent with the final word of the passage, which was presented in fragment form. Participants were divided into two groups (negatively trained and positively trained). For the negatively trained group, the final word fragment resolved the scenario in a negative way, whilst for the positively trained group, word fragments generally produced a non-negative or positive resolution. After 64 trials of training, significant differences emerged between the groups when they were asked to resolve new scenarios whose resolution was left ambiguous. The authors found that negatively trained participants were more likely to interpret novel socially ambiguous scenarios in a negative way compared to positively trained participants.

Training effects have also been shown to influence subsequent emotional vulnerability. For example Wilson *et al.* (2006) demonstrated that inducing a threat interpretation bias led to increased levels of state anxiety when individuals were shown a subsequent stressor (video's depicting real life rescue operations) compared to a benign interpretation bias induction group, who showed no changes in levels of state anxiety. Similar findings have been observed when the social stressor has been imaginal, (Hirsch, Mathews, & Clark, 2007; Murphy, Hirsch, Mathews, Smith, & Clark, 2007), and a public speaking performance task (Beard, et al., 2011). Predominantly, studies have used self-report data to assess for increases in anxiety during socially stressful situations. Increases or decreases in heart rate, blood pressure, and skin conductance as well as activation of the hypothalamus-pituitary-adrenal (HPA) axis have all been used as additional ways to measure

autonomic arousal to threatening stimuli in socially anxious individuals. However, evidence that distinguishes socially anxious individuals from controls on tasks that are designed to raise autonomic activity is limited (Staugaard, 2010).

More recently, cognitive bias modification of interpretation (CBM-I) has been successfully used in highly anxious populations to train individuals to interpret ambiguous social information in a more benign/positive manner with resultant reductions in trait anxiety (Mathews, Ridgeway, Cook, & Yiend, 2007; Murphy, et al., 2007; Salemink, van den Hout, & Kindt, 2009). For example, Mathews et al. (2007) examined the effects of four sessions of positive CBM-I training delivered over a two-week period (n=20) compared to a test-retest control condition (n=20) in a sample of 40 individuals high in trait anxiety. Participants in the training condition were administered 100 trials per session of ambiguous social stories taken from the Mathews and Mackintosh (2000) pool that were resolved in a progressively more positive fashion. Results showed that training significantly increased the likelihood that novel ambiguous events were interpreted positively compared to the test-retest group. In addition, the positive CBM-I group had significant reductions in trait anxiety one week following training.

Typically, most current multi-session programmes utilise the Word Sentence Association Paradigm (WSAP) to experimentally manipulate interpretative biases. This technique was developed by Beard and Amir (2008) and involves the presentation of a word (either threat related or benign) before the presentation of an ambiguous social sentence. Participants have to indicate if the word and sentence are related or not. Crucially, feedback contingency is manipulated in order to train individuals to reject threat interpretations and endorse positive interpretations of ambiguous social stimuli.

CBM-I techniques have also been shown to transfer across domains to other information processing biases. For example a single session of CBM-I training in a highly anxious population

has been shown to reduce the amount of time it takes to disengage attention from threatening stimuli using a measure of attentional bias (Amir, et al., 2010). Multi-session CBM-I training programs utilising the WSAP have also been shown to reduce trait anxiety as well as emotional vulnerability (Beard & Amir, 2008; Beard, et al., 2011; Brosan, Hoppitt, Shelfer, Sillence, & Mackintosh, 2011). For example Beard et al. (2011) found that after receiving eight sessions of combined CBM-I training with attentional bias training (CBM-A), individuals reported less self-reported social anxiety symptoms relative to a placebo control group. In addition, they also found that when individuals were asked to perform an impromptu speech, those that received active training performed significantly better than controls on a behavioural measure of speech performance scored by independent raters blind to condition. However, the combinational approach of two training techniques means that the mechanisms of change remain unclear. In addition, all current training programs use verbal stimuli. However, previous research has found that imagery has a greater impact on anxiety than verbal processing of the same material (Holmes, Mathews, Dalgleish, & Mackintosh, 2006). When interacting with others, individuals with social anxiety fear disapproval from others. The manipulation of facial stimuli would therefore be a source of imagery well suited to a socially anxious population.

There is some evidence to suggest that socially anxious individuals differentially interpret facial expressions in a biased way compared to non-anxious individuals. Joorman and Gotlib (2006) found that individuals with a diagnosis of social phobia required less intensity to identify angry facial expressions relative to individuals with a diagnosis of depression and healthy controls. They also found individuals high in trait anxiety also show an enhanced sensitivity for categorising facial expressions as fearful compared to low trait anxiety individuals. In another study, Winton, Clark and Edelman (1995) found that individuals scoring high on a measure of fear of negative evaluation were more accurate at detecting faces with a negative emotional expression and less accurate at detecting faces with a neutral expression compared to individuals low in fear of negative

evaluation. However, (Philippot & Douilliez, 2005) failed to find any differences in decoding accuracy or attributed emotional intensity in a task of facial perception across individuals with social phobia, a control group of individuals with other anxiety disorders and non-anxious healthy controls.

Using a different approach, Coles, Heimberg and Schofield (2008) used schematic line drawings to manipulate facial features such as eyebrows, mouth, and eyes. Participants (either high or low in social anxiety) were asked to use pairs of adjectives (e.g. friendly-unfriendly, strong-weak) to evaluate each drawing. Results showed that high and low socially anxious participants interpreted the facial expressions in similar ways. However, for ambiguous faces only, (those with frowning eyebrows, but a smiling face) individuals high in social anxiety reported more negative interpretations. This suggests that high socially anxious individuals are more liberal at determining that information is threatening when interpreting ambiguous facial expressions.

Garner, Mogg and Bradley (2006) examined the relationship between social anxiety and the propensity to make online and retrospective judgements of angry, neutral and happy faces using an illusory correlation paradigm. They found that whilst those high and low in social anxiety initially showed a positive bias to over-associate positive stimuli with a pleasant outcome, the bias in the high social anxiety group was extinguished during the course of the task, whilst the low social anxiety group continued to demonstrate a positive expectancy bias throughout the task. This compliments the interpretative bias data using verbal stimuli and suggests that social anxiety may be characterised by an absence of a positive inferential bias using facial stimuli.

In summary, there is some evidence to suggest socially anxious individuals exhibit an interpretative bias in the classification of negative emotional expressions. Despite this, no study to date has examined the use of facial stimuli in the modification of interpretative bias in social anxiety. The current study used a modified emotion recognition training program that has been

shown to be successful at modifying interpretative biases in depressed individuals (Penton-Voak, Bate, Lewis, & Munafo, 2012) and conduct disordered youth offenders (Penton-Voak et al., 2013). The program involves a similar training method as the WSAP procedure and modifies perception of ambiguous facial expressions via the use of corrective feedback over a number of training trials. In the previous study by Penton-Voak et al. (2012) facial expressions ranging from unambiguously sad to unambiguously happy were randomly shown to moderately depressed young adult participants in an active condition who had to make a forced choice in identifying the emotional expression. The authors found some evidence that the emotion recognition training program led to some improvements in positive affect for participants that completed training.

Anger is commonly used in studies investigating interpretative bias in socially anxious individuals. This is because anxious individuals are more likely to detect anger in another person's face because it is directly threatening to them personally (Richards, et al., 2002). Socially anxious individuals display a negative interpretative bias for the categorisation of angry facial expressions, (Joormann & Gotlib, 2006; Winton, et al., 1995) thus the current study sought to modify participants' interpretation of faces along a neutral-angry continuum.

Consistent with previous studies (and to maximise the effect of training), participants were randomized to training conditions that sought to either *increase* or *decrease* the perception of faces as 'angry.' The primary aim was to examine if training could alter individuals perceptions of ambiguous facial stimuli. The secondary aims of the study were to examine the effects of training on i) anxiety experienced during a socially stressful situation and ii) social performance (as measured by the participant and independent raters). A further aim was to explore if trait social anxiety scores moderated the effect of training on interpretative bias, and anxiety experienced during the social stressor.

Hypothesis

Primary

1. CBM-I-threat training will significantly increase participants' classification of ambiguous faces as angry relative to their baseline scores. Similarly, CBM-I- non-threat training will reduce perceptions of anger.

Secondary

1. CBM-I-non-threat training will buffer against increases in autonomic arousal and self-reported state anxiety scores during the social stress task, compared to CBM-I-threat training.
2. Non-threat trained participants will rate their performance during a social stressor task as significantly better than threat trained participants**.**
3. Independent raters will score non-threat trained participants' speech performances as indicating significantly fewer signs of social anxiety compared to threat trained participants.

Method

Ethical approval for this study was granted by the University of Southampton's ethics committee and Research Governance Office (see Appendix B).

Design

The study employed a double-blind 2 (Condition: threat, non-threat) x 2 (Time: baseline, post-training) mixed design with number of responses (number of faces classified as angry) as the dependent variable to assess the effectiveness of the emotion recognition training program. To assess the effects of completing a social stressor task on dependent variables of physiological arousal and self-reported state anxiety, a double-blind 2 (Condition: CBM-I-threat, CBM-I-non-threat) x 3 (Time: baseline, pre-speech, post speech) mixed design was employed. The four time points at which measures were taken in sequential order included: Baseline (before the intervention) post-training (following the intervention, but before the social stressor speech task was introduced) pre-speech (following the introduction of the social stressor speech task but before participants had completed the task), post-speech (following completion of the speech task). Participants were randomly allocated to groups (but were balanced for gender ratios). The researcher and participants were blind to condition. Groups did not differ in gender, ethnic origin or current medication (see Table 2).

Participants

This study sought to gain a heterogeneous sample. To be included in the study participants had to be studying an undergraduate degree on psychology at the University of Southampton. Due to the reliance on self-report questionnaire data and the requirements to give a speech, participants were required to endorse they had a good understanding of written and spoken English. A further exclusion criterion was that participants had to have been living in the United Kingdom for at least six months. This was to ensure that they had sufficient experiences to enable them to formulate an

answer to the speech topic of "what three rules would you change in British society to make the country a better place".

Participants were recruited through Psychobook – an online advertisement system coordinated by the Psychology Academic Unit. After reading a study advert (see Appendix C), participants electronically booked a test session. Participants always had at least a period of 24 hours between booking and attendance in order to consider the information and ask any questions before agreeing to participate and providing written informed consent. Seventy-six undergraduate students agreed to participate in the study. Three participants were omitted from the study - two participants withdrew their consent during the experiment and one participant was not fluent in English and had difficulty comprehending the questionnaires. Data reported for 73 participants comprised 54 female, 19 male (mean age = 21.44, SD = 3.96, range 18-42).

Measures

Self-report measures of current mood throughout the test session.

Spielberger state trait anxiety inventory- state version (STAI-S; Spielberger, et al., 1983). The STAI-S measures state anxiety. The scale consists of 20 items that ask, "how a person is feeling right now". Participants use a four point rating scale (almost never, sometimes, often, always). In the current study, state anxiety was measured at three time points (baseline, pre speech, post speech) with respective Cronbach alpha scores of .91, .94, and .93.

Visual analogue mood scales (VAMS). Participants were administered the VAMS at four time points (baseline/pre-training, post-training, pre-speech, post-speech). The form asked participants to rate "how you are feeling right now" corresponding to the following adjectives (anxious, alert, nervous, relaxed, happy, worried). Participants were instructed to mark a vertical line along a 15 cm visual analogue scale with anchor points (not at all, a little, moderately, quite a lot, extremely) similar to the procedure used by Hertel, Mathews, Peterson and Kintner (2003).

Scores were converted into percentages, with scores from the anxious, nervous, and worried scales aggregated to form an overall state anxiety score. The happy scale was used to measure state positive affect.

Trait measures.

STAI-Trait version (Spielberger, et al., 1983). This measure consists of 20 items that ask participants about "how they generally feel". The reported Cronbach alpha for this study was .95 indicating good internal consistency. Fear of negative evaluation scale (FNE; Watson & Friend, 1969). This measure was used as a primary measure of social anxiety. It is a 30-item-self-report scale requiring yes/no answers in response to questions concerning negative evaluation from others. Internal consistency for the current sample was good (α = .92). Social phobia inventory (SPIN; Connor et al., 2000). This is a 17-item self-report measure used to assess fear, avoidance and physiological discomfort in a number of social situations. Items are rated on a 5-point scale ranging from 0 not at all – 4 extremely. Internal consistency for the current sample was good (α = .92). Social interaction anxiety scale (SIAS; Mattick & Clarke, 1998).The SIAS assesses anxiety relating to social interactions between two or more people. The scale consists of 20 items rated from 0 not at all characteristic or true of me – 4 extremely characteristic or true of me. It has been reported to have good convergent validity with other measures of social phobia (Peters, 2000) and demonstrated good internal consistency in the current sample (α = .92). Social avoidance and distress scale (SADS; Watson & Friend, 1969). This 28-item measure assesses individuals' fear of social situations and also the extent to which they deliberately avoid social situations. The reported Cronbach alpha for this study was .93 indicating good internal reliability.

Hospital anxiety depression scale (HADS: Zigmond & Snaith, 1983). The Hospital Anxiety Depression Scale is a short self-report measure used to assess and differentiate symptoms of anxiety and depression. Responses are based on frequency of symptoms in the past week using a four point

likert scale ranging from 0 not at all – 3 very often indeed. The depression subscale was used in this study to assess if groups differed on levels of depression. Reported Cronbach alpha for this study (α = 0.8) indicated acceptable internal reliability.

Physiological. Measures of heart rate and blood pressure were taken at three time points (baseline/pre-training, pre-speech, post-speech) in order to assess if CBM-I training affected autonomic reactivity. The measures also served as an objective measure of social 'stress' experienced during the speech challenge.

CBM-I training program. The training program consisted of a prototypical angry and neutral facial expression of one male characters face taken from the Karolinska Directed Emotional Faces (Lundqvist, Flykt, & Ohman, 1998). The face was delineated to produce 15 emotional expressions equally spaced in a linear morph sequence that ranged incrementally from unambiguously neutral to unambiguously angry, (Munafo et al., 2011). The emotion recognition training program consisted of three phases. During the first phase (pre-training test) participants were asked to judge faces from a morphed sequence presented in a randomised order as either angry or neutral (two alternative forced choice) by indicating their response on a keyboard as quickly as they could. This allowed a calculation of participant's individual balance points (the point at which participants shifted from perceiving faces as angry in ambiguous faces). During the pre-training phase, each image was shown three times in a randomised order equating to 45 trials.

During the second (training) phase, participants received biased corrective feedback (dependent upon group allocation) on all images two morph sequences from the balance point (see Figure 4 for an example training trial). For example participants in the threat trained condition who previously judged an ambiguous face that was two morph sequences from the balance point as *neutral* during the pre-training test phase, received biased feedback each time they reported the same image as neutral during the training phase (INCORRECT: That face was angry). Feedback for

participants in the negatively trained group was the reverse. Participants completed 155 training trials.

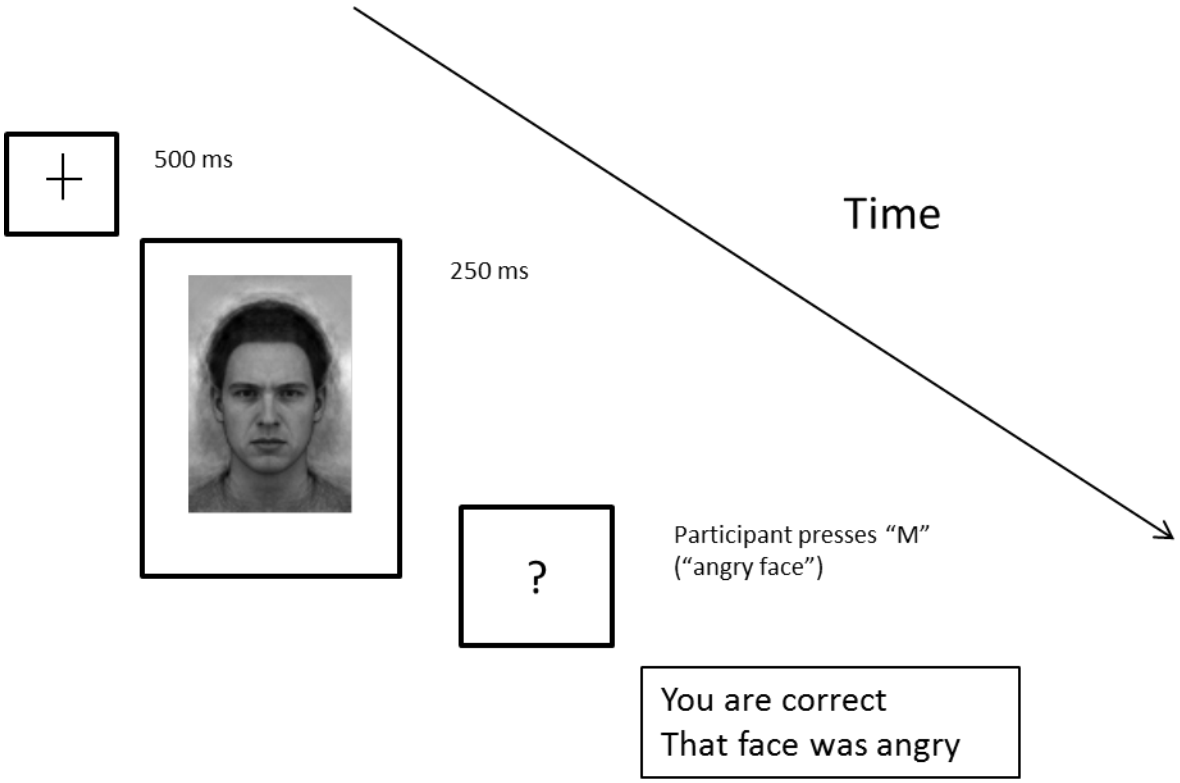

Figure 4. **An example training trial.**

In the third (post-training test) phase, participants completed 45 trials in an identical procedure to the pre-training assessment phase (see Figure 5 for an example of the training process).

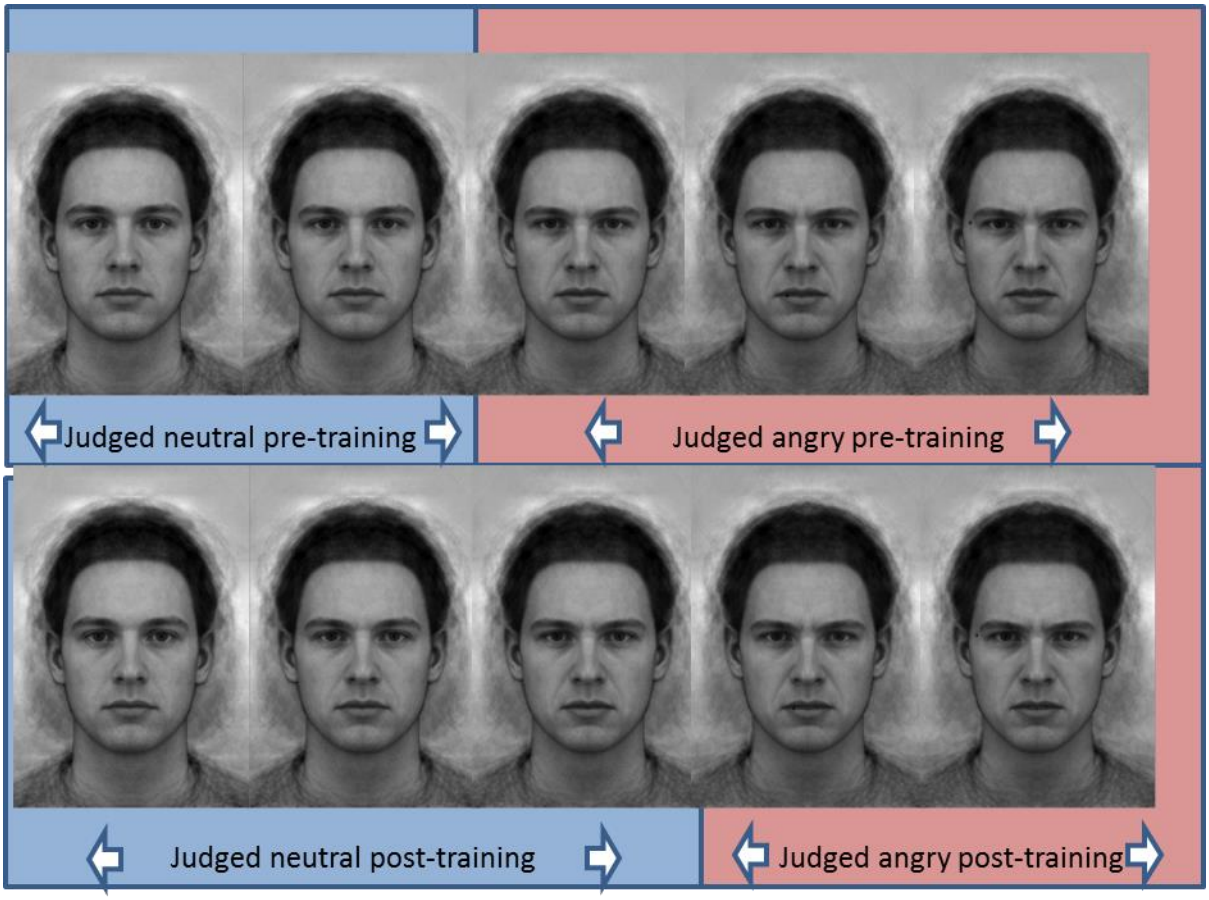

Figure 5. An illustration of the process of CBM-I- Non-threat training on perception.

Emotional vulnerability. In addition to determining whether the intervention could modify facial perception, the present study examined the extent to which the intervention modified anxiety experienced in response to a social stressor.

Speech task. Participants were given two minutes to prepare a five-minute speech on a topic chosen by the experimenter. They delivered the speech to the experimenter in the presence of a video recorder. Participants were given the speech topic printed on a single side of A4 "*What three rules in British society would you change in order to make the country a better place?"* along with a ballpoint pen to allow them to make notes. Participants were informed they would not be able to use their notes during the task and that the pen and paper would be taken away at the end of their two-minute preparation time (see Appendix D for a full description of speech instructions).

Participants were asked to stand six feet away from the digital video recorder and experimenter. The camera was mounted using a tripod upon a desk. The height of the camera measured 5ft 6 inches. During the speech the experimenter sat next to the video camera and held a neutral facial expression until the end of the task (a second digital video recorder was also positioned in the room to record the experimenters face for later ratings of facial emotionality).

Visual analogue scales. Participants were asked to rate their anticipated anxiety on a 15 cm visual analogue scale (VAS) with anchor points *(extremely anxious)* - *(extremely relaxed)*. Similarly, they were asked to rate their anticipated speech performance on a 15 cm VAS with anchor points ranging from *(extremely poorly) to (extremely well).* The same rating scales were used immediately post speech to assess immediate post event appraisal of levels of anxiety and performance.

Rapee and Lim speech performance scale (1992). Participants were also asked to rate their own speech performance using the Rapee and Lim speech performance scale. This 17-item measure was designed to be completed by individuals and by independent raters. The first 12 items measure specific aspects of performance such as *"stuttered"* and *"blushed"*, whilst the remaining five items measure global performance, such as *"generally spoke well"*. Items are rated using a 5-point likert scale ranging from 0 *(not at all)* to 4 *(very much).* The measure is reported to have adequate psychometric properties (Spurr & Stopa, 2003). Two independent raters were trained for reliability by rating three training videos of participants not used in the study. Fifteen speeches were rated by both raters, achieving a reliability estimate (r= .99).

Procedure

After obtaining informed consent all participants were engaged in a five-minute conversation *(about how they were enjoying the course)* in order to compensate for those that may have walked to the testing session thus artificially raising their blood pressure from baseline.

Following the filler conversation participants completed pre-training state measures (VAMS and STAI-S) and physiological measures (HR & BP). They were then positioned 15-20 inches away from a 19 inch Hanns G TFT computer monitor. They were randomised to condition and completed either CBM-I-threat or CBM-I-non-threat training.

Immediately after training participants completed a second mood VAMS. They were then informed that they would have to give an impromptu speech. Once informed (pre-speech phase) they repeated physiological and state anxiety measures and rated anticipatory anxiety and performance. Following the speech task (post-speech phase), physiological and state anxiety measures were taken. In addition, participants completed the speech performance self-rating form.

Finally, participants completed a battery of trait measures. Prior to debrief, participants completed an exit questionnaire (see Appendix E) that assessed their knowledge of the true aims of the experiment and which group they believed they were assigned. Participants were fully debriefed. A mood repair script was administered to participants who reported a continued negative emotional state (see Appendix F). The experimental session lasted approximately 1.5 hours (see Appendix G for procedural flowchart).

Results

Data Preparation

Missing data accounted for a minimal proportion of the dataset (see Appendix H). A mean substitution method was used to replace missing data. Dependent variables were examined to ascertain if they met parametric assumptions using histograms, z-scores of skewness and kurtosis, and the levene statistic of homogeneity of variance. Analysis of the data was conducted on the untransformed data as the selected method of analysis (Mixed model ANOVA's) have been shown to be robust to withstand violations of parametric assumptions (Field, 2005).

Inspection of the training task data identified three participants as extreme outliers (they rated every trial as neutral) and likely did not understand the task instructions. Their performance represented a floor effect and they were excluded from the analyses. Furthermore initial group comparisons on trait measures of social anxiety indicated that the threat trained and non-threat trained groups significantly differed on the primary measure of social anxiety (FNE), $t(68) = 2.31$, $p < .05$. Thus to ensure groups were matched on trait levels of social anxiety scores, those participants with an FNE score less than three were excluded. The final sample submitted to main analysis comprised 34 participants in the CBM-I-threat condition and 31 participants in the CBM-I-non-threat condition.

Group Characteristics

Groups did not differ on trait measures of social anxiety or depression (see Table 2). Furthermore, groups did not differ in baseline levels of state anxiety nor autonomic arousal (see Table 4).

Table 2

Group Characteristics

Variable	Non-threat trained (n=31)	Threat trained (n=34)	t (df)	P
Age in years	22.82 (5.42)	20.51 (1.96)	2.33 (63)	.02*
Year of Study (%)				
Year 1	32.3	29.4		
Year 2	41.9	58.8		
Year 3	25.8	11.8		
Gender (% female)	71.0	76.5		
Ethnic Origin (% British)	77.4	85.3		
SPIN	18.48 (11.05)	22.82 (12.46)	1.48 (63)	.14
STAI-T	38.39 (10.77)	41.44 (11.63)	1.10 (63)	.28
FNE	15.12 (7.99)	18.79 (7.91)	1.88 (63)	.07
SIAS	21.58 (12.88)	26.37 (13.01)	1.49 (63)	.14
HADS Depression Subscale	5.29 (2.66)	6.03 (2.97)	1.05 (63)	.30
Current medication use (%)	9.7	11.8		

Note. Standard deviations in parenthesis. % British compared to an aggregate of non-British origins. SPIN = Social Phobia Inventory. STAI-T = State Trait Anxiety Inventory Trait version. FNE = Fear of Negative Evaluation Scale. SIAS = Social Interaction Anxiety Scale. SBQ= Social Behaviour Questionnaire. HADS = Hospital Anxiety and Depression Inventory = T=Test score. (df) = Degrees of Freedom. P = Significance value.

*p< .05.

The Effect of Face Training on General Face Classifications

A comparison of number of faces identified as negative at the pre-training test phase of the training program revealed no significant differences between the groups (see Table 3). The proportion of faces classified as angry was entered into a Greenhouse-Geisser corrected 2 (Group: threat, non-threat) x 2 (Time: pre-training, post-training) repeated measures ANOVA. There were

significant main effects of Time [F (1,63) = 10.63, p < .001, partial η^2 = .14] and Group [F (1,63) = 8.33, p = .002, η^2 = .12]. This was qualified by a significant Group x Time interaction F (1,64) = 26.53, p < .001, η^2 = .30. Separate follow-up analyses were conducted. Independent samples t-tests revealed that groups did not differ significantly at pre-training in the number of threat interpretations endorsed, t (63) = 0.40, p =.69. However at post-training assessment the threat trained group endorsed significantly more angry interpretations than the non-threat trained group t (63) = 4.39, p < .001, d = 1.09. Additional separate pairwise comparisons were conducted within each group. The CBM-I-threat group showed a significant increase from pre-training to post-training in the number of faces classified as angry, t (33) = 8.52, p < .001, d = 0.84. In contrast, the CBM-I-non-threat group did not differ between pre-training and post-training in the number of faces classified as angry, t (31) = 1.18, p =.25, (see Figure 6).

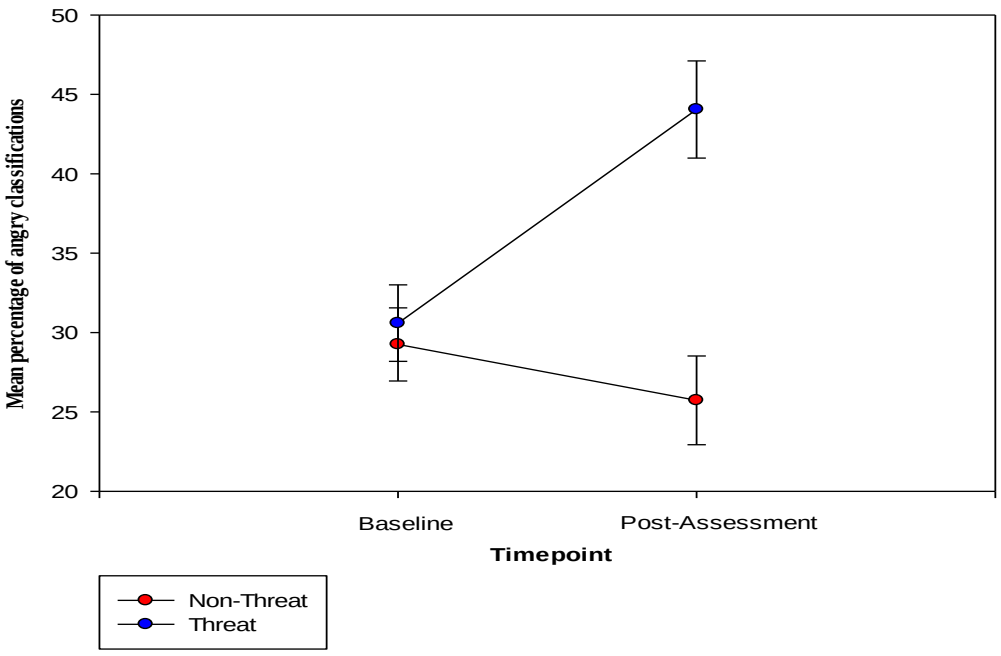

Figure 6. Mean anger responses for both groups before and after CBM-I training.

The Effects of Face Training on Classifying Moderately Neutral, Ambiguous and Moderately Angry Expressions

In order to assess the sensitivity of CBM-I training, face classification scores were computed for expressions that were either: moderately neutral (first five facial stimuli in the morphological sequence of fifteen delineated faces), ambiguous (second five faces in the sequence) and moderately angry (final five faces showing the greatest emotional response: see Appendix I). Proportion of anger classifications were entered into a mixed design ANOVA with Greenhouse-Geisser correction, with Group (threat, non-threat) as a between subjects factor and Time (pre-training, post-training) and Intensity (moderately neutral, ambiguous, moderately angry) as within subject factors. The results showed significant main effects of Group, [$F(1,63) = 8.33$, $p = .005$, $\eta^2 = .12$] Time, [$F(1, 105.82) = 9.12$, $p = .004$, $\eta^2 = .13$] and Intensity [$F(1.78, 105.82) = 438.39$, $p < .001$, $\eta^2 = .87$]. This was further qualified by a significant Group x Time x Intensity interaction, $F(1.78,105.82) = 6.90$, $p = .02$, $\eta^2 = .10$. Follow-up univariate analyses conducted within each group revealed that the threat trained group showed significant increases pre-post training in threat interpretations for ambiguous [$t(33) = 4.65$, $p < .001$, $d = 0.74$] and moderately angry [$t(33) = 6.29$, $p < .001$, $d = 0.79$] levels of intensity. When facial expressions were moderately neutral their ratings did not differ from baseline, $t(33) = 1.74$, $p = .09$).

The non-threat trained group's classifications of angry or neutral faces did not differ at post-training from pre-training when facial expressions were of a moderately neutral [$t(30) = 1.05$, $p = .3$], or moderately angry [$t(30) = 0.28$, $p = .78$) level of intensity. The non-threat trained group did make significantly fewer classifications of faces as angry when facial expressions were ambiguous, $t(30) = 2.61$, $p = .01$, $d = 0.5$.

Further post-hoc between groups analysis revealed that groups' classifications of facial expressions as angry (see Table 3) significantly differed from pre-training to post-training when shown faces were ambiguous [$t(63) = 5.12$, $p < .001$, $d = 1.09$], and moderately angry [$t(63) =$

2.61, p = .01, d = 1.00] levels of intensity. Groups did not differ at moderately neutral levels of intensity although the result was approaching significance, t (63) = 1.95, p = .056.

Table 3

Interpretative Bias Training Data[a]

		Non-Threat (31)		Threat (34)			
Time	Intensity	M	SD	M	SD	t (df)	P
Pre	Moderately neutral	1.94	(4.09)	1.24	(2.13)	0.87 (63)	.39
	Ambiguous	8.10	(6.19)	7.65	(6.31)	0.29 (63)	.77
	Moderately angry	19.21	(7.77)	21.70	(8.81)	1.20 (63)	.23
	Overall	29.25	(12.83)	30.59	(14.04)	0.40 (63)	.69
Post	Moderately neutral	1.08	(2.62)	2.48	(4.50)	1.52 (63)	.13
	Ambiguous	4.87	(6.27)	13.40	(9.03)	4.38 (63)	.00**
	Moderately angry	19.78	(9.31)	28.17	(7.59)	3.99 (63)	.00**
	Overall	25.73	(15.56)	44.05	(17.86)	4.39 (63)	.00**

Note. M = Mean. SD = Standard Deviation.

[a] number of angry responses were recoded into percentages for clarity. As the number of neutral responses follows the relationship of (1-number of angry responses) they are not reported.

*p< .05. ** p < .01.

Effects of CBM-I on Mood: A Comparison of Mood Before and After CBM-I Training

Ratings of state anxiety and positive affect as measured by the VAMS (see Table 4) were taken immediately following CBM-I training in order to see if changes observed in interpretative bias occurred independent of changes in state affect. A Greenhouse Geisser corrected repeated measures ANOVA with VAMS state anxiety and positive affect as the dependent variables, revealed that for state anxiety, there was a main effect of Time, F (1,63) = 11.10, p = .001, η^2 = .15.

Participants' anxiety ratings decreased after completing the training program compared to baseline. The Time x Condition interaction was non-significant, F (1,63) = 0.98, p = .33, thus this decrease was not significantly different between groups. For positive affect ratings there was a significant main effect of Time, F (1,63) = 24.71, p < .001, η^2 = .28. characterised by lower levels of positive affect post-training. The decrease was similar for both groups [Time x Condition interaction, F (1,63) = 0.50, p = .50].

Effects of CBM-I on Speech Anxiety

Change in self-report social anxiety symptoms. Ratings of state anxiety and positive affect were taken at three time points during the social stressor task: before the task was introduced (baseline phase), after the task was introduced but before participants were given their preparation time (pre-speech) and immediately following the completion of the speech (post-speech phase: See Table 4 for descriptive statistics). Independent samples t-tests showed that groups did not significantly differ at baseline on measures of state anxiety measured by STAI-S, t (63) = 0.91, p > .05, overall state anxiety measured by the VAMS, t (63) = 0.41, p > .05, or state positive affect, t (63) = 0.36, p > .05. This indicates that state mood was equivalent between both groups before the task was introduced.

A 3 (Time: baseline, pre-speech, post-speech) x 2 (Group: threat, non-threat) repeated measures ANOVA with Greenhouse-Geisser correction was conducted on state anxiety ratings as measured by STAI-S scores which revealed a significant main effect of Time, F (1.55, 97.31) = 24.52, p < .001, η^2 = .28. However the main effect of Group was non-significant, F (1,63) = 1.33, p = .25. The Time x Group interaction was also non-significant, F (1.55, 97.31) = 0.31, p = .68. This suggests that although the social stressor task was successful at increasing state anxiety, groups did not significantly differ in their response to the social stressor (see Figure 8).

Physiological. Physiological measures for two participants were not obtained as their arms were too big for the blood pressure monitor cuff. A multifactorial analysis of variance (MANOVA) was conducted to assess if there was a difference over Time (Baseline, pre-speech, post-speech) between participants in the threat trained group and participants in the non-threat trained group in the amount of change in their physiological measures scores of heart rate, systolic blood pressure and diastolic blood pressure. There were significant multivariate effects of Time, $F(6,56) = 7.63$, $p < .001$, $\eta^2 = .45$. The Group x Time interaction [$F(6,56) = 1.47$, $p = .23$] was non-significant. Follow up repeated measures ANOVA's revealed that the significant main effect of Time held true only for the dependent variables of systolic blood pressure [$F = (2,122) = 18.66$, $p < .001$, $\eta^2 = .23$] and diastolic blood pressure [$F = (2, 122) = 8.22$, $p = .001$, $\eta^2 = .12$], (see Table 3).

Table 4

Self-Report and Physiological Data

		Non-Threat		Threat			
Variable	Time	M	SD	M	SD	t (df)	P
STAI-S	Base	37.58	(8.75)	39.61	(9.08)	0.91 (63)	.36
	Pre	40.94	(9.96)	43.68	(11.42)	1.03 (63)	.31
	Post	42.81	(9.59)	46.18	(12.25)	1.23 (63)	.22
VAMS	Base	69.15	(45.89)	64.78	(41.96)	0.40 (63)	.69
Anxiety	Pre	113.12	(54.42)	124.46	(64.98)	0.76 (63)	.45
	Post	102.97	(58.67)	123.35	(71.60)	1.25 (63)	.22
VAMS	Base	63.48	(19.32)	64.92	(12.86)	0.36 (63)	.72
Positive Affect	Pre	56.68	(20.64)	55.96	(19.54)	0.14 (63)	.89
	Post	54.23	(19.76)	50.00	(20.46)	0.85 (63)	.40
HR	Base	75.94	(11.23)	76.34	(9.45)	0.16 (61)	.88
	Pre	75.48	(10.33)	76.56	(9.61)	0.43 (61)	.67
	Post	74.55	(12.74)	77.91	(10.85)	1.13 (61)	.26
BP	Base	117.61	(13.49)	116.84	(13.78)	0.22 (61)	.82
Systolic	Pre	117.16	(13.65)	114.53	(15.47)	0.72 (61)	.48
	Post	126.19	(15.04)	120.47	(13.09)	1.61 (61)	.11
BP	Base	69.58	(11.00)	67.88	(10.28)	0.63 (61)	.53
Diastolic	Pre	68.90	(8.35)	68.44	(13.36)	0.17 (61)	.87
	Post	73.32	(7.11)	72.16	(9.81)	0.54 (61)	.59
Speech VAS Anxiety	Pre	36.50	(22.94)	32.45	(16.09)	0.83 (63)	.41
	Post	34.81	(22.16)	35.06	(22.71)	0.72 (63)	.97
Speech VAS Performance	Pre	47.35	(18.44)	35.16	(17.60)	2.73 (63)	.01*
	Post	31.59	(24.65)	22.25	(22.31)	1.60 (63)	.11

Note. Base = Baseline Ant = Anticipatory phase of social stressor task. Post =Post speech phase of social stressor task. M = Mean. SD = Standard Deviation. (df) = Degrees of Freedom. STAI-S = State Trait Anxiety Inventory State version score. VAMS = visual analogue mood scale. HR = heart rate. BP = Blood pressure. VAS = Visual analogue scale.

*p< .05.

Evaluations of speech performance.

Anticipated and retrospective evaluations of speech performance. In order to see if estimates of subjective predicted anxiety and performance ratings and subsequent retrospective speech anxiety and performance ratings differed between groups separate Greenhouse-Geisser corrected repeated measures ANOVA's were conducted. There were no significant effects for the dependent variable of Anxiety (p's > .05). The dependent variable of Performance showed a significant main effect of Time [F (1,63) = 21.14, $p < .001$, $\eta^2 = .25$] and Group [F = (1,63) = 6.72, $p = .01$, $\eta^2 = .10$]. This was not qualified by a significant Time x Group interaction, F = (1,63) = .21, p = .65. Inspection of the means revealed that participants in the non-threat trained group expected their performance to be significantly better than participants in the threat trained group, t (63) = 2.73, p = .008, d = 0.68.

Self-report and independent ratings of speech performance. Following completion of the speech, participants completed self-report ratings of speech performance. Independent raters completed the same scale to provide a behavioural measure for comparison. Scores were submitted to a Greenhouse-Geisser corrected 2 (Rater: self-report, independent rater) x 2 (Group: threat, non-threat) repeated measures ANOVA. There was a significant main effect of Rater, F (1,63) = 133.47, $p < .001$, $\eta^2 = .68$. This was not qualified by an interaction effect, F (1,63) = 2.31, p = .40. Overall, results suggest that independent raters were unable to distinguish anxiety symptoms between threat and non-threat trained participants in response to a mild social stressor. Equally, groups did not differ in self-report judgments of speech performance. Groups did however consistently report poorer speech performance in comparison to independent raters. Further analysis conducted at a subscale level (see Table 5) highlighted that groups significantly differed on 'General' items, with non-threat trained participants reporting significantly better performance, t (63) = 2.36, $p < .05$, d = 0.66.

Table 5

Speech Performance Scale Data

		Non-Threat		Threat			
Variable	Rater	M	SD	M	SD	t (df)	P
SPRS Total	SR	33.87	12.90	28.73	11.97	1.67 (63)	.10
	IR	49.81	10.84	47.21	11.97	.92 (63)	.36
SPRS General subscale	SR	7.48	4.16	5.18	3.72	2.36 (63)	.02*
	IR	11.52	5.70	10.59	5.69	.66 (63)	.51
SPRS Specific subscale	SR	26.39	9.20	23.55	9.12	1.25 (63)	.22
	IR	38.29	5.57	36.62	6.56	1.10 (63)	.27

Note. SPRS = Rapee and Lim (1992) Speech performance rating scale. SR = Self Report. IR = Independent rater. M = Mean. SD = Standard Deviation. (df) = Degrees of Freedom.

*p< .05.

Supplementary Analysis.

Associations between trait anxiety and response to training. The amount of change in interpretative bias scores (pre-training to post-training) and social anxiety measures were analysed using bivariate correlations. Results showed that the SPIN (r = .351, p = .004) the SIAS (r = .322, p = .009) and FNE (r = .354, p = .004) were all significantly positively correlated with the amount of change in interpretative bias scores. This indicates that participants experiencing greater levels of social anxiety were more likely to show greater changes in the interpretation of ambiguous faces following CBM-I training. Additional correlations were conducted separately within each group. Results showed that correlations remained significant for the CBM-I-non-threat group [SPIN (r = .401, p = .025), SIAS (r = .388, p = .031) and FNE (r = .355, p = .05)] although the effects disappeared for the CBM-I-threat group [SPIN (r = .211, p = .232), SIAS (r = .106, p = .549) and FNE (r = .187, p = .298)]. This suggests that for participants assigned to CBM-I-non-threat training,

those with greater levels of social anxiety were more likely to demonstrate training effects (i.e. their training bias was likely to shift towards neutral).

Further correlations examined associations between change in self-reported anxiety during the social stressor task and trait social anxiety scores. Results showed that the SPIN ($r = .430$, $p < .001$), the SIAS ($r = .322$, $p = .009$) and FNE ($r = .421$, $p = .001$) were all significantly positively correlated with the amount of change in self-reported anxiety from baseline to the pre-speech phase of the social stressor task (i.e. participants with higher levels of trait anxiety reported a greater response to the stressor).

Associations between change in training and change in mood. A further set of correlations examined the relationship between the degree to which training had been successful, (as measured by the difference between the number of anger responses classified in the post-training assessment compared to the pre-training assessment) and the magnitude of change in state anxiety from the baseline – pre-speech phase of the social stressor task. Results indicated that there was a strong trend in the expected direction, $r = .24$, $p = .054$. Additional correlations conducted at a group level revealed that there was a significant positive relationship between degree of training and change in social anxiety scores for participants in the CBM-I-non-threat group, $r = .358$, $p = .048$. This effect disappeared when examining the CBM-I-threat groups scores, $r = .066$, $p = .712$. This suggests that for participants assigned to CBM-I-non-threat training, those that showed the strongest training effects were likely to have smaller increases in state anxiety when introduced to the social stressor task.

Awareness check. Finally, in order to explore the validity of the training program. An analysis of post-hoc control questions was conducted. To the question, *"Do you think you were assigned to the training condition?"* 55.4% of participants believed they received active training. The number of participants that believed they received active training did not differ between groups

x^2 (1, N=65) = 0.31, p = .86. This indicates that participants were no better than chance at guessing if the program they completed was designed to alter their perception. Of the proportion of participants that believed they were assigned to active training, 65.7% correctly identified which training group they were assigned. The CBM-I-non-threat training group were significantly better at correctly identifying their assigned condition compared to the CBM-I-threat training group x^2 (3, N =36) = 10.718, p = .01.

Discussion

The main aim of the present study was to explore the effectiveness of a novel CBM-I procedure that used delineated facial expressions as stimuli in order to train individuals to view ambiguous facial expressions as either more threatening (angry), or less threatening (neutral). The primary manipulation involved giving biased feedback during training trials. Secondary aims of the study included the exploration of training effects on anxiety, autonomic arousal and perceived performance during a social stressor (speech task).

The main findings from the present study were that participants receiving CBM-I-threat training endorsed a significantly greater proportion of facial expressions as angry compared to participants receiving CBM-I-non-threat training following the intervention. In addition, the effects between the groups was large (d=1.09). Taken together this suggests the training program was successfully able to modify the threshold at which individuals' interpreted ambiguous facial expressions as either threatening or non-threatening.

A strength of the current study is the inclusion of a baseline measure of facial interpretative bias. This allowed the nature of the bias modification to be quantified. Results show that the threat-trained group demonstrated a significant increase in the number of faces identified as angry in the post-training assessment compared to their pre-training score. This suggests that CBM-I training successfully induced a negative interpretative bias in threat-trained participants. An examination of the non-threat trained participants data shows that the number of non-threat items endorsed did not significantly differ from pre-post training. It appears the non-threat trained group were resistant to change. These findings are consistent with the CBM-I literature using verbal stimuli (Grey & Mathews, 2000 Experiment 4; Mathews & Mackintosh, 2000 Experiment 3). Similar to other studies that have included a baseline condition, results suggest that the unselected participants tend to exhibit a benign/positive inferential bias that might be at ceiling i.e. could not be trained further.

In order to examine the sensitivity of the training program, results were reanalysed by intensity of facial expression (moderately neutral, ambiguous, and moderately angry). The findings highlight that the number of facial expressions identified as angry significantly differed at post-assessment between threat trained and non-threat trained participants when faces were ambiguous or moderately angry. Exploring each groups' change scores relative to baseline revealed that participants in the threat-trained group made significantly more threat interpretations of ambiguous and moderately angry facial expressions. Of most interest, is the finding that the non-threat trained group made significantly more non-threat (neutral) interpretations in the post-training assessment compared to baseline scores when facial expressions were ambiguous only. This suggests that the non-threat training program was somewhat successful at modifying the threshold at which participants viewed ambiguous faces as non-threatening. Importantly, training only occurred when faces were ambiguous.

Competing resources theory suggests that when there is a sufficient level of ambiguity, more than one explanation of meaning is available (Macleod & Mathews, 1991). However this will depend upon context, recency of priming and previous frequency of usage (Grey & Mathews, 2000). Amir and Foa (2001) hypothesised that this process occurs unconsciously, and that possible alternative meanings complete with each other via mutual inhibition for entry into awareness. In addition, the theory posits that previous meanings that have been repeatedly accessed are more likely to take dominance in similar situations in the future. This process accounts for how socially anxious individuals learn to view ambiguous social information in a negative light. For socially anxious individuals, the negative explanation seems to take dominance over positive/benign interpretations, which makes it more likely in future, that similar negative interpretations will be more readily accessible.

The aim of CBM-I training programs therefore, is to break this cycle by repeatedly exposing individuals to benign/positive interpretations of ambiguous social information. It is hypothesised

that repeated exposure makes it more likely that alternative positive/benign interpretations will be stronger and take preference in the interpretation stage of processing. This process is seen in clinical practice. For example, during cognitive restructuring (as part of a CBT intervention) patient and therapist work to learn to recognise and eventually alter seemingly automatic negative thoughts. This study suggests that the meanings of sufficiently ambiguous facial images can be trained through repeated exposure.

This study purposely used an unselected sample of undergraduate students. It was expected that training effects would be likely to be identified in individuals not already characterised by a negative interpretative bias and our baseline data suggests that this was the case. In addition, supplementary analysis revealed that the success of the CBM-I program to train individuals to view ambiguous facial expressions as more neutral/benign was related to social anxiety scores. Socially anxious individuals in the CBM-I-non-threat group demonstrated the greatest training effects. Future research should be conducted using high anxious populations to explore if CBM-I-non-threat training can produce positive training effects in socially anxious individuals that hold a negative interpretative bias.

Effects on Emotional Vulnerability

This study was successfully able to induce an anxiety response by using an impromptu speech task as a social stressor. The main findings were that following CBM-I training, groups significantly differed in their expected and post-event judgements of speech performance.

This study included a physiological measure of arousal. Systolic and diastolic blood pressure readings significantly increased from baseline to post-speech. The increase in blood pressure was not significantly different between threat and non-threat trained participants. This suggests that the speech task was successful at inducing a stress response. It is unsurprising that groups did not significantly differ in arousal levels as evidence suggests that people differ on the

subjective experience of anxiety rather than quantitative autonomic differences (Staugaard, 2010). This would support psychological models that emphasise dysfunctional patterns of thinking and cognitive biases in the maintenance of social anxiety.

Previous CBM-I research has explored the effects of verbal CBM-I training interventions on state anxiety. It has been found that training threatening resolutions of ambiguous material has led to a subsequent increase in self-reported state anxiety following training (Salemink, van den Hout, et al., 2010b). In fact, Holmes, Mathews, Dalgleish, and Macintosh (2006) found that imagery and the instructions to actively imagine a socially threatening scenario that was read to participants was the key process involved in producing increases in state anxiety as a result of CBM-I. The current study found that both groups reported significant decreases in state anxiety and positive affect. This finding does not fit with the literature on verbal CBM-I procedures. Perhaps the use of facial stimuli may account for the differences observed. It has been argued elsewhere that static photographs represent "safe" stimuli because they do not respond to the beholder (Staugaard, 2010). If the resolution of ambiguous facial stimuli as threatening was not perceived as personally relevant to the participants, this could explain the absence of an anxiety response to threatening faces. Perhaps participants viewed the task as irrelevant and therefore monotonous, thus decreasing anxiety and positive affect (i.e. producing a flattened affect). Future studies could lead participants to believe they would have to engage in a social interaction with the person whose face is used in the training program in order to increase the personal relevance of the training materials.

The study found no evidence that training would differentially affect groups' state anxiety during a social stressor task (hypothesis 2). Results showed that in both groups, state anxiety significantly increased in response to the speech task, with no difference between training groups. Previous research has demonstrated that interpretation bias mediates state anxiety levels in socially anxious individuals in response to social evaluative threat (Impromptu speech: Beard & Amir, 2010). However, Beard et al. used a socially anxious population of undergraduate students.

Furthermore, cognitive models of social phobia do not make predictions of how non-anxious individuals respond to social evaluative threat. Given that interpretative bias plays a causal role in the maintenance of social phobia (Wilson, et al., 2006), it was expected that an induction of an interpretative bias should affect state anxiety levels in response to social threat (with anxiety increasing significantly less in the 'non-threat' training condition).

Given the malleability of interpretative biases, it is possible that training effects did not endure long enough to exert any influence on state anxiety during the speech task. However, this explanation seems unlikely given that interpretative biases induced by a single sessions of verbal CBM-I training have been shown to last for 24 hours (Yiend, et al., 2005). Nevertheless, future studies should examine the duration of training effects by manipulating the time delay of administering the post-training assessment test of interpretative bias.

The lack of significant differences in emotional vulnerability between threat trained and non-threat trained participants is not uncommon within the literature. Standage, Ashwin and Fox (2009*)* used a similar procedure. They successfully induced a positive and negative interpretation bias in a sample of 48 undergraduate students with medium levels of social anxiety through verbal CBM-I training. Participants were then informed they would have to give an impromptu speech. The authors found that positively and negatively trained participants did not significantly differ in levels of self-reported social anxiety in response to a speech task.

The current study also examined how a socially stressful task would affect judgments of speech performance. Results showed that non-threat trained participants expected their speech performance to be significantly better than participants who were threat trained[5]. This finding should be interpreted with caution as it was measured by the use of a single visual analogue scale.

[5] Based on results from visual analogue scales measuring anticipated performance and anxiety with actual performance and anxiety ratings taken post-speech.

Nevertheless, this method of measuring social evaluative judgements have been successfully used elsewhere (Hirsch, et al., 2007). In addition, results from the Rapee and Lim Speech Performance Scale provide some convergent evidence. The self-reported speech performance scale showed that although there were no significant differences when comparing total scores, groups significantly differed on the 'general' subscale. The general subscale measures the way participants think significant others evaluate their performance. Results showed that threat trained participants believed significant others evaluated their speech performance significantly more negatively than non-threat trained participants.

One explanation for this could be that training led participants to develop a general production rule (a process of assigning similar learnt meanings through training to subsequent novel stimuli within the same category e.g. socially ambiguous information) to view novel social stimuli in a negative light. This could explain why threat trained participants expected their performance to be significantly poorer. Cognitive models of social phobia would support this contention which suggest socially anxious individuals make exaggerated negative estimates of cost and probability in stressful situations (Foa, et al., 1996). However, results are somewhat mixed and any conclusions drawn are tentative. Further research is required to understand the underlying cognitive mechanisms of facial CBM-I training. Furthermore, research could also include a no-treatment control group in order to establish a baseline measure of judgements following social evaluative threat (speech task). In addition, the use of audience members during the speech phase may increase the ecological validity of the task.

Beard *et al.* (2011) found significant differences in self-reported anxiety scores in response to an impromptu speech between individuals trained using a combined attentional and interpretative bias modification program compared to participants in a placebo control group. The main difference in this study was that participants received eight sessions of training. In addition, participants completed a speech at two time-points in order to establish a baseline. Perhaps the

increased training, which led to trait reductions in anxiety, is necessary to produce transfer effects to emotional vulnerability in socially stressful situations.

In the current study, a supplementary analysis explored the relationship between training, social anxiety, and the anxiety response to the mild social stressor. Interestingly, the success of training correlated significantly with both level of trait social anxiety, and with the degree of change in state anxiety in response to the speech task. However, this was only apparent in the CBM-I-non-threat group. One explanation for this could be that the CBM-I-threat training worked effectively with the majority of the sample (who were not characterised by a negative interpretation bias prior to training): therefore, there was less opportunity for individual differences to occur. However, a co-variation in the CBM-I-non-threat trained group may reflect greater individual differences in response to training. Whilst the majority of participants already held a benign interpretation bias and were unlikely to be further trained to favour neutral stimuli, the results suggest that those high in trait social anxiety were more likely to show stronger training effects. Furthermore, a significant relationship was also identified between the magnitude of change in training (in the preferred direction towards neutral) and changes in state anxiety, such that the greater effects of CBM-I-non-threat training, the greater the buffer effect on emotional reactivity to the mild social stressor. Taken together, these findings suggest that CBM-I-non-threat training may modify negative interpretative biases in socially anxious individuals. Furthermore, CBM-I-non-threat training may also moderate state anxiety levels when socially anxious individuals experience social evaluative threat. Further research should therefore explore the benefits of CBM-I-non-threat training using a socially anxious population.

Limitations

In future studies, the training material could be improved. This study used one delineated face. This would limit the opportunity to generalise training to ecologically valid experimental tasks like the social stressor task. It will be important for future studies to increase the number of

different facial stimuli used in the training procedure. In order to improve the effectiveness of the procedure, it may also be necessary to adjust the sensitivity of facial images displayed in order to increase the number of faces perceived as ambiguous. In addition, the same stimuli were used in the post-training assessment. Previous research has shown that when using the Mathews and Mackintosh (2000) CBM-I training paradigm, alternative tasks used to assess interpretative bias (that are different from the training procedure), have been unable to distinguish training effects in interpretative bias between threat and non-threat trained groups. A criticism of the training procedure is whether training simply teaches participants to learn a pattern of responding that is reliant on a similar task to training to produce similar effects (method dependent learning strategy). In the current study, the absence of novel stimuli, or alternative method of measuring the effectiveness of training means that it is unclear if training produced a method dependent learning strategy, or led participants to produce a general production rule for perceiving threatening faces. Future studies should use previously unseen stimuli in the post-training assessment phase to explore this further.

Another factor outside the control of the study was that similar studies had been previously conducted within the University of Southampton, which deceived individuals into believing they would have to perform a speech. Subsequently some participants in the current study reported they did not anticipate they would be expected to complete a speech and were therefore less anxious in the pre-speech phase of the speech procedure. However, the proportion of students that reported this was minimal (3%). It is unlikely that this observation affected the overall results of the social stressor task[6].

[6] An analysis conducted after excluding the sub-group that reported they had completed a similar experiment did not alter any findings. However, it is unclear how many students completed similar experiments that used deception and did not mention it to the experimenter in their debriefing session.

Clinical Implications

Whilst the use of facial stimuli as a CBM-I technique requires replication and further research, findings suggest that the program could be used in similar ways to other CBM-I procedures: For example, as an adjunctive treatment to CBT for social phobia and in combination with verbal CBM-I procedures. Furthermore, it may be that the program could be improved by using images personally relevant to socially anxious individuals. The clinician would be able to do some preparatory work with patients who avoid certain people or situations by firstly exposing them to images of that person. The program could also serve the purpose of being a first step in a graded hierarchy to individuals' feared situations as well as altering their interpretation of individuals whom they fear could evaluate them negatively, by altering the threshold at which they confirm that the face of an individual is threatening.

Summary and Conclusions

Overall, this study is the first to provide preliminary evidence for the use of facial stimuli in the cognitive modification of interpretative biases in relation to social anxiety. More research is needed to ascertain if this method could be successfully used with a clinical population and potentially become a viable adjunctive treatment option. However, preliminary results suggest that ambiguous facial stimuli can be used to train participants to alter the degree to which they judge ambiguous faces as threatening, and that individuals with elevated levels of social anxiety may be more receptive to training. Finally, these findings suggest that face training may help reduce anticipated and retrospective negative evaluations of social performance.

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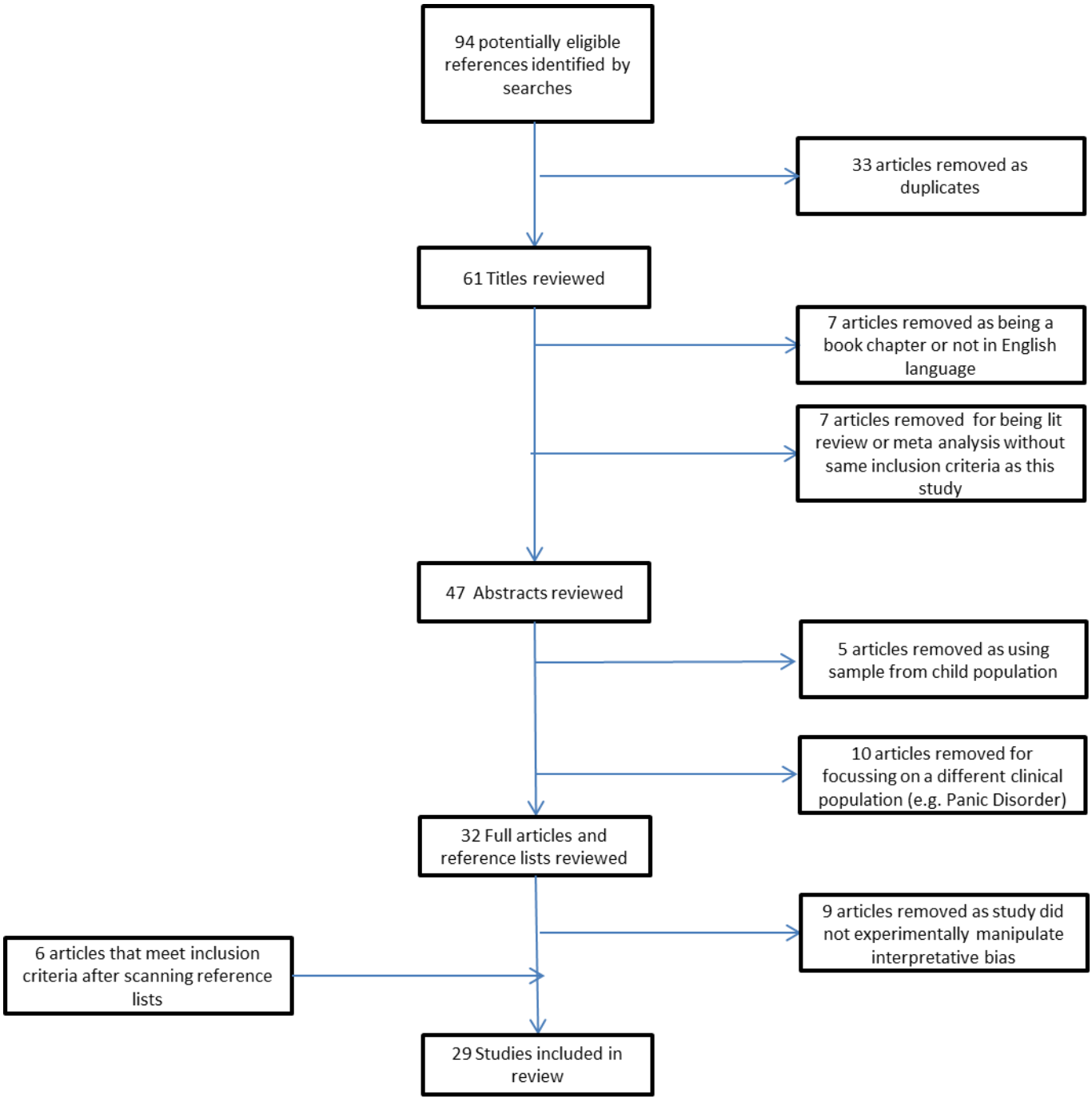
Appendices

Appendix A

Flow Chart of Search Strategy



Appendix B

Ethics Confirmation

Submission Number 3858:

This email is to confirm that the amendment request to your ethics form (Effects of emotional face training on cognition and emotion processing (Amendment 1))has been approved by the Ethics Committee.

You can begin your research unless you are still awaiting specific Health and Safety approval (e.g. for a Genetic or Biological Materials Risk Assessment)

Comments

None

Click here to view your submission

ERGO : Ethics and Research Governance Online

http://www.ergo.soton.ac.uk

DO NOT REPLY TO THIS EMAIL

Appendix C

Study Advert

Psychobook Advert v2 (01/10/12).

Effects of emotional face training on cognition and emotion processing!

We are recruiting healthy male and female volunteers, aged 18 years and above, to participate in our research investigating the effects of emotional face training on cognition and emotion processing (from 1st Nov 2012 to 29th of March 2013).

You will complete various questionnaire measures and computerized reaction time/classification tasks. At the end of the session, you will be asked to give a short 5-minute presentation.

The study will last two hours and you will earn 8 credits for your participation.

If you are interested in participating please sign-up using Psychobook or if you have any further queries contact me, Ross Godfree at rcpg1g10@soton.ac.uk

Thank you.

Appendix D

Speech Instructions

Shortly you will be asked to give a 5-minute speech in front of the video camera. You will be presented with a topic chosen by me. You will then have 2 minutes to prepare your speech. You may use the pen and paper that I will provide to help you prepare. After your 2 minutes preparation time I will collect your pen and paper so that you can't see it and position you in front of the camera. The aim of the task is to use the full 5 minutes to deliver your Speech. Please aim to deliver the speech to me and not the camera. Your speech is being recorded so that it can be judged by myself and also two doctoral level trainee psychologists at a later date for its content and quality.

Appendix E

Exit Questionnaire

Effects of emotional face training on cognition and emotion processing

Debriefing Statement (v3, 28/09/12)

The aim of this research was to see if we could train to modify the perception of emotional facial interpretation and attentional processing through a facial modification training-feedback programme. It is expected participants in the training condition would increase the facial interpretive threshold level for emotionally ambiguous facial expressions towards the positive end and decrease attentional bias for negative facial stimuli compared to the control condition. The purpose of the social stressor (presentation) was to see whether the training had any effect on your physiological and psychological measures. Your data will help our understanding of interpretation and attentional biases in social anxiety disorder and how training can modify these biases in order to reduce the symptoms. Once again, results of this study will not include your name or any other identifying characteristics. The experiment did not use deception. You may have a copy of this summary if you wish and a summary of research findings once completed.

Q) Do you think you were assigned to the training condition? Please circle

YES **NO**

Please explain why?

_____

_____

_

Were you trained……..

Please circle

1. **To perceive faces as angry**
2. **To perceive faces as not angry**
3. **Not Sure**

If you have any further questions please contact me Ross Godfree at rcpg1g10@soton.ac.uk

Thank you for your participation in this research.

Signature _____ Date _____

Name

If you have questions about your rights as a participant in this research, or if you feel that you have been placed at risk, you may contact the Chair of the Ethics Committee, Psychology, University of Southampton, Southampton, SO17 1BJ. Phone: +44 (0)23 8059 4663, email slb1n10@soton.ac.uk

If you are interested in knowing more about this subject here are some useful articles.

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

Beard, C., & Amir, N. (2008). A multi-session interpretation modification program: changes in interpretation and social anxiety symptoms. *Behaviour Research and Therapy, 46,* 1135–1141.

Amir, N., Weber, G., Beard, C., Bomyea, J., & Taylor, C. T. (2009). The effect of a single-session attention modification program on response to a public speaking challenge in socially anxious individuals. *Journal of Abnormal Psychology, 117,* 860–868.

Appendix F

Mood repair script

Mood Repair Stimuli

Pensioner's radio sparks call to police

A bad-tempered German pensioner could be charged with wasting police time after complaining about loud music - from her own radio.

Elsie Weiss, 71, from Mulheim called police late at night to complain she couldn't sleep because of the noise.

But police who turned up to investigate found the music was coming from the pensioner's own radio that she had left on full volume in the back garden earlier in the day.

A police spokesman said they were considering sending her a bill for the time spent on the call and said:

"She had taken the radio outside and left it switched on full volume when she went inside," said a police spokesperson.

A neighbour said: "She always plays her music really loud - for once she gave herself a taste of her own medicine."

Computer error means £2.3 trillion electricity bill

A man has received a bill from British Gas for £2.3 trillion after a computer mix-up.

Brian Law got an initial bill for £59 last November, but when he forgot to pay it, they sent him a final demand.

The demand for £2,320,333,681,613 was supposed to be for electricity supplied to Mr Law's new home at Fartown, Huddersfield.

The company warned they would take him to court if he didn't pay the bill in full immediately, reports the Yorkshire Post.

But Mr Law said he made numerous efforts to have the matter sorted out, but British Gas failed to return phone calls having left his number with representatives.

He said: "Eventually, I decided the only way I was going to sort it out was to go to court and offer a penny a week."

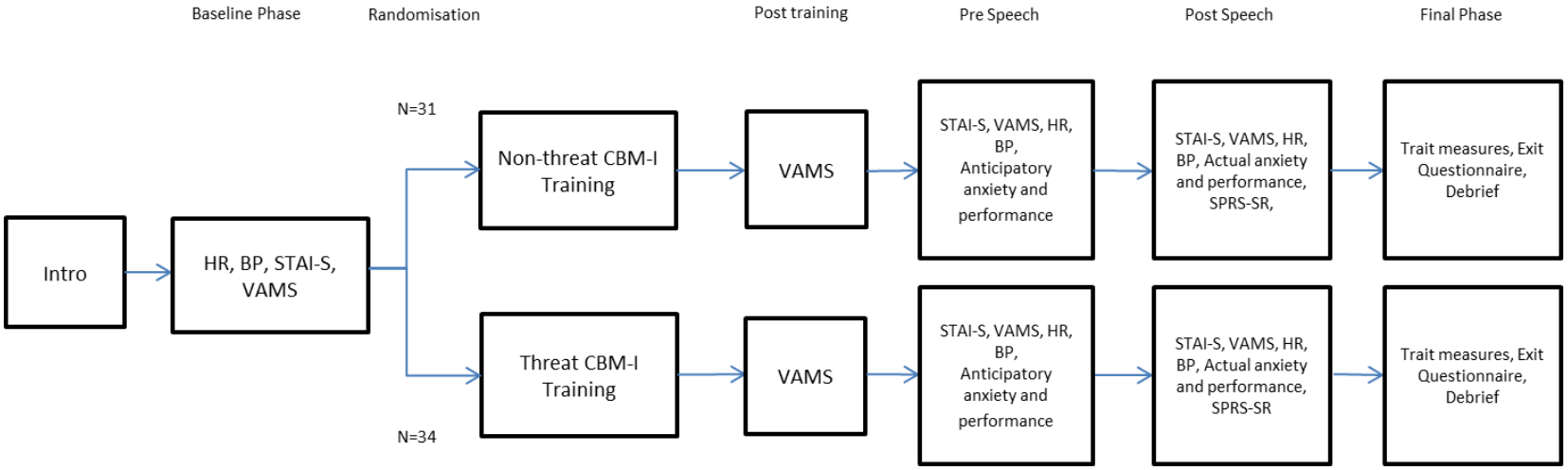
But after local media intervened, British Gas said there had been mistake with a computer mixing up the reference number for the property.

"We have agreed that I owe £59 and I will set up a direct debit for the future," said Mr Law.

A British Gas spokeswoman said Mr Law was told the bill was a "simple clerical mistake.

Appendix G

Procedural Flowchart



Note. HR = Heart rate. BP= Blood pressure. STAI-S = Spielberger State Trait Anxiety Inventory – State version. VAMS = Visual analogue mood scale. CBM-I = Cognitive bias modification of interpretation. SPRS-SR = Speech performance rating scale – self-report.

Appendix H

Appendix G

Percentages of Missing data

Variable	Percentage Missing (%)
STAI-S Baseline	0.08
STAI-S Pre Speech	0.15
STAI-S Post Speech	0.08
VAMS Baseline	0.21
VAMS Post Training	0
VAMS Pre Speech	0
VAMS Post Speech	0
Heart Rate – Baseline	3
Heart Rate – Pre Speech	3
Heart Rate – Post Speech	3
Systolic Blood Pressure- Baseline	3
Systolic Blood Pressure- Pre Speech	3
Systolic Blood Pressure- Post Speech	3
Diastolic Blood Pressure- Baseline	3
Diastolic Blood Pressure- Pre Speech	3
Diastolic Blood Pressure- Post Speech	3
Anticipated anxiety VAS	0
Actual anxiety VAS	0
Anticipated performance VAS	0
Actual performance VAS	0
Self-report speech performance scale	1.59
Independently rated speech performance scale	

Note. STAI-S = Spielberger state trait anxiety inventory state version. VAMS = Visual analogue mood scale. VAS = Visual analogue scale.

Appendix I

CBM-I Facial Stimuli