Do Cognitive Biases to Negative Information Causally Contribute to Diminished Anxiety Dissipation?

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THESIS DECLARATION

I, Stephanie Anne Stevens, certify that:

This thesis has been substantially accomplished during enrolment in the degree.

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ABSTRACT

Elevated Dispositional Anxiety is characterised by an increased likelihood to experience heightened state anxiety at any point in time. This can be the result of two distinct pathways to heightened state anxiety. One pathway is through a heightened readiness to experience an increase in state anxiety in response to a stressor, which is referred to here as Anxiety Reactivity. Another pathway is through experiencing a slower rate of decline in state anxiety following its evocation, and this is referred to here as Anxiety Dissipation. It is important to distinguish the mechanisms that causally contribute to each of these patterns of heightened state anxiety in order to determine best procedure for reducing Dispositional Anxiety.

There is currently strong evidence to suggest that information processing biases in attention and interpretation, specifically attentional bias towards negative information and negative interpretation bias, causally contribute to increased Anxiety Reactivity. This has been revealed in studies using Cognitive Bias Modification (CBM) procedures for both attentional bias (CBM-A) and interpretation bias (CBM-I). These studies have shown that the successful modification of attentional bias to negative information and negative interpretation bias serves to produce a group difference in Anxiety Reactivity. Specifically, individuals who are trained using CBM-A procedures to selectively attend away from negative information, or who are trained using CBM-I procedures to impose less negative interpretations on ambiguous information, show reduced elevations in state anxiety in response to subsequent stressors as compared to individuals assigned to a no-training control condition. Research to date has thus focused on Anxiety Reactivity and so it remains unknown whether variation in negative cognitive biases causally contribute to diminished Anxiety Dissipation. Therefore, the purpose of the current research program is twofold. Firstly, to determine whether variation in attentional bias
to negative information causally contributes to diminished Anxiety Dissipation, and secondly, to determine whether variation in negative interpretation bias causally contributes to diminished Anxiety Dissipation.

To accomplish these aims two separate research lines, each consisting of a series of experiments, were carried out. In each of these research lines the experiments commenced with an anxiety induction procedure, designed to increase state anxiety, followed by a CBM procedure and measurement of the rate of Anxiety Dissipation. In the first series of experiments participants completed a CBM-A procedure designed to reduce attention to negative information. In the second series of experiments participants completed a CBM-I procedure designed to reduce negative interpretations of ambiguity. If variation in attentional bias to negative information or negative interpretation bias causally contributes to diminished Anxiety Dissipation then the successful manipulation of these biases through the CBM procedure will impact on the rate of Anxiety Dissipation.

In the first series of experiments addressing the impact of CBM-A on diminished Anxiety Dissipation, the intended manipulation of attention bias using a conventional Dot Probe CBM procedure was not successful in the initial experiments. Therefore, the Emotion-in-Motion CBM-A manipulation was introduced and this proved effective in manipulating attentional bias. However, no evidence was obtained in these experiments that attentional bias to negative information causally contributes to diminished Anxiety Dissipation. In the second series of experiments addressing the impact of CBM-I on diminished Anxiety Dissipation, the CBM-I procedure was consistently successful in manipulating patterns of negative interpretation bias. There was also evidence that the successful manipulation of interpretation bias elicited a trend level differential decline in state anxiety in the final study. This provides tentative
support that variation in interpretation bias can make a causal contribution to
diminished Anxiety Dissipation.

The limitations of the studies, the methodological, theoretical and applied
implications of the findings, and avenues for future research, are discussed throughout
the thesis and are returned to with more detail in the final discussion chapter of the
thesis.
# TABLE OF CONTENTS

Acknowledgments .......................................................................................................................... viii

Authorship Declaration ................................................................................................................. xi

Chapter 1: General Introduction ................................................................................................... 1

  General Introduction to the Research Theme .............................................................................. 2
  Anxious Disposition: Distinguishing Between Anxiety Reactivity and Anxiety Dissipation .......... 3
  Cognitive Models of Elevated Dispositional Anxiety ................................................................. 5
  Is Elevated Dispositional Anxiety Characterised by an Attentional Bias to Negative Information? ................................................................................................................................. 7
  Does Manipulating Attentional Bias Reduce Dispositional Anxiety? ............................................ 9
  Is Elevated Dispositional Anxiety Characterised by Negative Interpretation Bias? .................... 14
  Does Manipulating Interpretation Bias Reduce Dispositional Anxiety? ....................................... 16
  The Current Research Program: Using CBM to Target Anxiety Dissipation .............................. 21

Chapter 2: Does Attentional Bias to Negative Information Causally Contribute to Diminished Anxiety Dissipation in Socially Anxious Individuals? ................................................. 26

  Method ........................................................................................................................................ 31
    Participants ................................................................................................................................. 31
    Materials ................................................................................................................................... 31
    Procedure ................................................................................................................................... 37

  Results ......................................................................................................................................... 38
    Participant Characteristics at Test Time ..................................................................................... 38
    Did the CBM-A Procedure Successfully Induce a Group Difference in Attentional Bias to Negative Information? ............................................................................................................. 39
    Did the Stressor Evoke Heightened State Anxiety? ..................................................................... 41
    Did the Dot Probe CBM-A Manipulation Affect the Rate of Anxiety Dissipation? ......................... 42

  Discussion .................................................................................................................................... 43

Chapter 3: Does Attentional Bias to Negative Information Causally Contribute to Diminished Anxiety Dissipation in Test Anxious Individuals? ................................................................. 48

  Method ........................................................................................................................................ 52
    Participants ................................................................................................................................. 52
Chapter 4: Does Attentional Bias to Negative Information Causally Contribute to Diminished Anxiety Dissipation in Socially Anxious Individuals? Introducing the Emotion-in-Motion CBM-A Procedure

Method ................................................................. 76
Participants ............................................................. 76
Materials ................................................................. 77
Procedure ............................................................... 82
Results ................................................................. 83
Participant Characteristics at Test Time ......................................................... 83
Did the CBM-A Procedure Successfully Induce a Group Difference in Attentional Bias to Negative Information? ........................................... 84
Did the Stressor Evoke Heightened State Anxiety? ........................................... 85
Did the Emotion-in-Motion CBM-A Manipulation Affect the Rate of Anxiety Dissipation? ................................................................. 86
Discussion ................................................................ 88

Chapter 5: Does Negative Interpretation Bias Causally Contribute to Diminished Anxiety Dissipation in Socially Anxious Individuals? ......................................................... 95

Method ................................................................. 101
Participants ............................................................. 101
Materials ................................................................. 102
Procedure ............................................................... 110
Results ................................................................. 111
Participant Characteristics at Test Time ......................................................... 111
Did the CBM-I Procedure Successfully Induce a Group Difference in Negative Interpretation Bias? ................................................................. 112
Did the Stressor Evoke Heightened State Anxiety? ..........................117
Did the CBM-I Manipulation Affect the Rate of Anxiety Dissipation? ...118
Discussion ..........................................................................................119

Chapter 6: Does Negative Interpretation Bias Causally Contribute to Diminished Anxiety Dissipation in Test Anxious Individuals? .................................................................124

Method .............................................................................................129
Participants .....................................................................................129
Materials .......................................................................................130
Procedure ......................................................................................136
Results ............................................................................................137
Participant Characteristics at Test Time ...........................................137
Did the CBM-I Procedure Successfully Induce a Group Difference in Negative Interpretation Bias? .................................................................138
Did the Stressor Evoke Heightened State Anxiety? .........................141
Did the CBM-I Manipulation Affect the Rate of Anxiety Dissipation? ...142
Discussion ..........................................................................................145

Chapter 7: General Discussion ............................................................151

The Inconsistent Capacity of CBM Procedures to Induce a Group Difference in Cognitive Biases .................................................................153
The Effectiveness of CBM-A Procedures in Producing a Group Difference in Attentional Bias to Negative Information ........................154
Future Directions in Developing Effective CBM-A Tasks .................160
The Effectiveness of CBM-I Procedures in Producing a Group Difference in Negative Interpretation Bias ..................................................164
The Decline in State Anxiety Following its Evocation in Response to a Stressor ....165
Does Variability in Attentional Bias to Negative Information and Negative Interpretation Bias Causally Contribute to Variation in Anxiety Dissipation? ........168
The Causal Contribution of Negative Interpretation Bias to Diminished Anxiety Dissipation .................................................................169
Summary ............................................................................................174

References ..........................................................................................176

Appendix 1 ..........................................................................................186
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AUTHORSHIP DECLARATION

This thesis does not contain work that has been prepared for publication. The candidate played a significant role in all aspects of the studies reported within this thesis. This included experimental design and development, participant recruitment and testing, data entry, data analysis and interpretation, and the preparation and revision of the thesis. Development of the experimental tasks used in all experiments was conducted in collaboration with the candidate’s supervisor, Professor Colin MacLeod. Participant recruitment and testing for Experiment 3 was conducted in collaboration with Georgina Mann as part of her honours project. Revision of the thesis was conducted in collaboration with all the candidate’s supervisors, Professor Colin MacLeod, Professor Ernst Koster, and Dr Lies Notebaert.

Signature: [signature]

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Chapter 1: General Introduction
General Introduction to the Research Theme

Elevated Dispositional Anxiety is characterised by two patterns of anxiety states. These include increased Anxiety Reactivity which refers to individual differences in the degree to which anxiety elevates in response to a stressor, and Anxiety Dissipation which refers to individual differences in the rate at which anxiety declines following its evocation. Current literature examining the relationship between cognitive biases and elevated Dispositional Anxiety has revealed that attentional and interpretation biases causally contribute to the elevation of Dispositional Anxiety (Mathews & MacLeod, 2002). This has been consistently demonstrated by studies that have successfully induced a group difference in cognitive biases using Cognitive Bias Modification (CBM) procedures. These studies have shown that following the successful modification of cognitive biases, a group difference can be observed in Anxiety Reactivity (Mogoase, David, & Koster, 2014). However, the impact of such CBM procedures on Anxiety Dissipation remains unknown. The purpose of this research program is to determine whether cognitive biases, specifically attentional bias to negative information and negative interpretation bias, causally contribute to diminished Anxiety Dissipation. This will be carried out by testing whether successfully modifying these cognitive biases can increase the rate of Anxiety Dissipation, which could have both theoretical and applied implications.

This chapter will begin by describing the patterns of information processing that are associated with elevated Dispositional Anxiety and how these biases can be modified using tasks that have a contingency designed to encourage the processing of benign rather than negative information. Following this, evidence will also be presented to show that successfully inducing a group difference in attentional or interpretation
bias can subsequently reduce Anxiety Reactivity, while also highlighting the absence of any such research on Anxiety Dissipation. Based on these state of affairs, it will be argued that examining the causal relation between elevated Disposition Anxiety, cognitive biases and diminished Anxiety Dissipation is of paramount importance. Finally, the current research program will be outlined including the research aims and hypotheses, and structure of the thesis.

**Anxious Disposition: Distinguishing Between Anxiety Reactivity and Anxiety Dissipation**

A large proportion of the general population suffers from symptoms of anxiety as is reflected in the high prevalence rates of clinical anxiety disorders (Somers, Goldner, Waraich, & Hsu, 2006). Importantly, these anxiety disorders are often preceded and more present in individuals who have a stable disposition to respond with elevated state anxiety to novel and or stressful events (Spielberger, 2010). These individuals are referred to as having increased trait anxiety, or as termed here as elevated Dispositional Anxiety. The symptoms of elevated Dispositional Anxiety are characterised by an apprehension of the future, whereby symptoms are provoked through the knowledge and/or expectation of an upcoming situation that will cause the individual distress (i.e. a threat) because a negative event may occur (i.e. danger).

Individuals with elevated Dispositional Anxiety also spend a greater proportion of their time experiencing heightened state anxiety than individuals low in Dispositional Anxiety.

Logically, two patterns of heightened state anxiety that could lead to elevated Dispositional Anxiety can be discerned, namely increased Anxiety Reactivity and diminished Anxiety Dissipation. Anxiety Reactivity refers to individual differences in the degree to which state anxiety elevates in response to a stressor. Anxiety Dissipation
4 General Introduction

refers to individual differences in the rate at which state anxiety declines following its evocation. Individuals with elevated Dispositional Anxiety have the tendency to experience increased Anxiety Reactivity and diminished Anxiety Dissipation. This means that they have a heightened anxious reaction to anxiety provoking situations as compared to individuals low in Dispositional Anxiety, and this heightened state anxiety takes longer to decline as compared to individuals low in Dispositional Anxiety. To demonstrate these patterns of Dispositional Anxiety, two examples are provided below:

1. Someone high in disposition for social anxiety will experience fear when having to meet new people. Therefore, this person may experience an initial increase in anxiety symptoms when introduced to a stranger, and/or this heightened anxiety may persist throughout the conversation that follows. As a comparison, a person low in disposition to experience social anxiety may still feel those initial nerves when being introduced to someone new, but this will not be as significant as someone high in disposition to experience social anxiety. Likewise, the less dispositionally anxious person may not have these symptoms persist as their heightened state anxiety is more likely to have an increased rate of decline as compared to the more dispositionally anxious individual. This example shows that the initial anxious reaction to a stressor (Anxiety Reactivity), in this case meeting someone new, is greater for those individuals high in Dispositional Anxiety. Also, this rate at which this heightened state anxiety declines (Anxiety Dissipation) is decreased for those individuals high in Dispositional Anxiety.

2. A man high in Dispositional Anxiety who was instructed by his GP to undergo a prostate examination may experience heightened state anxiety in anticipation of an upcoming appointment. Again, a man low in Dispositional Anxiety will also be likely to experience worry when anticipating the upcoming appointment but the
heightened state anxiety is significantly greater for the man high in Dispositional Anxiety. For this man, arriving at the doctor’s office could be enough to evoke a heightened state anxious reaction (Anxiety Reactivity). This heightened state anxiety may then also persist following arrival at the doctor’s office and take a long time to go away, a lot longer than it would take a man with low Dispositional Anxiety whose nerves will likely dissipate at a steeper slope.

In both of these examples it is apparent that elevated Dispositional Anxiety is characterised by heightened state anxiety, and that both increased Anxiety Reactivity and diminished Anxiety Dissipation would each result in elevated Dispositional Anxiety. However, the casual contribution of diminished Anxiety Dissipation remains unknown. It becomes apparent that interventions targeting both increased Anxiety Reactivity and diminished Anxiety Dissipation could be extremely useful in improving the quality of life for the many individuals with elevated Dispositional Anxiety. In order to develop effective treatment techniques to target heightened state anxiety it is important to first understand the mechanisms that contribute to elevated Dispositional Anxiety.

**Cognitive Models of Elevated Dispositional Anxiety**

Cognitive models of elevated Dispositional Anxiety have consistently implicated cognitive biases that favour the processing of negative information including biased attention and biased interpretation (Beck, 1976, Bower, 1981; Simspn, 1984; Mogg & Bradley, 1998). Many cognitive models of Dispositional Anxiety have been based on an influential model proposed by Beck. He suggested that our reality is constructed through cognitive ‘schemas’, which embody an individual’s representation of prototypical situations (Beck, 1976; Beck et al., 1985; Beck & Clark, 1988). According to Beck’s model, information in the environment that is consistent with an
individual’s schema is more likely to be encoded than information that is inconsistent with their schema. This leads to biases of selective information processing in which individuals high in Dispositional Anxiety are more likely to process negative information than benign information. This model was the first explanation that elevated Dispositional Anxiety is characterised by attentional biases and interpretive biases favouring negative information.

Building on this and other earlier models (Williams, Watts, MacLeod & Mathews, 1988; Wells & Mathews 1994; Öhman, 1993) Mathews & Mackintosh (1998) developed a model of elevated Dispositional Anxiety called the Threat Evaluation System. This states attentional bias to negative information requires processing of two or more stimuli under competitive conditions. This model assumes that the demand of the situation, i.e. the threats present, influences the representation of the threat and distractor stimuli thus determining where attention is allocated. This model assumes that cognitive biases exist and more specifically that attentional bias to negative information causally contributes to elevated Dispositional Anxiety. Similarly, Eysenck, MacLeod & Mathews (1987) developed a model for interpretation bias. Their review highlighted an association between high trait anxiety and processing ambiguous information in a threatening way. While they offered alternative explanations for this phenomenon, it was concluded that the cognitive system is involved in stimulus interpretation and that interpretation bias is a function of trait anxiety. Here, it was suggested that negative interpretation bias is observed in individuals with elevated Dispositional Anxiety. These early cognitive models have provided explanations of the association between negative cognitive biases and elevated Dispositional Anxiety that has led to two predictions. One prediction is that individuals high in Dispositional Anxiety will show an attentional bias towards negative information and a negative interpretation bias. The other prediction is
that these cognitive biases will causally contribute to Dispositional Anxiety. The next two sections will provide evidence for these predictions in turn.

**Is Elevated Dispositional Anxiety Characterised by an Attentional Bias to Negative Information?**

Attentional bias to negative information refers to the tendency to preferentially attend to negative information rather than to benign or positive information (Mathews & MacLeod, 2002). Since models of anxiety-linked attentional bias were introduced, researchers have sought to empirically establish whether there is an association between elevated Dispositional Anxiety and attentional bias to negative information. Researchers have developed a myriad of paradigms to assess anxiety linked attentional bias to negative information. Some of these involve assessing the impact of task-irrelevant negative information on primary task performance, for example, the Stroop task. In the emotional Stroop task participants are presented with words and are required to name the colour the words are printed in as quickly as possible while ignoring the meaning of the word. The findings show that the meaning of the word does interfere with the speed of colour naming. In particular, individuals high in Dispositional Anxiety will be slower to name words that have negative meanings relative to the speed of colour naming neutral words (Yiend, 2010). However, in this task it is difficult to distinguish between orientation towards negative information other response factors, such as difficulty maintaining attention due to emotional arousal (Mathews & MacLeod, 1985; Watts, McKenna, Sharrack & Trezise, 1986).

Researchers have also presented both negative and benign (or positive) information in spatially separated locations and assessed the distribution of attention towards these sources of information, for example dichotic listening tasks (Mathews & MacLeod, 1986). A dichotic listening task requires participants to listen to two auditory
messages simultaneously and repeat out loud one of them while ignoring the other. Findings from this task have shown that individuals high in Dispositional Anxiety were better at detecting anxiety relevant stimuli compared to neutral ones, suggesting that this type of stimuli dominated attentional resources. Older versions of these tasks have had difficulty drawing conclusions about the allocation of attention as it was not possible to discern if the results reflected a mood-dependent response bias. To overcome the problems that arose with earlier tasks developed to assess attentional bias, the Dot Probe Task was created (Mathews, MacLeod & Tata, 1986).

The Dot Probe Task begins with presenting a pair of stimuli on a computer screen followed by a probe which the participant must identify. The stimulus pair typically consists of one negative and one benign stimulus. The probe often consists of two dots which appears angled to either the left or the right. The stimulus pair is presented briefly and then a probe appears in the location of either the benign or negative stimulus. Participants must discriminate the identity of the probe as quickly as possible. The latency to identify the probe is recorded on each trial. If attention is allocated to the negative stimulus, probe discrimination latencies will be faster for probes that appear in the location of the negative stimuli than for probes that appear in the location of the benign stimuli. Therefore, the speeding to probes in the locus of negative information relative to probes in the locus of benign information serves as a measure of attentional bias to negative information. Across many studies that have implemented this paradigm, findings have shown that individuals high in Dispositional Anxiety, or with diagnosed clinical anxiety, are disproportionately speeded to discriminate probes in the vicinity of negative stimuli rather than benign stimuli, as compared to individuals low in Dispositional Anxiety (Mathews & MacLeod, 2002; MacLeod & Mathews, 2012). This earlier research was very important in providing
evidence for an association between attentional bias to negative information and elevated Dispositional Anxiety, but it did not reveal the causal nature of this association.

**Does Manipulating Attentional Bias Reduce Dispositional Anxiety?**

As reviewed, many influential cognitive models of anxiety propose that attentional bias to negative information causally contributes to elevated Dispositional Anxiety (Van Bockstaele et al., 2014). To examine whether this causal contribution exists, researchers developed procedures to modify the process of attentional bias in order to reveal the impact of differential patterns of attentional bias on elevated Dispositional Anxiety. MacLeod, Rutherford, Campbell, Ebsworthy, & Holker (2002) sought to determine whether successfully modifying attentional bias impacts on elevated Dispositional Anxiety. They adapted the Dot-Probe Task to create a Cognitive Bias Modification for Attention (CBM-A) procedure designed to encourage attentional allocation to one particular class of stimulus. This was done by introducing a contingency such that the probe was consistently presented in the locus of one type of stimuli (negative or neutral words), with the intention of encouraging an attentional bias towards this type of information. In this study participants were allocated to either a neutral training condition, where the probe was consistently presented in the locus of the neutral stimuli or to a negative training condition where the probe was consistently presented in the locus of the negative stimuli. Following the Dot Probe CBM-A manipulation, attentional bias was assessed and a stressor was introduced. It was hypothesised that should a group difference in attentional bias be induced then a subsequent group difference in Anxiety Reactivity to the stressor will be seen. Specifically, the neutral training condition will have a significantly lower state anxious response to the stressor than the negative training condition. The original assessment version of the Dot Probe Task was used to assess attentional bias for negative
information and the stressor task involved asking participants to solve a set of anagrams of which half were impossible and the other half were very difficult. Participants were required to solve as many anagrams as possible in three minutes and were provided bogus feedback which indicated that their accuracy for correct completions was unusually low for their peer group. In this study, Dispositional Anxiety was assessed by measuring participant’s Anxiety Reactivity. A Visual Analogue Mood Scale (VAMS) was used as a self-reported measure of state anxiety in order to assess group differences in Anxiety Reactivity.

The results revealed that attentional bias could indeed be successfully modified as seen by a group difference in attentional bias to negative information. Specifically, those participants allocated to the neutral training condition became significantly faster to identify probes in the vicinity of neutral stimuli than probes in the vicinity of negative stimuli. Whereas participants allocated to the negative training condition became significantly faster to identify probes in the vicinity of negative stimuli than probes in the vicinity of neutral stimuli. The results also showed that the degree to which state anxiety heightened from pre to post stressor was larger for participants allocated to the negative training condition as compared to participants allocated to the neutral training condition. This study was therefore the first demonstration that a group difference in attentional bias can be induced using a Dot Probe CBM-A manipulation, and that this modification of attentional bias results in a subsequent group difference in Anxiety Reactivity. This provides evidence that attentional bias to negative information causally contributes to elevated Dispositional Anxiety (Hakamata et al., 2010). It is critical to note, however, that in this seminal study the impact of the CBM-A procedure on elevated Dispositional Anxiety has been assessed only by measuring the impact of CBM-A on Anxiety Reactivity. As will be seen, all research to date has used this
method to assess Dispositional Anxiety. This ultimately ignores the alternative pattern of state anxiety underlying elevated Dispositional Anxiety which was referred to earlier as diminished Anxiety Dissipation. Therefore, the potential impact of CBM-A procedures on Anxiety Dissipation remains unknown.

Another study to assess whether modifying attentional bias reduces Dispositional Anxiety was conducted by Amir, Weber, Beard, Bomyea, & Taylor (2008). This study employed the Dot Probe CBM-A manipulation as was previously described in the MacLeod et al (2002) study above but the stimuli consisted of pairs of benign and socially threatening faces. In the benign training condition, a contingency was introduced such that the probe was consistently presented in the locus of the benign face to encourage an attentional bias away from the negative and towards benign faces. This condition was compared against a control training condition in which no contingency was introduced, meaning that the probe was presented in the locus of the benign stimuli on half of the trials and in the locus of the negative stimuli on the other half of the trials. This study recruited individuals high in disposition for social anxiety and measured state anxiety in response to a public speaking challenge. Results revealed, firstly, that a group difference in attentional bias was induced whereby the degree to which participants responded faster to the probes in the locus of benign stimuli than probes in the locus of negative stimuli was disproportionately great for the benign training condition as compared to the control training condition. Further, self-reported anxiety ratings in response to the public speaking stressor were significantly lower in the benign training condition as compared to the control training condition. This suggests that the group difference induced in attentional bias had a subsequent impact on Anxiety Reactivity. The authors concluded that these results provide support for the causal contribution of attentional bias to elevated disposition to experience social
anxiety. It could have been possible here for the researchers to monitor the decline in state anxiety following the public speaking challenge. Then by assessing for group differences in the rate of decline it would allow exploration of the causal contribution of attentional bias to negative information on diminished Anxiety Dissipation and given insight into the impact of CBM-A on the rate of Anxiety Dissipation. However, as with all studies to date, this was not conducted.

With the establishment of the Dot Probe Task as a CBM-A procedure and the well demonstrated causal contribution of the attentional bias to increased Anxiety Reactivity, researchers have also started implementing the Dot Probe CBM-A manipulation in clinical populations. The goal of targeting this population is to attenuate the clinical manifestations of elevated Dispositional Anxiety. However, the measures and methodologies employed in these studies assess Dispositional Anxiety in a manner that does not differentiate between Anxiety Reactivity and Anxiety Dissipation. Therefore, the impact of CBM-A on Anxiety Dissipation remains unclear. A classic study from within this research is from Schmidt, Richey, Buckner, & Timpano (2009), who implemented a CBM-A procedure in a sample of individuals who met the DSM-IV diagnostic criteria for Social Anxiety Disorder (SAD). Participants were allocated to one of two conditions, the benign training condition or the control training condition. The benign training condition delivered a Dot Probe CBM-A manipulation designed to encourage attention away from socially threatening faces and towards benign faces by placing the probe in the locus of the benign face on 80% of the trials. The control training condition delivered the same Dot Probe CBM-A manipulation but in this condition the probe appeared an equal number of times in the locus of the socially threatening faces and benign faces. The Dot Probe CBM-A manipulation was administered in eight 15 minute sessions (two sessions a week for four weeks), and both
clinical and self-reported emotional measures were recorded prior to commencement of the treatment, post treatment and at a four month follow up. The results revealed that participants in the benign training condition rated themselves as significantly less socially anxious following treatment. This was supported by the clinician ratings who assessed the diagnostic criteria following treatment and found 72% of the participants in the benign training condition no longer met DSM diagnosis for SAD, as compared to only 11% in the control training condition. These results suggest that CBM-A is effective in attenuating clinical anxiety. However, the measures administered by the clinicians are made up of symptom checklists and rate the intensity of symptoms typically associated with social anxiety, which are questions that reveal information about Dispositional Anxiety without differentiating the two patterns of state anxiety, Anxiety Reactivity and Anxiety Dissipation. Questions regarding the intensity of anxious symptoms following their evocation have not been asked, as such there is no measure provided of the dissipation of their heightened state anxiety.

These studies and others like it clearly make important contributions to our understanding of the mechanisms underlying elevated Dispositional Anxiety. They demonstrate not only that attentional bias can be manipulated but also that biased attention to negative information causally contributes to increased Anxiety Reactivity (Wadlinger & Isaacowitz, 2008; Li, Tan, Qian, Liu, 2008; Klumpp & Amir, 2009; Koster, Fox, & MacLeod, 2009; MacLeod & Mathews, 2012; Heeren, Peschard, & Philpott, 2012; Van Bockstaele et al 2014). However, all these studies have exclusively assessed elevated Dispositional Anxiety by measuring Anxiety Reactivity, and none have employed a methodology that observes the impact of differential patterns of attentional bias on the rate of Anxiety Dissipation following the evocation of heightened
state anxiety. As such, the capacity of CBM-A paradigms to induce a group difference in the rate of Anxiety Dissipation remains unclear and untested.

**Is Elevated Dispositional Anxiety Characterised by Negative Interpretation Bias?**

Negative interpretation bias is defined as a tendency to favour negative interpretations of emotionally ambiguous information over benign or positive interpretations (Mathews & MacLeod, 2002). Since the idea of an anxiety-linked interpretation bias was introduced, researchers have sought to empirically establish whether there is an association between heightened anxious disposition and negative interpretations of ambiguous information. Researchers have developed many different tasks to assess anxiety linked negative interpretation bias, all of which initially present ambiguous information that requires interpretation. The interpretation imposed on that information can be assessed by using a subsequent processing task. One example of a processing task used to assess interpretation bias is a homophone priming task (Mathews, Richards, & Eysenck, 1989) in which homophones that have both a negative and a benign meaning were presented auditorily. Participants were required to write down the word and the spelling of the word provided an interpretation of ambiguous information. The results revealed that individuals high in Dispositional Anxiety wrote down the threatening version of the homophone significantly more than the individuals low in Dispositional Anxiety. Researchers have also employed lexical decision tasks that use homographs as primes then determine whether the speed of making a lexical decision on target words is affected. For example, (Richards & French, 1992) presented participants high and low in Dispositional Anxiety with homograph priming words that had both a threatening and a benign meaning. Participants were then presented with a target non-word on half of the trials and a target word, which was associated with either the threatening or benign meaning of the homograph, on the other half of the trials.
Participants were required to identify whether the target was a word or a non-word as quickly as possible. The results showed that for participants high in Dispositional Anxiety there was a priming effect for threatening target words when they were preceded by the threat prime, but no priming effect for the benign target words. This effect was not evident for the participants low in Dispositional Anxiety. These early studies have been useful in revealing interpretation biases but do not come without limitations. The homograph primes or homophones are presented in isolation which does not allow the words to be put in context and so does not reflect the everyday use of the words. Also, asking participants to write down a single spelling of a homophone may be difficult for participants who are consciously aware of both meanings. Finally, there are a limited number of homophones and homographs that possess both threatening and benign meanings and that are used frequently enough for participants to recognise, and so these variables are difficult to control.

To overcome these problems a new task was developed by Eysenck, Mogg, May, Richards, & Mathews (1991). In this approach, ambiguous passages are presented and participants impose their own interpretations on this information. Then a subsequent Recognition Task is used to infer what meaning has been imposed on the ambiguous passages. The Recognition Task measures whether participants judge candidate benign interpretations of the preceding ambiguity to be more familiar than candidate negative interpretations. Specifically, a series of emotionally ambiguous passages are presented that each permits a negative or a benign interpretation. Then, for each of the ambiguous passages participants are presented with four alternative Test Sentences. This set of four Test Sentences includes two target sentences, one consistent with a benign interpretation of the ambiguity and one consistent with a negative interpretation of the ambiguity. The set also includes two foil sentences that describe
events unrelated to either possible interpretation of the ambiguity but one is benign in meaning and one is negative in meaning. Participants are required to rate how similar each test sentence is to the meaning of the original passage. Given that elevated Dispositional Anxiety may be associated with a general tendency to endorse negative interpretations, which would represent a negative response bias, the two foil sentences are also included to assess for response bias. Any tendency to rate negative foil sentences as more similar to the original passage than benign foil sentences would reflect a response bias. If the same effect is also found on the target sentences then this could again be attributed to a response bias. However, if this effect is seen only on the target sentences or is evident to a greater degree on target sentences than the foil sentences then this will reflect an interpretation bias. So, a negative interpretation bias will be revealed when participants rate negative target sentences as more similar than the benign target sentences to the original passage, to a greater degree than is the case for negative foil sentences. There is now substantial evidence using this Recognition Task that implicates negative interpretation bias as a cognitive mechanism underlying elevated Dispositional Anxiety (Mathews, Richards & Eysenck 1989; Mathews & Mackintosh, 1998; Williams, Watts, MacLeod & Mathews, 1997).

**Does Manipulating Interpretation Bias Reduce Dispositional Anxiety?**

As reviewed, many influential cognitive models of anxiety propose that negative interpretation bias causally contributes to elevated Dispositional Anxiety (Beck, 1976; Bower, 1981; Simpson, 1984; Mogg & Bradley, 1998; Eysenck, MacLeod & Mathews, 1987). To examine whether this causal contribution exists, researchers developed procedures to modify the process of interpretation bias in order to reveal the impact of differential patterns of interpretation bias on elevated Dispositional Anxiety. In an attempt to modify interpretation bias Mathews & Mackintosh (2002) created a Cognitive Bias Modification for Interpretation (CBM-I) procedure designed to encourage tendency to favour one type of interpretation of ambiguous information. This task consists of presenting emotionally ambiguous passages that describe common
everyday events, and are constructed in a manner that allows them to be interpreted in either a benign or negative manner. Each ambiguous passage is made up of three lines of text describing a common scenario from everyday life and ends with a word fragment. For each passage two word fragments were created, one from a word consistent with a benign interpretation and one from a word consistent with a negative interpretation of the ambiguous passage. These word fragments can only be completed to yield the specific word it is derived from. For each passage a comprehension question is also presented to ensure that the participant understood the meaning of the passage. Participants are asked to read the ambiguous passage and complete the word fragment by filling in the first missing letter. To assess group differences in negative interpretation bias Mathews & Mackintosh (2000) allocated participants to either a benign CBM-I condition, in which the CBM-I manipulation was configured to induce a benign interpretation bias, or a negative CBM-I condition, in which the CBM-I manipulation was configured to induce a negative interpretation bias. To induce these interpretive styles the same ambiguous passages were used in both conditions but the word fragments differed depending on condition. In the benign condition the final words were always consistent with a benign interpretation of the ambiguous passage. Hence, in this condition, participant’s ability to complete the task easily and efficiently would be enhanced by adopting a benign interpretive style, as this would enable correct anticipation of the meaning of the final word from which the word fragment was created. Therefore, by providing word fragment that were always consistent with a benign interpretation when completed, this was intended to encourage the participants to adopt a benign interpretation bias. In the negative condition the word fragments presented were always consistent with a negative interpretation of the ambiguous passage when completed. Hence, in this condition, participant’s ability to complete the
task easily and efficiently would be enhanced by adopting a negative interpretive style.
Therefore, by providing word fragments that were always consistent with a negative interpretation, this was intended to encourage the participants to adopt a negative interpretation bias. By using the Recognition Task to assess interpretation bias following this CBM-I procedure, Mathews & Mackintosh (2000) were able to determine whether this CBM-I procedure could successfully induce a group difference in interpretation bias. Many studies have been conducted using this procedure and the results indicate, as a recent meta-analysis has confirmed, that this CBM-I procedure, can successfully modify negative interpretation bias (Menne-Lothmann et al., 2014).

With the development of this procedure that has been shown to be capable of inducing a group difference in interpretation bias it has become possible for researchers to investigate the causal contribution of negative interpretation bias to elevated Dispositional Anxiety. As with the CBM-A literature, this has often been examined by measuring the impact of CBM-A on state anxiety in response to a stressor, which only reveals the impact of CBM-I procedures on Anxiety Reactivity. This leaves the question of whether these procedures also impact on Anxiety Dissipation unanswered. For example, Wilson, MacLeod, Mathews, & Rutherford (2006) assigned one group of participants to the negative CBM-I condition designed to encourage a tendency to impose threat interpretations on ambiguity. A second group of participants was assigned to the benign CBM-I condition which was designed to reduce the tendency to impose threat interpretation on ambiguity. Participants were then assessed on their interpretation bias using a lexical decision task. Finally, participants were administered a stressor task that consisted of watching four video clips depicting distressing real life rescue operations. The results revealed, firstly, that the CBM-I procedure induced a group difference in interpretation bias. Specifically, the degree to which benign
information was endorsed more than threatening information was disproportionately great for participants in the benign CBM-I condition relative to participants in the negative CBM-I condition. Secondly, a significant group difference was subsequently found on state anxiety responses to the video stressor. Specifically, participants who completed the negative CBM-I procedure showed a greater increase in state anxiety in response to the stressor (i.e., increased Anxiety Reactivity), as compared to participants who completed the benign CBM-I procedure. These results demonstrate that not only can interpretation bias be successfully modified, but that negative interpretation bias causally contributes to individual differences in increased Anxiety Reactivity. Had the researchers measured the dissipation of state anxiety following the stressor task then it would have been possible to observe the causal contribution of interpretation bias on diminished Anxiety Dissipation. However, no such assessment was carried out so the effect of CBM-I on the rate at which the evoked state anxiety subsequently declines is unknown.

Another study to observe the effect of CBM-I on elevated Dispositional Anxiety was from Murphy, Hirsch, Mathews, Smith, & Clark (2007). They recruited high socially anxious individuals who were allocated to either a benign CBM-I condition or control CBM-I condition of an auditory variant of CBM-I. Participants in the benign CBM-I condition listened to ambiguous social scenarios that were always resolved in a benign manner. Participants in the control CBM-I condition always listened to scenarios that were resolved in a manner that did not refer to the emotional outcome of the social situation. This procedure was followed by a social stressor which consisted of informing the participants that they would be meeting two strangers and would be required to engage in a five minute conversation with them. The Recognition Task was employed to assess interpretation bias and revealed that participants who completed the benign
CBM-I procedure had higher ratings for benign target sentences than negative target sentences, to a greater degree than participants who completed the control CBM-I procedure. No group difference in ratings for negative and benign foil sentences was observed, indicating that the CBM-I procedure was successful in inducing a group difference in interpretation bias. The results also showed a significantly greater state anxiety response to the social stressor for participants who completed the control CBM-I procedure as compared to participants who completed the benign CBM-I procedure. These results indicate that negative interpretation bias causally contributes to increased Anxiety Reactivity. These studies provide evidence for the causal contribution of negative interpretation bias on elevated Dispositional Anxiety by showing that a reduction in negative interpretation bias reduces increased Anxiety Reactivity (Salemink, van den Hout, & Kindt, 2009; Steinman & Teachman, 2010). Meanwhile the causal contribution of a negative interpretation bias to Anxiety Dissipation remains unknown even though variability in Anxiety Dissipation could have been measured in any of these studies.

Researchers have also started to implement CBM-I procedures in clinical samples. These studies either specifically assess Anxiety Reactivity or do not differentiate between Anxiety Reactivity and Anxiety Dissipation. An example of this type of research is a study by Amir and Taylor (2012), who recruited participants clinically diagnosed with social anxiety to determine the effect of a CBM-I procedure on their anxiety symptoms. This was a multiple session design whereby participants were randomly assigned to the training or control condition of a CBM-I procedure. This task was completed on 12 separate occasions over a 6 week period. Measures of social anxiety symptoms, functional impairment and emotional distress were recorded prior to and immediately following the 6 week training period, and at a three month follow up
for the training condition only. Results demonstrated a significant change in
interpretation bias from pre to post training, with participants in the benign CBM-I
condition coming to display a less negative interpretation bias and more positive
interpretation bias than those participants in the control CBM-I condition. With regard
to the impact of the CBM-I procedure on Dispositional Anxiety, participants who
completed the benign CBM-I procedure had a significantly greater reduction in anxious
symptoms as reported by a clinician using the Liebowitz Social Anxiety Scale (LSAS).
These participants also displayed significantly less functional impairment, trait anxiety
and depression than participants who completed the control CBM-I procedure. The
effects of the CBM-I procedure on social anxiety symptoms and functional impairment
remained present at three month follow up, indicating that the treatment gains had an
enduring effect. As previously mentioned in the section for attentional bias, measures
such as the LSAS do not ask questions about current state anxiety. This means that there
is no information that allows differentiating Anxiety Reactivity and Anxiety
Dissipation. This study’s methodology also does not allow for observing group
differences in Anxiety Dissipation. To do this a stressor would need to be introduced in
order to evoke heightened state anxiety which would need to be measured at intervals
following its evocation to obtain a measure of Anxiety Dissipation. It is unknown,
therefore, whether the effect of CBM-I on reducing Dispositional Anxiety was due to a
reduction in Anxiety Reactivity, an increase in the rate of Anxiety Dissipation, or both.

**The Current Research Program: Using CBM to Target Anxiety Dissipation.**

From the development of tasks that can successfully modify attentional bias
towards negative information and negative interpretation bias has come confirmation
that these cognitive biases causally contribute to elevated Dispositional Anxiety.
However, both the CBM-A and CBM-I literature has examined the impact of CBM on
elevated Dispositional Anxiety in a manner that has either focused solely on assessing Anxiety Reactivity or does not differentiate between Anxiety Reactivity and Anxiety Dissipation. This means that, while the causal contribution of attentional and interpretation bias to increased Anxiety Reactivity has been established, the influence on diminished Anxiety Dissipation is still unknown. Therefore, the current research program aims to i) determine whether attentional bias to negative information causally contributes to diminished Anxiety Dissipation, and ii) determine whether negative interpretation bias causally contribute to diminished Anxiety Dissipation. This will be determined by assessing whether CBM procedures that successfully induce a group difference in each type of negative cognitive bias also serves to produce a group difference in the rate of Anxiety Dissipation. In order to address these aims, the methodology will involve evoking heightened state anxiety in individuals high in Dispositional Anxiety prior to delivering the CBM procedure. State anxiety will be monitored following the evocation of heightened state anxiety to assess the dissipation of state anxiety. Specifically, across the studies presented within this research project, the basic procedure is as follows. First, anxiety symptoms are evoked by a stressor. Second, participants complete either a CBM task designed to modify cognitive bias, or a control variant of the task in order to provide a comparison when examining the success of the CBM procedure. Third, state anxiety is assessed at regular intervals, following the evocation of heightened state anxiety, to observe the rate of Anxiety Dissipation.

As the key aspect of this research program is measuring Anxiety Dissipation, one of the most important steps in the methodology is ensuring that state anxiety is heightened in order to measure its subsequent decline. To do this, a stressor must be introduced that meets the requirements that it i) reliably evokes heightened state anxiety, and ii) that the evoked state anxiety subsequently declines so that it is possible
to assess variability in the decline of state anxiety across the temporal window
considered in the experiment. Upon consideration of the many types of stressors used in
the previous literature, it was decided to employ two different types of stressors. The
critical reason for selecting two different types of stressors is to ensure the
generalisability of the findings. If the CBM procedure is found to have effects on
Anxiety Dissipation it will be important to know whether these effects generalise across
stressors, or if they are specific to a particular type of stressor. The stressors employed
in this research program will have in common their ability to evoke heightened state
anxiety but will differ in terms of the concern they are focused on. Therefore, one of the
stressors chosen concerned social evaluation, and the other concerned test/exam
performance.

Within the social anxiety literature, state anxiety evocation methodologies often
employ stressors that target socially anxious individuals’ fear of negative evaluation, for
example by having them anticipate giving speeches or having conversations with
strangers (Heeren, Coussement, & McNally, 2015; Klumpp & Amir, 2009; Murphy et
al., 2007). For example, in one such study to employ a socially relevant stressor, Amir,
Weber, Beard, Bomyea, & Taylor (2008) allocated individuals high in trait social
anxiety to either a benign CBM-A condition in which participants completed a CBM-A
task designed to selectively attend away from negative information. Or participants
were allocated to a control CBM-A condition in which they completed a control variant
of the task that had no contingency designed to modify attentional bias. Following this,
participants were asked to prepare a speech which they were told would be recorded and
later reviewed by a graduate student for quality. Measures of state anxiety were
recorded before and after this stressor. The results showed firstly that a greater
attentional bias away from negative information was induced in participants who
completed the benign CBM-A procedure than participants who completed the control CBM-A procedure. Importantly, participants who completed the benign CBM-A procedure subsequently demonstrated lower state anxiety reactions to the speech stressor than did participants who completed the control CBM-A procedure. These results demonstrate that the speech stressor was effective in inducing a group difference in Anxiety Reactivity. An important aspect of this speech stressor was introducing the expectation that participants would be required to give a speech that would be scrutinised by a stranger. The alternative stressor employed in the current research project concerns test anxiety, and as such the studies using this stressor were run in the study period prior to exams. This stressor consists of instructing the participants to worry about the upcoming exams, with emphasis placed on the need to evoke the same thoughts and emotional experience as they usually would when worrying about exams. This instructed worry period is a commonly used stressor in the anxiety literature which has proved to be reliable in effecting an increase in state anxiety (Hayes, Hirsch, & Mathews, 2010; Hirsch, Hayes, & Mathews, 2009; Krebs, Hirsch, & Mathews, 2010; Verkiul, Brosschot, Putman & Thayer, 2008; Delgado et al 2010).

In order to maximise the breadth of knowledge surrounding the underlying mechanisms of elevated Dispositional Anxiety, the current research project will include one line of research focus on the impact of modifying patterns of attentional bias and another line of research focus on the impact of modifying patterns of interpretation bias. Bias modification studies of each type will be conducted using both types of stressors. It is hypothesised that variation in attentional bias towards negative information causally contributes to diminished Anxiety Dissipation, and that variation in negative interpretation bias also causally contributes to diminished Anxiety Dissipation. These hypotheses generate the prediction that, if the CBM procedure is successful in
producing group differences in negative cognitive biases, then a group difference in the rate of Anxiety Dissipation following evocation of state anxiety will be seen. In order to adequately discriminate the validity of the hypotheses under examination, four critical requirements need to be met. First, there must be no group difference in Dispositional Anxiety prior to beginning the experiment. Secondly, the CBM procedure must induce a group difference in interpretation or attentional bias, depending upon which is targeted. Third, the stressor must evoke heightened state anxiety and do so to an equivalent degree in both groups of participants. Fourth, there must be a significant decline in state anxiety across the experimental window. The third and fourth requirements are necessary to enable assessing the rate of decline in heightened state anxiety, and as such index the rate of Anxiety Dissipation. The outcomes of this research project will serve to determine whether or not each type of cognitive bias makes a causal contribution to variability in Anxiety Dissipation. This will in turn help to determine whether CBM can be utilised as a method of increasing the rate of Anxiety Dissipation.
Chapter 2: Does Attentional Bias to Negative Information Causally Contribute to Diminished Anxiety Dissipation in Socially Anxious Individuals?
Past research has demonstrated that attentional bias towards negative information functionally contributes to elevated Dispositional Anxiety (MacLeod & Mathews, 1988; Mathews & MacLeod, 1986; Walsh, Wilding & Eysenck, 1994; Fox, Russo, Bowles & Dutton, 2001). As reviewed in the General Introduction, this attentional bias to negative information has been found to be a causal factor in the determination of elevated Dispositional Anxiety in both non-clinical samples (Mathews & Macleod, 1994; Mathews, May, Mogg & Eysenck, 1990), as well as in clinically anxious individuals (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). As previously indicated, elevated Dispositional Anxiety is defined as the tendency to experience heightened state anxiety. However, elevated Dispositional Anxiety can reflect two patterns of state anxiety, namely increased Anxiety Reactivity or diminished Anxiety Dissipation. Anxiety Reactivity refers to the degree to which state anxiety elevates in response to a stressor, and Anxiety Dissipation refers to the rate at which heightened state anxiety dissipates following its evocation.

To date, the research examining the relationship between Dispositional Anxiety and attentional bias to negative information has failed to determine whether increased attention to negative information causally contributes to diminished Anxiety Dissipation. This is concerning given that both patterns of state anxiety are detrimental to the well-being of the individual. For example, a socially anxious individual may experience heightened state anxiety in reaction to conversations with new people (increased Anxiety Reactivity). This person will then feel uncomfortable maintaining a conversation with the stranger and so could also find it difficult to reduce this heightened state anxiety (diminished Anxiety Dissipation). Either pattern of state
anxiety can be a negative experience for the individual that can lead to avoidance of socialising in the future, consequently isolating the individual and compromising their well-being. However, while it has been well established that attentional bias to negative information causally contributes to increased Anxiety Reactivity it is yet to be determined whether or not it causally contributes to diminished Anxiety Dissipation.

Recently, procedures have been developed to influence the tendency to preferentially attend towards or away from negative information, now known as cognitive bias modification for attention (CBM-A; Koster, Fox, & MacLeod, 2009; Colin MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). This work was reviewed in the “Manipulating attentional bias to reduce Dispositional Anxiety” section of the General Introduction, which described the cognitive bias modification variant of the Dot Probe Task (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). This task, which is the most commonly used procedure for modifying attentional bias, introduces a contingency to the conventional assessment variant of the Dot Probe Task. In the benign version of this task a probe is consistently presented in the locus of benign stimuli to encourage the development of an attentional bias towards benign information. In the control version of this task the probe is presented in the locus of benign stimuli on half the trials, and negative stimuli on the other half of the trials, which does not encourage a directional attentional bias. The successful modification of attentional bias is demonstrated by a group difference in attentional bias towards negative information.

The General Introduction also reviewed how the use of such CBM-A procedures to attenuate attentional bias to negative information can reduce Anxiety Reactivity (Mogoașe et al., 2014). This was assessed by introducing a stressor following completion of a CBM-A procedure, and measuring the elevation of state anxiety in response to this stressor. A group difference in Anxiety Reactivity subsequent to the
CBM-A procedure demonstrates the causal contribution of attentional bias to Anxiety Reactivity. The results from this methodology have repeatedly demonstrated that the degree to which state anxiety is heightened following the introduction of a stressor is attenuated in participants who receive a benign version of the CBM-A procedure relative to participants who receive a control version of the CBM-A procedure. However, this is only a measure of the impact of CBM-A procedures on Anxiety Reactivity which has been the focus of all CBM-A studies to date. Therefore it is unknown whether attentional bias to negative information causally contributes to diminished Anxiety Dissipation.

The current study was designed to determine whether a CBM-A procedure that successfully creates a group difference in selective attentional responding towards negative information also serves to produce a group difference in the rate of Anxiety Dissipation following evocation of state anxiety. To fulfil this aim, participants were first allocated to one of two experimental conditions. Participants allocated to the Benign CBM-A Condition completed a CBM-A Task designed to encourage an attentional bias away from negative information. Those allocated to the Control CBM-A Condition completed a variant of the CBM-A Task that was configured in a manner that did not encourage a directional attentional bias. As described in the General Introduction, there are two types of stressors that will be employed in this research program, and the one that will be employed in this initial study is the speech stressor, which requires participants to engage with the prospect of delivering a speech to be scrutinised by their peers. The dissipation of the state anxiety elevated by the stressor was monitored following its evocation to measure variability in the decline of state anxiety, and as such index Anxiety Dissipation. In order to maximise the capacity of the
speech stressor to evoke state anxiety, participants selected to take part in the current study were individuals with heightened disposition for social anxiety.

The experimental hypothesis for the current study is that attentional bias to negative information causally contributes to diminished Anxiety Dissipation. This hypothesis generates the prediction that, if the CBM-A procedure is successful in producing a group difference in selective attention towards negative information, then a group difference in the rate of Anxiety Dissipation following evocation of state anxiety will also be seen. Specifically, participants in the Benign CBM-A Condition will show a significantly greater rate of Anxiety Dissipation than will participants in the Control CBM-A Condition. In order to adequately evaluate the hypothesis under examination, four critical requirements must be met. First, there must be no group difference in Dispositional Anxiety prior to beginning the experiment. Second, the CBM-A procedure must induce a group difference in attentional bias such that participants in the Benign CBM-A Condition come to demonstrate significantly less selective attention towards socially negative information than is shown by participants in the Control CBM-A Condition. Third, the stressor must evoke heightened state anxiety, and do so to an equivalent degree in both groups of participants. Fourth, there must be a significant decline in state anxiety across the experimental window. If all of these requirements are fulfilled then it will be possible to determine whether or not attentional bias to negative information causally contributes to Anxiety Dissipation. This will be determined by examining whether inducing a group difference in attentional bias then induces a subsequent group difference in Anxiety Dissipation.
Method

Participants

The study required participants high in disposition to experience social anxiety, and so 63 participants were recruited based on their high scores on the Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998). These participants were recruited from the full first year Psychology student cohort at The University of Western Australia, who were all screened on the SIAS. The students invited to participate all scored in the top third of this sample’s SIAS score distribution (i.e. above 32). Participants, of whom 43 were female, had an average age of 18.52 years (SD=2.58), and received partial course credit in exchange for participation.

Participants were randomly allocated to one of two CBM-A Conditions. Participants allocated to the Benign CBM-A Condition completed a CBM-A Task configured to encourage selective attention towards benign information and away from negative information. Participants allocated to the Control CBM-A Condition completed a control version of this task that was not configured to modify selective attention. Participants assigned to each of the two CBM-A Conditions did significantly differ in age, \( t(34.52) = -2.23, p = 0.03, \) \( d = .58 \) (assumption of homogeneity of variances was violated, results for equal variances not assumed has been reported) but not in gender ratio, \( \chi^2 = .43, p = .51, \) \( w = .08 \).

Materials

Emotional Assessment Instruments

Social Interaction Anxiety Scale (SIAS). The SIAS (Mattick & Clarke, 1998) was used as the screening tool that guided participant recruitment. The SIAS was also used to confirm that participants assigned to the two CBM-A Conditions did not initially differ in their disposition to experience social anxiety, in order to verify that
this element of the first requirement of the study was met. The SIAS is a self-report scale used to assess the severity of fears surrounding social interaction. It consists of 20 items that describe potential physiological, emotional and cognitive reactions to social situations; for example, “I have difficulty making eye contact with others” and “I am nervous mixing with people I don’t know well”. Participants are asked to indicate the degree to which each statement is true for them on a 5 point Likert scale ranging from 0 (Not at all) to 4 (Extremely). Total scores range from 0 to 80, with higher scores on this scale reflecting greater disposition to experience social anxiety. The SIAS has shown to have good internal consistency and test-retest reliability (Mattick & Clarke, 1998).

**Spielberger Trait Anxiety Inventory (STAI).** The trait version of the State-Trait Anxiety Inventory (Spielberger et al, 1983) was used to verify that participants assigned to the two CBM-A Conditions did not significantly differ in dispositional anxiety, thereby fulfilling this second and final element of the first requirement of the study. The STAI consists of 20 items that are statements people can use to describe themselves. Participants are required to rate the frequency with which they experience each statement (e.g. “I feel nervous and restless”) on a 4 point Likert scale ranging from 1 (Almost never) to 4 (Almost always). Total scores range from 20 to 80, with higher scores indicating higher levels of trait anxiety. This scale is a commonly used measure of dispositional anxiety and has good reliability and validity (Spielberger et al, 1983).

**Visual Analogue Mood Scale (VAMS).** A visual analogue mood scale (Wilson, MacLeod, Mathews, & Rutherford, 2006b) was used to assess anxious mood state at various points during the study. The purpose of this was to verify that state anxiety was evoked by the stressor and to provide an index of the subsequent dissipation of this evoked state anxiety, in order to fulfil the third and fourth requirements of the study. This scale consisted of a 15cm line, made up of points that divided the line into 60 equal
portions and with end labels anxious (right) and relaxed (left). Using the mouse, participants selected their current level of state anxiety by clicking on the point along the scale line they considered to correspond to their current level of state anxiety. This yielded a score between 0 (relaxed) to 60 (anxious).

**Experimental Stimuli**

*Emotional Word Pairs.* The Dot Probe CBM-A manipulation and Attentional Bias Assessment Task employed word pairs as stimuli. Each word pair consisted of one word that was negative in emotional meaning and related to concerns typical of social anxiety (e.g. “DISGRACE”) and one of equivalent letter length that was benign in emotional meaning (e.g. “BALLOONS”). They were selected from a larger group of words that were rated by six individuals on Valence (1=Not at all negative to 5=Very negative) and Relevance to Social Anxiety, specifically public speaking (1=Not at all relevant to 5= Very relevant). Including a greater degree of congruency between the content of the stimuli and the types of concerns that predominate the type of anxiety in question has shown to improve the effectiveness of CBM for both attentional bias (Constans, Penn, Ihen, & Hope, 1999; Pergamin-Hight, Naim, Bakermans-Kranenburg, van IJzendoorn, & Bar-Haim, 2015). Therefore, from these ratings, 96 word pairs were formed by selecting one word with the highest association with social anxiety and rated as having negative valence and one other word selected based on its identification as having the least negative valence, with each pair matched for letter length. From these word pairs a set of 48 word pairs was selected for the Dot Probe CBM-A manipulation and the remaining 48 word pairs were selected for the Attentional Bias Assessment Task.
Experimental Tasks

**Dot Probe CBM-A manipulation.** This task was designed to induce a group difference in selective attention in response to emotionally negative stimuli, the second requirement of this study. The task was a modified version of the standard Dot Probe Task developed by MacLeod, Mathews & Tata (1986) configured with the intention of manipulating attentional bias. At the start of each trial, a fixation cross was presented in the centre of the screen for 500ms, followed by a word pair which was presented for 1000ms. One of the words in the pair was presented 1.5 cm above fixation, while the other was presented 1.5 cm below fixation. The negative member of the word pairs was presented an equal number of times in the top and bottom position. Immediately following offset of the word pair, a probe appeared in the location previously occupied by one of the words. This probe consisted of two dots that angled upwards to either the left (.) or the right (.). Participants were required to identify as quickly as possible whether the probe was angled to the left or right and indicate this by clicking the left or right mouse button, respectively. The task consisted of 6 blocks of 96 trials and participants were provided with a self-paced break at the end of each block. In each block, every one of the 48 word pairs was presented twice in a random order for a total of 96 trials per block. The negative word was presented in the top and bottom position with equal frequency and the probe was angled to the left on half the trials and to the right on half the trials. In the Benign CBM-A Condition the probe always appeared in the location of the benign word on every trial with the objective of training attention away from negative information. In the Control CBM-A Condition there was no such training contingency. Therefore, in this condition the probe appeared in location of the benign word on half of the trials and in the location of the negative word for the other half. Accuracy in identifying the direction of probe was recorded on each trial in order
Attentional Bias and Social Anxiety

to verify that participants were completing the task as instructed. As completing the task as instructed is necessary before the procedure could induce attentional bias, it was required that participants display an accuracy level substantially above chance (50%) on probe discrimination. Therefore, the inclusion criterion was set at 75% accuracy for probe discrimination on Dot Probe CBM-A manipulation trials, and participants who fell below this accuracy level were excluded from analysis.

**Attentional Bias Assessment Task.** This task was delivered immediately prior to and following the Dot Probe CBM-A manipulation to obtain a measure of attentional bias, in order to determine whether the Dot Probe CBM-A manipulation was successful in inducing group differences in selective attentional response to negative socially relevant information, thereby fulfilling the second requirement of study. As previously mentioned, it is a requirement of this study that group differences in attentional bias are successfully induced to be able to attribute any effect on state anxiety to this bias modification procedure. The Attentional Bias Assessment Task consisted of one block of 96 trials (with each assessment word pair presented twice in a random order). Four trial types existed each determined by the position in which the Probe and the Negative Word were presented. These consisted of two trials with the probe in the same location of the negative word: 1) Negative Word in top position and Probe in top position, 2) Negative Word in bottom position and Probe in bottom position; and two trials with the probe in the opposite location of the negative word: 3) Negative Word in top position and Probe in bottom position, 4) Negative Word in bottom position and Probe in top position. Therefore, across the assessment task the probe appeared in same location as the negative word on half of the trials, and in the same location as the neutral word on the other half of the trials.
The degree to which the participants allocated attention towards the location of the probe would be expected to result in a faster discrimination latency for that probe. Therefore, the degree to which participants were speeded in the locus of benign information compared to the locus of negative information would index the degree to which attention was oriented towards the negative. The reaction time (milliseconds) to correctly discriminate the probe’s direction was recorded on each trial and used to calculate an Attentional Bias to Negative Information Score (incorrect responses were not used in the computation). An index of attentional bias towards negative information can be computed by subtracting the correct probe discrimination latencies on trials where the probe replaced the negative word from the correct probe discrimination latencies on trials where the probe replaced the benign word.

**State Anxiety Evocation and Dissipation Task.** This task consisted of two phases. The first phase of the task was designed to evoke elevated state anxiety by exposing participants to a stressor intended to evoke state anxiety to an equivalent degree in both groups of participants, thereby fulfilling the third requirement of the study. This will be referred to as the Anxiety Evocation Phase. The stressor employed in this phase was a speech stressor. This involved telling the participants that, following the computer tasks, they would be required to give a speech about their personal experience at university which would be recorded and later shown to other students. Participants were also told that the students subsequently watching their recorded speech would be asked to rate them on the degree to which they exhibited signs of emotional distress during the speech. This was designed to induce the participant’s fear of social evaluation. After these instructions, participants were offered the opportunity to ask any questions. The participants were never actually required to give a speech.

State anxiety was assessed pre and post exposure to this speech stressor using VAMS
ratings, in order to verify that this evoked an increase in state anxiety and did so to an equivalent degree in both groups, as required.

The second phase of the task was designed to measure the subsequent rate of state anxiety dissipation, as needed to meet the fourth requirement of the study that state anxiety must dissipate over time. To do this, state anxiety was measured at five minute intervals across a 35 minute period subsequent to the speech stressor using VAMS. This will be referred to as the Anxiety Dissipation Phase. The intervals between each VAMS will be referred to as the Dissipation Phase Blocks, and (as will be discussed in the procedure) the Dot Probe CBM-A manipulation was delivered during these intervals. The post stressor rating and the subsequent 6 VAMS ratings gave rise to seven VAMS ratings and revealed the rate of decline in state anxiety throughout the Anxiety Dissipation Phase.

**Procedure**

Participants were seated in an individual testing room and provided with an information sheet and consent form. Once their written consent to participate was given, they completed the SIAS and STAI questionnaires, and received instructions for completing the Dot Probe CBM-A manipulation and the VAMS ratings. They then completed a short practice task, which consisted of four trials of benign word pairs presented in the same manner as the Dot Probe CBM-A manipulation, preceded and followed by a VAMS rating. Immediately following this practice, participants completed the first Attentional Bias Assessment Task. They were then administered the Anxiety Evocation Phase of the Anxiety Evocation and Dissipation Task. Then, across the Anxiety Dissipation Phase of the Anxiety Evocation and Dissipation Task they completed the Dot Probe CBM-A manipulation. Specifically, a Dot Probe CBM-A manipulation block was delivered during each of the six Anxiety Dissipation Phase
Attentional Bias and Social Anxiety

Blocks. Following this they completed the final Attentional Bias Assessment Task. Finally, participants were debriefed about the aim and design of the study.

**Results**

The accuracy to identify probe orientation during the Dot Probe CBM-A manipulation assessed whether participants completed the task as instructed and this permitted exclusion of participants who failed to show at least 75% correct probe discrimination. This resulted in the exclusion of three participants from the Control CBM-A Condition. Therefore, analyses were run with 32 participants in the Benign CBM-A Condition, and 28 participants in the Control CBM-A Condition. This results section will first report on the baseline dispositional and state anxiety characteristics of these participants. It will then report whether the Dot Probe CBM-A manipulation induced a group difference in selective attention to negative socially relevant information. The results section will then report the effect of the social stressor on evoking heightened state anxiety, and finally the effect of the Dot Probe CBM-A manipulation on Anxiety Dissipation. Prior to each analysis the assumptions of normality of distribution and homogeneity of variance were tested. Normality of distribution for each set of data was tested by considering tests of kurtosis and skewness with cutoff scores for both of above 3.29 as recommended by Field (2009). Homogeneity of variance was tested with Levene’s Test for Equality of Variances.

**Participant Characteristics at Test Time**

Anxiety scores obtained by participants are shown in Table 1. These anxiety scores were found to be normally distributed and the assumption of equality of variances was met. As shown in the final column of Table 1, participants in the two CBM-A Conditions did not significantly differ on any of these anxiety measures. Therefore, anxiety was not confounded with CBM-A Condition.
Attentional Bias and Social Anxiety

Table 1. Participant Characteristics at Test Time

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Benign CBM-A Condition Mean (SD)</th>
<th>Control CBM-A Condition Mean (SD)</th>
<th>t (df)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spielberger Trait Anxiety Inventory</td>
<td>53.66 (7.01)</td>
<td>55.11 (6.70)</td>
<td>.82 (58)</td>
<td>.42</td>
</tr>
<tr>
<td>Social Interaction Anxiety Scale</td>
<td>39.72 (12.73)</td>
<td>44.46 (9.11)</td>
<td>1.64 (58)</td>
<td>.11</td>
</tr>
<tr>
<td>Baseline State Anxiety</td>
<td>29.59 (11.37)</td>
<td>29.64 (11.68)</td>
<td>-.16 (58)</td>
<td>.99</td>
</tr>
</tbody>
</table>

Did the CBM-A Procedure Successfully Induce a Group Difference in Attentional Bias to Negative Information?

Correct probe discrimination latencies were employed as described earlier to compute an Attentional Bias to Negative Information (ABNI) Score, however initial data cleaning first screened for outliers among the correct probe discrimination latencies. Outliers were defined using a 95% confidence interval and as such were identified as probe discrimination latencies that fell more than 1.96 standard deviations from the participants’ mean reaction time for that trial type. Probe discrimination latencies were also considered outliers if they were less than 200ms or more than 2000ms. The subsequent ABNI Scores derived from the Attentional Bias Assessment Tasks implemented before and after the Dot Probe CBM-A manipulation are shown in Table 2. The Pre and Post Dot Probe CBM-A manipulation ABNI Scores in both conditions were found to be normally distributed and assumptions of sphericity and homogeneity of variance were met.
Table 2. Pre and Post Dot Probe CBM-A manipulation Attentional Bias to Negative Information Scores

<table>
<thead>
<tr>
<th>CBM-A Condition</th>
<th>Pre CBM-A manipulation ABNI Score (SD)</th>
<th>Post Dot CBM-A manipulation ABNI Score (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign</td>
<td>-2.38 (25.24)</td>
<td>-2.32 (29.07)</td>
</tr>
<tr>
<td>Control</td>
<td>1.36 (26.30)</td>
<td>15.12 (34.81)</td>
</tr>
</tbody>
</table>

To examine the second requirement of the study, whether the Dot Probe CBM-A manipulation successfully induced a group difference in attentional bias, the ABNI Scores were subjected to a mixed model ANOVA with Assessment Point as the within subjects factor (Pre CBM-A manipulation vs Post CBM-A manipulation) and CBM-A Condition as the between subjects factor (Benign vs. Control). If the Dot Probe CBM-A manipulation was successful in inducing a group difference in attentional bias, then this would give rise to an interaction between Assessment Point and CBM-A Condition reflecting no group difference in attentional bias pre Dot Probe CBM-A manipulation but a significant group difference in attentional bias observed post Dot Probe CBM-A manipulation. This significant post Dot Probe CBM-A manipulation group difference will be seen as participants in the Benign CBM-A Condition showing less attention to negative information than participants in the Control CBM-A Condition. The results revealed that in all cases $F(1, 57) \leq 1.94$ and did not reach significance. Of most importance there was no evidence of a significant interaction between Assessment Point and CBM-A Condition, $F(1, 57)=1.91$, $p=.17$, partial-$\eta^2=.03$. As this is a directional hypothesis a one tailed test would be warranted and in this case the result is still non-
significant. This indicates that the Dot Probe CBM-A manipulation failed to induce a group difference in attentional bias to negative information.

**Did the Stressor Evoke Heightened State Anxiety?**

The state anxiety VAMS ratings for both conditions pre and post the speech stressor were found to be normally distributed and assumptions of sphericity and homogeneity of variance were met. The third requirement of this study was that the stressor must evoke heightened state anxiety, and do so to an equivalent degree for participants assigned to each of the two CBM-A conditions. The state anxiety VAMS ratings obtained before and after the stressor are presented in Table 3.

*Table 3. Pre and Post Stressor Mean VAMS Ratings (SD’s in brackets)*

<table>
<thead>
<tr>
<th>Assessment Point</th>
<th>Benign CBM-A Condition Mean (SD)</th>
<th>Control CBM-A Condition Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Stressor</td>
<td>29.59 (11.37)</td>
<td>29.64 (11.68)</td>
</tr>
<tr>
<td>Post Stressor</td>
<td>42.50 (9.32)</td>
<td>47.86 (7.02)</td>
</tr>
</tbody>
</table>

These state anxiety VAMS ratings were subjected to a 2x2 repeated measures ANOVA with Assessment Point (Pre vs. Post Stressor) as the within subject factor and CBM-A Condition (Benign vs. Control) as the between subject factor. This revealed a significant main effect of Assessment Point, $F(1, 58)=108.81, p<.01$, partial-$\eta^2=.65$ which indicates that state anxiety was significantly elevated post stressor ($M=45.18$, $SD=8.35$) as compared to pre stressor ($M=26.62$, $SD=11.54$). No other effects were found to be significant. Of particular relevance the main effect of Assessment Point was not significantly modified by CBM-A Condition in the two way interaction, $F(1, 58)=3.17, p=.08$, partial-$\eta^2=.05$. This indicates that participants in each of the conditions did not experience a differential elevation in state anxiety following the stressor. These
Attentional Bias and Social Anxiety

results provide evidence that participants were experiencing heightened state anxiety to an equivalent degree in both groups of participants prior to beginning the Dot Probe CBM-A manipulation, as was required for the study.

Did the Dot Probe CBM-A Manipulation Affect the Rate of Anxiety Dissipation?

Given that the Dot Probe CBM-A manipulation did not succeed in inducing a group difference in this attentional bias, no effects of the process of bias modification on the rate of anxiety dissipation are expected. Despite this, the analysis of the rate of Anxiety Dissipation will be run. The seven state anxiety VAMS ratings subsequent to the speech stressor for each of the two CBM-A Conditions were found to be normally distributed and the assumption of homogeneity of variance was met. However, the assumption of sphericity was violated so Greenhouse-Geisser corrected tests are reported. Average state anxiety VAMS ratings for each assessment point across the Anxiety Dissipation Phase are presented in Figure 1.

![Average state anxiety VAMS ratings across the seven assessment points](attachment:image.png)

*Figure 1.* Average state anxiety VAMS ratings across the seven assessment points
The seven state anxiety VAMS ratings were subjected to a 2 x 7 Repeated Measures ANOVA with Assessment Point (seven Post Stressor time points) as the within subjects factor and CBM-A Condition (Benign vs. Control) as the between subjects factor. The only significant effect found was the main effect of Assessment Point, F(3.26, 188.95)=24.36, p<.01, partial-\eta^2=.30. A trend analysis revealed that this was due to a linear decline across time, F(1,58)=50.78, p<.05, partial-\eta^2=.47, as can be seen in Figure 1. This fulfilled the fourth requirement of the study that the induced state anxiety declined across the experimental window. However, the interaction of Assessment Point and CBM-A Condition did not approach significance, F(3.26, 188.95)=.42, p=.76, partial-\eta^2=.01 (again, this is a directional hypothesis so a one tailed test would be warranted and in this case the result is still non-significant) which indicates there was no difference between the two conditions in the rate in which the heightened state anxiety dissipated.

Discussion

The current study aimed to determine whether attentional bias to negative information causally contributes to Anxiety Dissipation. This was determined by examining whether a CBM-A procedure that successfully creates a group difference in selective attentional responding to socially negative information also serves to produce a group difference in the rate of Anxiety Dissipation following evocation of state anxiety. From this aim arose the experimental hypothesis that attentional bias to negative information causally contributes to Anxiety Dissipation. In order to test the proposed hypothesis, four requirements must have been met in this study. First, there could be no group difference in Dispositional Anxiety prior to beginning the experiment. Second, the CBM-A procedure had to induce a group difference in selective attention towards negative socially relevant information. Third, the speech stressor had
to evoke heightened state anxiety to an equivalent degree in both groups of participants. Fourth, there had to be a significant decline in state anxiety across the experimental window. The results section showed that all but one of these requirements was fulfilled, as will be discussed below.

In this study, the first requirement was met as no group difference was observed in general dispositional anxiety or in the specific disposition to experience social anxiety, at the beginning of the experiment. Thus, Dispositional Anxiety was not confounded with CBM-A Condition. The third requirement of the study was also met, as the introduction of the stressor significantly heightened state anxiety, and did so to an equivalent degree across all participants. The fourth requirement of the study was met as well, as this heightened state anxiety was seen to dissipate significantly across the duration of the study. Importantly, however, the second requirement was not fulfilled, as the CBM-A procedure did not produce the intended and required group difference in selective attentional responding to socially negative information. As mentioned earlier, the hypothesis that attentional bias causally contributes to Anxiety Dissipation generated a conditional prediction and can only be tested if a group difference in attentional bias towards negative information was successfully induced. Therefore, it is not possible to determine whether attentional bias to negative information causally contributes to Anxiety Dissipation on the basis of the findings produced by this study (Macleod & Clarke, 2015; Clarke, Notebaert, & MacLeod, 2014; Grafton, MacLeod, Rudaizky, Holmes, Salemink, Fox, & Notebaert, 2017). Despite the fact that the requirement of inducing a group difference in attentional bias was not met, analyses were still run on the rate of decline in state anxiety. Critically, the results revealed that state anxiety declined significantly across all participants, but no group difference in the rate of this dissipation was found.
Research has now shown that in order to see an effect on mood that is subsequent to a CBM-A procedure then the CBM-A procedure must have had an effect on attentional bias (P. Clarke, Notebaert, & MacLeod, 2014). For a long time now it has not been uncommon to find that procedures intended to modify attentional bias fail to consistently produce this intended group difference in selective attention to negative information (Emmelkamp, 2012). However, a study by MacLeod & Clarke (2015) showed that it is not possible to draw conclusions about group differences in state anxiety if this group difference in attentional bias is not successful. They drew from all the CBM-A literature to make the discovery that all studies that did report a successful group difference in attentional bias following CBM-A also reported significant effects on mood. Moreover, all studies that did not find this bias change reported no significant effects on mood. This has been a pivotal finding for CBM-A research and suggests that a group difference in attentional bias will result in a group difference in mood, but this is not entirely the case. Having an effect on attentional bias does not guarantee a mood effect, but rather the group difference in attentional bias is necessary in order to observe whether the subsequent effect on mood actually exists. This is highly relevant for the current study as it is important here not to conclude that the absence of a group difference in Anxiety Dissipation means that it does not exist and suggest no causal contribution of attentional bias to diminished Anxiety Dissipation. Rather, as the CBM-A procedure was not successful in inducing a group difference in attentional bias, there is no way to see how attentional bias to negative information impacts on diminished Anxiety Dissipation. Thus, further research is required.

Given that the absence of a group difference in attention bias means it is not possible to determine whether or not the CBM-A procedure serves to produce a group difference in Anxiety Dissipation, it is necessary to make amendments to the study in order to
Attentional Bias and Social Anxiety

successfully induce this group difference in attentional bias. One possible limitation is that the study may not have been well powered to detect the intended effect. Therefore, a post hoc power analysis was conducted using the software package, GPower (Faul and Erdfelder 1992), to explore this limitation. The sample size of 60 was used for the statistical power analyses. The recommended effect sizes used for this assessment were as follows: small (partial-η²=.01), medium (partial-η²=.06), and large (partial-η²=.14). The alpha level used for this analysis was \( p < .05 \). The post hoc analyses revealed the statistical power for this study was .12 for detecting a small effect and .47 for detecting a moderate effect, whereas the power was .85 for the detection of a large effect size. Thus, there was more than adequate power (i.e., power \* .80) at the large effect size level, but less than adequate statistical power at the small to medium effect size level.

The efficacy of the task in modifying attentional bias is an important consideration and changes to the task could potentially be necessary for achieving a change in attentional bias, this will be discussed in more detail in the General Discussion. As previously described, there are two types of stressors that will be employed in this research program in order to determine the generalisability of the effects found in the study. Therefore, the following study aims to test the same hypothesis as the current study by administering an exam stressor. As described in the General Introduction, the stressor will concern worry about exams for test anxious students. Therefore, the next study in this research project will determine if a CBM-A procedure that successfully creates a group difference in attentional bias towards negative test relevant information also serves to produce a group difference in the rate of Anxiety Dissipation following evocation of more modest state anxiety elevation.
Chapter 3: Does Attentional Bias to Negative Information Causally Contribute to Diminished Anxiety Dissipation in Test Anxious Individuals?
CHAPTER 3

As will be recalled from the previous chapters, there are two stressors that will be employed in this research project in order to determine whether any outcome effects are generalisable to different types of stressors. In Chapter 2 the social stressor was delivered which successfully evoked heightened state anxiety and saw a decline in state anxiety across the experimental window. However, the Dot Probe CBM-A manipulation was not successful in inducing a group difference in attentional bias and as such the hypothesis could not be tested. Therefore, no clear conclusions could be drawn in regards to the hypothesis. Despite this, to determine whether the requirements of the study can be met it is considered necessary to introduce a different stressor to evoke heightened state anxiety. As such, in the current study an exam stressor was administered to evoke heightened state anxiety and the negative stimuli used in the Dot Probe CBM-A manipulation was tailored to be relevant to the concerns of test anxious individuals.

Test anxiety is the tendency to experience heightened state anxiety in anticipation of and/or during examinations or tests (Sarason, 1980). There exists a firm theoretical background to suggest that test anxiety is characterised by negative information processing biases. A literature review from Wine (1971) identified negative interpretation bias and attentional bias to negative information to be core characterising features of test anxiety alongside worry and rumination. This theory is also supported by current research assessing the impact of test anxiety on working memory (Calvo & Eysenck, 1996), inferential reasoning skills (Richards, French, Keogh & Carter, 2000) and worry (Eysenck & Calvo, 1992, Sarason, 1988). However, while this literature suggests negative information processing biases as characterising test anxiety, there is
only one study to date that assesses attentional bias to negative information in participants with elevated test anxiety. Putwain, Langdale, Woods, & Nicholson (2011) assessed attentional bias to negative test relevant information using the Dot Probe CBM-A manipulation in high and low test anxious participants. The results showed that participants high in test anxiety demonstrated an attentional bias towards negative test relevant information that was not seen for individuals low in test anxiety. This provides evidence that elevated disposition to experience test anxiety is characterised by an attentional bias towards negative information. However, there are no studies to date that have examined the causal relationship between disposition to experience elevated test anxiety and attentional bias to negative information. Therefore, the current study will be the first to explore this causal relationship.

As with Experiment 1, the current study aimed to determine whether attentional bias to negative information causally contributes to diminished Anxiety Dissipation. This study was designed to determine whether a CBM-A procedure that successfully creates a group difference in selective attentional responding towards negative information also serves to produce a group difference in the rate of Anxiety Dissipation following evocation of state anxiety using an exam stressor. To address this aim, participants were first allocated to one of two CBM-A conditions. Participants allocated to the Benign CBM-A Condition completed a CBM-A Task designed to encourage an attentional bias away from test relevant negative information. Those allocated to the Control CBM-A Condition completed a control variant of the CBM-A Task that was configured in a manner that did not encourage a directional attentional bias. In order to maximise the capacity of the exam stressor to evoke state anxiety, participants selected to take part in the current study were individuals with an elevated disposition for test anxiety. As the stressor references the participants’ upcoming exams, the experiment
was carried out in the study week prior to the exam period. This exam stressor involved instructing the participants to worry about their upcoming exams, with emphasis placed on the need to experience the same thoughts and emotions as they usually would when worrying about exams. The dissipation of state anxiety elevated by the exam stressor was monitored to measure variability in the decline of state anxiety, and as such index the rate of Anxiety Dissipation.

It is hypothesised that attentional bias to negative information causally contributes to diminished Anxiety dissipation. This hypothesis generates the prediction that, if the CBM-A procedure is successful in inducing a group difference in selective attention towards negative information, then this will serve to induce a group difference in the rate of Anxiety Dissipation following evocation of heightened state anxiety using an exam stressor. Specifically, if it is the case that attentional bias to negative information causally contributes to diminished Anxiety Dissipation, then participants in the Benign CBM-A Condition will show a significantly greater rate of Anxiety Dissipation than participants in the Control CBM-A Condition. In order to adequately evaluate the hypothesis, four critical requirements need to be met. First, there must be no group difference in Dispositional Anxiety prior to beginning the experiment. Second, the CBM-A procedure must induce a group difference in attentional bias such that participants in the Benign CBM-A Condition demonstrate significantly less selective attention towards negative information than participants in the Control CBM-A Condition. Third, the stressor must evoke heightened state anxiety and do so to an equivalent degree in both groups of participants prior to delivery of the CBM-A procedure. Fourth, there must be a significant decline in state anxiety across the experimental window. It is expected that should all the requirements be met then the CBM-A procedure will produce a differential decline in state anxiety.
Method

Participants

This study required participants with a high disposition to experience test anxiety, thus 47 participants were recruited based on their scores on the Revised Test Anxiety Scale (RTAS; Benson, et al., 1992). These participants were recruited from the full first year Psychology student cohort at The University of Western Australia, who were screened on the RTAS. The students invited to participate all scored in the top third of this sample’s RTAS score distribution (i.e. above 47). The participants, 38 of whom were female, had an average age of 18.45 years (SD=2.00), and received partial course credit in exchange for participation.

Participants were randomly allocated to one of two CBM-A Training Conditions. Participants allocated to the Benign CBM-A Training Condition completed a CBM-A Training Task configured to encourage selective attention towards benign information and away from negative information. Participants allocated to the Control CBM-A Training Condition completed a control version of this task that was not configured to modify selective attention. Participants assigned to each of the two CBM-A Training Conditions did not significantly differ in age, t(33.63)=.93, p=.36, d=.27 (assumption of homogeneity of variances was violated, results for equal variances not assumed has been reported) or in gender ratio, χ²=.20, p=.66, w=.06.

Materials

Emotional Assessment Instruments

Revised Test Anxiety Scale (RTAS). The RTAS (Benson, et al., 1992) was used as the screening tool that guided participant recruitment. In order to verify that this element of the first requirement of the study was met, the RTAS was also used to confirm that participants assigned to the two CBM-A Training Conditions did not
initially differ in their disposition to experience test anxiety. The RTAS is a self-report scale used to assess the severity of fears around completing tests and exams. It consists of 20 statements that describe emotional, physical and cognitive reactions during test situations, for example “During tests I feel very tense” and “While taking a test I often think about how difficult it is”. Respondents are required to indicate how often the statements are true for them by selecting on a 4 point Likert scale ranging from 1 (Almost Never) to 4 (Almost Always). Total scores range from 20 to 80, with higher scores on this scale indicating elevated disposition to experience test anxiety. The RTAS has been shown to have good construct validity and reliability (Benson, et al., 1992).

Spielberger Trait Anxiety Inventory (STAI). As in Experiment 1, the trait version of the State-Trait Anxiety Inventory (Spielberger et al, 1983) was used to verify that participants assigned to the two CBM-A Conditions did not significantly differ in dispositional anxiety, thereby fulfilling this second element of the first requirement of the study.

Visual Analogue Mood Scale (VAMS). Also as in Experiment 1, a VAMS was used to assess anxious mood state at various points during the study. The purpose of this was to verify that state anxiety was evoked by the stressor, as well as to provide an index of the subsequent dissipation of this evoked state anxiety, in order to fulfil the third and fourth requirements of the study. The VAMS yielded a score between 0 (relaxed) to 60 (anxious).

Experimental Stimuli

Experimental Word Pairs. The Dot Probe CBM-A manipulation and Attentional Bias Assessment Task employed word pairs as stimuli. Each word pair consisted of one word that was negative in emotional meaning and related to concerns
typical of test anxiety (e.g. “EXAM”), and one of equivalent letter length that was benign in emotional meaning (e.g. “PONY”). They were selected from a larger group of words that were rated by six individuals on Valence (1=Not at all negative to 5=Very negative) and Relevance to Test Anxiety (1=Not at all relevant to 5= Very relevant). From these ratings, 96 word pairs were formed by selecting one word with the highest association with test anxiety and rated as having negative valence and one other word selected based on its identification as having the least negative valence, with each pair matched for letter length. From these word pairs a set of 48 word pairs was selected for the Dot Probe CBM-A manipulation and the remaining 48 word pairs were selected for the Attentional Bias Assessment Task.

Experimental Tasks

*Dot Probe CBM-A manipulation.* The Dot Probe CBM-A manipulation was identical to Chapter 2. This consisted of a modified version of the standard Dot Probe Task developed by MacLeod, Mathews, & Tata (1986), which was configured with the intention of manipulating attentional bias. This task was designed to induce a group difference in selective attention in response to emotionally negative stimuli, the second requirement of this study. As can be recalled, each trial began with a fixation cross presented in the centre of the screen for 500ms, followed by a word pair presented for 1000ms. A probe then appeared in the location previously occupied by one of the words and participants were required to identify as quickly as possible whether the probe was angled to the left or right and indicate this by clicking the left or right mouse button, respectively. The task consisted of 6 blocks of 96 trials and participants were provided a self-paced break at the end of each block. In each block, each of 48 word pairs was presented twice in a random order for a total of 96 trials per block. The negative word was presented in the top and bottom position with equal frequency and the probe was
angled to the left on half the trials and to the right on half the trials. In the Benign CBM-A Condition the probe always appeared in the location of the benign word on every trial, with the objective of training attention away from negative information. In the Control Condition there was no such training contingency. Therefore, in this condition the probe appeared in location of the benign word on half of the trials and in the location of the negative word for the other half. Accuracy in identifying the direction of probe was recorded on each trial in order to verify that participants were completing the task as instructed. As completing the task as instructed is necessary before the procedure could induce attentional bias, it was required that participants display an accuracy level substantially above chance (50%) on probe discrimination. Therefore, the inclusion criterion was set at 75% accuracy for probe discrimination on Dot Probe CBM-A manipulation trials, and participants who fell below this accuracy level were excluded from analysis.

**Attentional Bias Assessment Task.** The Attentional Bias Assessment Task used in the present study was identical to the Attentional Bias Assessment Task described in Experiment 1. This task was delivered immediately prior to and following the Dot Probe CBM-A manipulation to determine whether the Dot Probe CBM-A manipulation was successful in inducing a group difference in selective attentional response to negative test anxiety relevant information, thereby fulfilling the third requirement of study. The Attentional Bias Assessment Task consisted of one block of 96 trials (with each assessment word pair presented twice in a random order). The degree to which the participants allocated attention towards the location of the probe would be expected to result in faster discrimination latency for that probe. Therefore, the degree to which participants were speeded in the locus of benign information compared to the locus of negative information would index the degree to which attention was oriented towards
the negative. As with Experiment 1, the reaction time (milliseconds) to correctly
discriminate the probe’s direction was recorded on each trial and used to calculate an
Attentional Bias to Negative Information Score (incorrect responses were not used in
the computation). An index of attentional bias towards negative information can be
computed by subtracting the correct probe discrimination latencies on trials where the
probe replaced the negative word from the correct probe discrimination latencies on
trials where the probe replaced the benign word.

*State Anxiety Evocation and Dissipation Task.* This task consisted of two
phases. The first phase of the task was designed to elevate state anxiety, to an equivalent
degree in both groups of participants, by exposing them to a stressor, thereby fulfilling
the third requirement of the study. This will be referred to as the Anxiety Evocation
Phase. The stressor employed in this phase was an exam stressor which involved a
worry manipulation. Participants were instructed to engage in intense worry about their
upcoming exams for a five minute period. Participants were initially informed that this
was a very important part of the task and were instructed to try very hard to succeed in
evoking this worry. They were then told to focus on holding in mind the kinds of
worrying thoughts, and evoking the same emotional and mental experiences that they
would usually have when worrying about exams. The experimenter left the room during
this time to return when the five minute period was over. After the five minutes the
participant was informed that the worry period was over and told it was no longer
necessary to make a conscious effort to worry about the exams. State anxiety was
assessed pre- and post-exposure to this exam stressor using VAMS ratings, in order to
verify that this evoked an increase in state anxiety and did so to an equivalent degree in
both groups, as required.
The second phase of the task was designed to measure the subsequent rate of state Anxiety Dissipation, as needed to meet the fourth requirement of the study that heightened state anxiety must dissipate. To do this, state anxiety was measured at five minute intervals across a 35 minute period subsequent to the exam stressor using VAMS. This will be referred to as the Anxiety Dissipation Phase. The intervals between each VAMS will be referred to as the Dissipation Phase Blocks, and (as will be discussed in the procedure) the Dot Probe CBM-A manipulation was delivered during these intervals. The post stressor rating and the subsequent 6 VAMS ratings gave rise to seven VAMS ratings and revealed the rate of decline in state anxiety throughout the Anxiety Dissipation Phase.

**Procedure**

Participants were seated in an individual testing room and provided with an information sheet and consent form. Once their written consent to participate was given, they completed the RTAS and STAI questionnaires, and received instructions for completing the Dot Probe CBM-A manipulation and the VAMS ratings. They then completed a short practice task, which consisted of four trials of benign word pairs presented in the same manner as the Dot Probe CBM-A manipulation, preceded and followed by a VAMS rating. Immediately following this practice, participants completed the first Attentional Bias Assessment Task. They were then administered the Anxiety Evocation Phase of the Anxiety Evocation and Dissipation Task. Then, across the Anxiety Dissipation Phase of the Anxiety Evocation and Dissipation Task they completed the Dot Probe CBM-A manipulation. Specifically, a Dot Probe CBM-A manipulation block was delivered during each of the six Anxiety Dissipation Phase Blocks. Following this, they completed the final Attentional Bias Assessment Task. Finally, participants were debriefed about the aim and design of the study.
Results

The accuracy to identify probe orientation during the Dot Probe CBM-A manipulation assessed whether participants completed the task as instructed and this permitted exclusion of participants who failed to show at least 75% correct probe discrimination. No such cases existed therefore analyses continued with 23 participants in the Benign CBM-A Condition, and 24 participants in the Control CBM-A Condition. This results section will first report on the baseline dispositional and state anxiety characteristics of these participants. It will then report whether the Dot Probe CBM-A manipulation induced a group difference in selective attention to negative test relevant information. The results section will then report the effect of the exam stressor on evoking heightened state anxiety, and finally the effect of the Dot Probe CBM-A manipulation on Anxiety Dissipation. Prior to each analysis the assumptions of normality of distribution and homogeneity of variance were tested. Normality of distribution was tested by considering tests of kurtosis and skewness with cutoff scores for both of above 3.29 as recommended by Field (2009). Homogeneity of variance was tested with Levene’s Test for Equality of Variances.

Participant Characteristics at Test Time

Anxiety scores obtained by participants are shown in Table 1. These anxiety scores were found to be normally distributed and the assumption of equality of variances was met. As shown in the final column of Table 1, participants in the two CBM-A Conditions did not significantly differ on any of these anxiety measures. Therefore, anxiety was not confounded with CBM-A condition.
Table 1. Participant Characteristics at Test Time

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Benign CBM-A</th>
<th>Control CBM-A</th>
<th>t (df)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Condition Mean (SD)</td>
<td>Condition Mean (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spielberger Trait Anxiety</td>
<td>48.18 (2.99)</td>
<td>48.87 (3.14)</td>
<td>-0.75 (43)</td>
<td>.46</td>
</tr>
<tr>
<td>Revised Test Anxiety Scale</td>
<td>46.04 (9.92)</td>
<td>45.63 (8.34)</td>
<td>0.16 (45)</td>
<td>.88</td>
</tr>
<tr>
<td>Baseline State Anxiety</td>
<td>21.96 (13.33)</td>
<td>22.46 (12.78)</td>
<td>-0.13 (45)</td>
<td>.90</td>
</tr>
</tbody>
</table>

**Did the CBM-A Procedure Successfully Induce a Group Difference in Attentional Bias to Negative Information?**

Correct probe discrimination latencies were employed as described earlier to compute an Attentional Bias to Negative Information (ABNI) Score, however initial data cleaning first screened for outliers among the correct probe discrimination latencies. Outliers were defined using a 95% confidence interval and as such were identified as probe discrimination latencies that fell more than 1.96 standard deviations from the participants’ mean reaction time for that trial type. Probe discrimination latencies were also considered outliers if they were less than 200ms or more than 2000ms. The subsequent ABNI Scores derived from the Attentional Bias Assessment Tasks implemented before and after the Dot Probe CBM-A manipulation are shown in Table 2. Pre and Post Dot Probe CBM-A manipulation ABNI Scores were each checked for normality which revealed both were skewed. A log transformation was performed on the data and showed no changes to the results of the analysis, therefore analyses
Attentional Bias and Test Anxiety

using the untransformed data have been reported. These scores were also checked for
sphericity and homogeneity of variance, and both of these assumptions were met.

*Table 2. Pre and Post CBM-A manipulation Attentional Bias to Negative Information
Scores*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Pre CBM-A manipulation ABNI Score (SD)</th>
<th>Post CBM-A manipulation ABNI Score (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign CBM-A</td>
<td>-1.48 (23.60)</td>
<td>9.54 (44.05)</td>
</tr>
<tr>
<td>Control</td>
<td>4.29 (22.72)</td>
<td>0.25 (23.57)</td>
</tr>
</tbody>
</table>

To examine the second requirement of the study, whether the Dot Probe CBM-A
manipulation successfully induced a group difference in attentional bias, the ABNI
Scores were subjected to a mixed model ANOVA, with Assessment Point as the within
subjects factor (Pre CBM-A manipulation vs Post CBM-A manipulation) and Condition
as the between subjects factor (Benign CBM-A vs. Control). If the Dot Probe CBM-A
manipulation was successful in inducing a group difference in attentional bias, then this
would give rise to an interaction between Assessment Point and Condition reflecting no
group differences in attentional bias being observed pre Dot Probe CBM-A
manipulation but a significant group difference in attentional bias being observed post
Dot Probe CBM-A manipulation. This significant post Dot Probe CBM-A manipulation
group difference will be seen as participants in the Benign CBM-A Condition showing
less attention to negative information than participants in the Control CBM-A
Condition. The results revealed that in all cases $F(1, 45) \leq 1.50$ and did not reach
significance. Of most importance there was no evidence of a significant interaction
between Assessment Point and CBM-A Condition, F(1, 45)=1.50, p=.23, partial-\(\eta^2=.03\) (not significant with a one tailed test). This indicates that the Dot Probe CBM-A manipulation failed to induce a group difference in attentional bias to negative information.

**Did the Stressor Evoke Heightened State Anxiety?**

The state anxiety VAMS ratings for both conditions pre and post the exam stressor were found to be normally distributed and assumptions of sphericity and homogeneity of variance were met. The third requirement of this study was that the stressor must evoke heightened state anxiety, and did so to an equivalent degree for participants assigned to each of the two CBM-A conditions. The state anxiety VAMS ratings obtained before and after the stressor are presented in Table 3.

<table>
<thead>
<tr>
<th>Table 3. Pre and Post Stressor Mean VAMS ratings (SDs in brackets)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benign CBM-A</strong></td>
</tr>
<tr>
<td>Condition Mean (SD)</td>
</tr>
<tr>
<td>Pre Stressor</td>
</tr>
<tr>
<td>Post Stressor</td>
</tr>
</tbody>
</table>

These state anxiety VAMS ratings were subjected to a 2x2 repeated measures ANOVA with Assessment Point (Pre vs. Post Stressor) as the within subject factor and CBM-A Condition (Benign vs. Control) as the between subject factor. This revealed a significant main effect of Assessment Point, F(1, 45)=43.90, p<.05, partial-\(\eta^2=.49\), which indicates that state anxiety was significantly elevated post stressor (M=33.03, SD=12.42) as compared to pre stressor (M= 22.21, SD=13.06). No other effects were found to be significant but of most importance the main effect of Assessment Point was
not significantly modified by Condition in the two way interaction, \( F(1, 45)=0.07, \) \( p=.79 \), partial-\( \eta^2=.00 \). This indicates that participants in each of the CBM-A conditions did not experience a differential elevation in state anxiety in response to the stressor. These results show that all participants were experiencing heightened state anxiety to an equivalent degree in each of the conditions, prior to beginning the Dot Probe CBM-A manipulation, as was required for the study.

**Did the Dot Probe CBM-A Manipulation Affect the Rate of Anxiety Dissipation?**

As with Experiment 1, the Dot Probe CBM-A manipulation did not succeed in inducing a group difference in attentional bias to negative information. As such, no effects of CBM-A on the rate of anxiety dissipation are expected. Despite this, the analysis of the rate of Anxiety Dissipation will be run. The seven state anxiety VAMS ratings subsequent to the exam stressor for each of the two CBM-A Conditions were found to be normally distributed and the assumption of homogeneity was met. However, the assumption of sphericity was violated therefore Greenhouse-Geisser corrected tests are reported. Average state anxiety VAMS ratings for each assessment point across the Anxiety Dissipation Phase are presented in Figure 1.
The seven state anxiety VAMS ratings were subjected to a 2 x 7 Repeated Measures ANOVA with Assessment Point (seven Post Stressor time points) as the within subjects factor and CBM-A Condition (Benign vs. Control) as the between subjects factor. The fourth requirement of this study stipulates that state anxiety must decline across time, to an equivalent degree in each of the experimental groups. This will be seen as a progressive decline in state anxiety across time, as indicated by a main effect of Assessment Point that is either linear or quadratic in nature. The only significant effect found was the main effect of Assessment Point, $F(3.60, 161.84)=3.92$, $p<.05$, partial-$\eta^2=.08$. A trend analysis revealed that this was due to a linear decline across time, $F(1, 45)=7.21$, $p<.05$, partial-$\eta^2=.14$, as can be seen in Figure 1. This fulfilled the fourth requirement of the study that the induced state anxiety dissipated across the duration of the experimental window. However, the interaction of

Figure 1. Average state anxiety VAMS ratings across the seven assessment points
Attentional Bias and Test Anxiety

Assessment Point and CBM-A Condition did not approach significance, $F(3.60, 161.84)=1.43$, $p=.23$, partial-$\eta^2=.03$ (not significant with a one tailed test). This indicates there was no difference between the two conditions in the rate in which the heightened state anxiety dissipated.

**Discussion**

The current study aimed to determine whether attentional bias to negative information causally contributes to Anxiety Dissipation. This was determined by examining whether a CBM-A procedure that successfully creates a group difference in selective attentional responding to test relevant negative information also serves to produce a group difference in the rate of Anxiety Dissipation following evocation of state anxiety. From this aim arose the theoretical hypothesis that attentional bias to negative information causally contributes to Anxiety Dissipation. In order to test the proposed hypothesis, four requirements must have been met in this study. As with Experiment 1, the results section showed that all but one of these requirements was fulfilled, as will be discussed below. In this study, the first requirement was met as no group difference was observed in Dispositional Anxiety or in the specific disposition to experience test anxiety, at the beginning the experiment. Thus, Dispositional Anxiety was not confounded with CBM-A Condition. The second requirement of the study, that the CBM-A procedure had to induce a group difference in selective attention towards negative test relevant information, was not fulfilled as no significant group difference was observed. The third requirement of the study is that the exam stressor had to evoke heightened state anxiety to an equivalent degree in both groups of participants. This requirement was met as the introduction of the stressor significantly heightened state anxiety to an equivalent degree across all participants. Finally, the fourth requirement of the study, that there had to be a significant decline in state anxiety across the
experimental window, was also met. The heightened state anxiety evoked by the exam stressor declined significantly across the duration of the study.

As explained in Experiment 1, the theoretical hypothesis that attentional bias to negative information causally contributes to diminished Anxiety Dissipation generated a conditional prediction and can only be tested if that condition is met. Therefore, again, it is not possible to determine the causal contribution of attentional bias to negative information to Anxiety Dissipation on the basis of the findings produced by this study. Despite this requirement not being met, analyses were run on the rate of decline in state anxiety. Critically, the results revealed that state anxiety declined significantly across all participants, but no group difference in the rate of this dissipation was found. As explained in the Experiment 1, in order to see an effect on mood that is subsequent to a CBM-A procedure then the CBM-A procedure must have had an effect on attentional bias (P. Clarke et al., 2014), and so it is not surprising to find no evidence of a group difference in Anxiety Dissipation given this requirement was not met.

There is now cause to question what factors are contributing to the lack of a group difference in attentional bias to negative information following completion of the Dot Probe CBM-A manipulation. Two key explanations for a lack of a significant finding are the type of stressors employed and the efficacy of the Dot Probe CBM-A manipulation itself. In terms of the stressors, it may be the case that attentional change is not possible when participants are experiencing heightened state anxiety due to a decrease in cognitive control and the type of state anxiety they are experiencing. These will be explored further in the General Discussion. In regards to the efficacy of the Dot Probe CBM-A manipulation, it is now necessary to consider the possibility that there may be a problem with the task itself. For the purposes of the current research program the Dot Probe Task was considered to be the ideal CBM-A procedure to employ, as was
Attentional Bias and Test Anxiety

outlined in the General Introduction. However, it does not come without limitations. One of the primary limitations of the Dot Probe CBM-A manipulation is that it is not reliable in inducing a group difference in attentional bias to negative information, as was highlighted in the Macleod & Clarke (2015) review. There is a lot of variation in the results of studies that employ the Dot Probe CBM-A manipulation with some finding success in the manipulation. But, many others have found that the Dot Probe CBM-A manipulation was not successful in inducing a group difference in selective attention to negative information, as has been the case for the current research program. Therefore, this variation brings the efficacy of this as a CBM-A procedure into question, particularly as it was originally designed as an assessment task. Another limitation is that the Dot Probe CBM-A manipulation is monotonous in nature and the protocol is a very simple static display that usually presents only two stationary emotional stimuli, which can lead to boredom, fatigue and loss of concentration. Also, this does not reflect the real world patterns of attentional selectivity that require individuals to scan a complex and dynamic environment. Finally, one possible limitation is that the study may not have been well powered to detect the intended effect. Therefore, a post hoc power analysis was conducted using the software package, GPower (Faul and Erdfelder 1992). The sample size of 47 was used for the statistical power analyses. The recommended effect sizes used for this assessment were as follows: small (partial-$\eta^2=.01$), medium (partial-$\eta^2=.06$), and large (partial-$\eta^2=.14$). The alpha level used for this analysis was $p < .05$. The post hoc analyses revealed the statistical power for this study was .10 for detecting a small effect and .38 for detecting a moderate effect, whereas the power was .75 for the detection of a large effect size. This indicates that there was not adequate power in this study to find the intended effect and more participants are required.
The apparent limitations of the Dot Probe CBM-A manipulation led researchers to discuss the need for a novel CBM-A procedure that is more effective in inducing a group difference in attentional bias to negative information. Also, many researchers have suggested that novel CBM-A tasks should be gamified in a way that better represents the real world and are more engaging for the participants, as a means to strengthen the magnitude of the attentional bias change and improve reliability (Bar-Haim, 2010; Beard, 2011; P. Clarke et al., 2014; Hallion & Ruscio, 2011; Van Bockstaele et al., 2014). However, it is of most importance when developing these novel CBM-A tasks to focus on being more effective than the Dot Probe CBM-A manipulation. In order to determine whether they are better than the Dot Probe CBM-A manipulation they must be evaluated on their success in modifying attentional bias, then compared to the Dot Probe CBM-A manipulation to demonstrate that it is more effective and finally the effects must be replicated in additional studies. The following study aims to test the current research projects hypothesis by introducing a newly developed CBM-A task. The novel CBM-A task will be selected from the literature based on how effective it is in inducing a group difference in attentional bias compared to the Dot Probe CBM-A manipulation.
Chapter 4: Does Attentional Bias to Negative Information Causally Contribute to Diminished Anxiety Dissipation in Socially Anxious Individuals? Introducing the Emotion-in-Motion CBM-A Procedure
CHAPTER 4

The two experiments conducted in the research program thus far have employed a modified version of the Dot Probe Task with the intention of modifying attentional bias in order to determine whether attentional bias to negative information causally contributes to diminished Anxiety Dissipation. Both studies have been unsuccessful in inducing a group difference in attentional bias and so have not met the necessary requirements needed to assess the effect of CBM-A on Anxiety Dissipation. Unfortunately, this means that the theoretical hypothesis could not be tested. It was suggested that the Dot Probe CBM-A manipulation may not be the optimal procedure for inducing a group difference in attentional bias. Therefore, the current study will employ a newly developed CBM-A task, chosen from the literature, to address the aim of the research project. The CBM-A task chosen will be based on three selection criteria, 1. The task must be evaluated on its success in modifying attentional bias, 2. The task should be compared to the Dot Probe CBM-A manipulation to demonstrate that it is more effective and, 3. The effects have been replicated in additional studies.

Many researchers have sought to develop a variety of novel CBM-A tasks, updated versions of the Dot Probe CBM-A manipulation and new methods of delivering the Dot Probe CBM-A manipulation with the aim of creating an CBM-A approach that is more capable of producing a group difference in attentional bias than the Dot Probe CBM-A manipulation (Urech, Krieger, Chesham, Mast, & Berger, 2015; Amir, Kuckertz, & Strege, 2016; Dennis-Tiway, Egan, Babkirk, & Denefrio, 2016). For example, Enock, Hofmann, & McNally (2014) delivered the Dot Probe CBM-A manipulation via smart phones. This change in the mode of delivering the Dot Probe CBM-A manipulation may increase the effectiveness of the bias modification process as
the task is readily available so participants may access it more frequently. In this study, individuals high in disposition to experience social anxiety, generalised anxiety or worry were recruited. Participants were allocated to either a Control CBM-A condition, or a Benign CBM-A condition and were instructed to complete the Dot Probe CBM-A manipulation three times a day for a four week training period on their smartphone. Attentional bias to negative information was assessed on their smart phone and symptoms of social anxiety were measured using the SIAS prior to beginning the training, and at the end of each week during the training period. A multilevel linear modelling analysis revealed a significant group difference in attentional bias, showing that participants who completed the Benign CBM-A task on their smart phone demonstrated less attention towards negative information than participants who completed the Control CBM-A task on their smartphone. However, the researchers pointed out that this effect was small and when the data was analysed in the traditional fashion the results were not significant. Therefore, using the Dot Probe CBM-A manipulation on a smart phone has not yet been found to be an effective method of modifying attentional bias to reduce Dispositional Anxiety. This means that it does not meet the first of the selection criteria. Further, the effects found in the study have not been compared against the original Dot Probe CBM-A manipulation nor have they been replicated and as such this version of the Dot Probe CBM-A manipulation does not meet the other two selection criteria needed to be chosen for the current study.

Bernstein & Zvielli (2014) developed an updated version of the Dot Probe CBM-A manipulation for modifying attentional bias. This updated variant, which they call Attention Feedback Awareness and Control Training (A-FACT) consisted of delivering the Dot Probe CBM-A manipulation while providing feedback to the participant regarding their allocation of attention. The Dot Probe CBM-A manipulation
consisted of 60 neutral trials which presented two neutral images, and 40 threat trials which presented one threatening and one neutral image. For the threat trials, the probe was presented in the locus of the threatening image on 20 of the trials and in the locus of the neutral image the other 20 trials. Feedback was presented in the form of a “bias scale” which consisted of a scale with end points of “Bias” and “No Bias” and an arrow directed at a point along the scale. The arrow indicated the participant’s individual attentional bias score for that trial and was calculated by comparing the reaction time to that trial with their baseline neutral trial mean reaction time. Participants were presented with the “bias scale” following completion of trials that have included certain threat images (e.g. trials that present a snake as the threat). Participants were informed that the bias scale reflected the degree to which their attention was influenced by a threatening image on the preceding trial only. This study recruited participants who were both high in Dispositional Anxiety and demonstrated an attentional bias to negative information. Participants were allocated to either the A-FACT Condition or Control Condition. In the A-FACT condition participants were instructed to learn from the bias scale feedback to reduce their attentional bias. In the Control Condition participants were told that the bias scale represents their allocation of attention but are not instructed to learn from the scale. The results revealed a significantly greater reduction in attentional bias to threat images in the A-FACT Condition than the Control Condition demonstrating that it was successful in creating a group differences in attentional bias to negative information. The success of this task in modifying attentional bias justifies it as a possibility for use in the current study as it meets the first selection criteria. However, the effects were not compared with the original Dot Probe CBM-A manipulation nor have the effects been replicated at the time of this study, both of which are selection criteria that cannot be
evaluated. Therefore, this task is also not considered suitable for use in the current study.

One study that did compare the effect of modifying attentional bias in a novel task with the original Dot Probe CBM-A manipulation was created by Notebaert, Clarke, Grafton, and MacLeod (2015). This novel task consisted of a virtual card game based on the traditional card game “Snap”. Each card displayed two faces, one depicting a happy face and one depicting an angry face. Participants had to judge whether the identity of the face on each successive card matched one of the faces on the previous card. Participants allocated to the Benign CBM-A Condition were required to determine whether the person showing the happy expression was the same individual on each successive card. This was designed to encourage selective attention towards happy faces. Conversely, participants in the Negative CBM-A Condition made a similar matching decision based on the identities of the angry faces, which was designed to encourage selective attention towards angry faces. In this study, a conventional Dot Probe CBM-A manipulation was also administered to a second group of participants who were allocated to either a Benign CBM-A Condition or a Negative CBM-A Condition in order to compare the efficacy of the new task. The results demonstrated successful modification of attentional bias in the novel task, which meets the first of the selection criteria for the current study. Further, the Dot Probe CBM-A manipulation did not induce a group difference in attentional bias. Therefore, it can be seen that the novel card game task was more effective than the Dot Probe CBM-A manipulation in inducing a group difference in attentional bias to negative information, meeting the second of the selection criteria. However, while this task has proved to be very promising this effect has not yet been replicated and so it is not considered the ideal novel CBM-A procedure for use in the current study.
In contrast, Notebaert et al. (under review) developed a novel CBM-A task that has not just proved to be effective but this finding has also been replicated. This novel CBM-A procedure requires attentional scanning and tracking in a complex and dynamic environment. This task, named the Emotion-in-Motion CBM-A manipulation, involves eight boxes moving around the screen, each of which contains an image of a face, all of different individuals. The faces each display either an angry or happy expression with seven of the boxes containing a face with the same emotional expression and one box containing a facial expression that differs from that of the other seven faces on the screen. The box containing the face with the unique emotional expression is the target box. The identities of the faces within the boxes constantly change but the emotional expression remains the same, and at random intervals the target box switches from its current location to one of the 7 boxes surrounding it. Participants were required to attend to and track the target box by following it around the screen with the mouse cursor and when the target box switched they needed to quickly find it again elsewhere on the screen and continue tracking it. Participants were allocated to one of two conditions. In the Benign CBM-A Condition, the target box to be tracked always displayed a happy expression while the other seven rectangles displayed angry expressions, these are referred to as “track happy trials”. In the Negative CBM-A Condition, the target box to be tracked always depicted an angry expression while the other seven rectangles displayed happy expressions, and these are referred to as “track angry trials”. Attentional bias was assessed by employing an assessment version of the Emotion-in-Motion CBM-A manipulation that administered alternating blocks of track happy and track angry trials. The percentage of time that the participants correctly tracked the target box with the mouse cursor was recorded. The tracking scores from track happy trials were averaged to compute a Happy Tracking Score, and the tracking
scores from track angry trials were averaged to compute an Angry Tracking Score. The Happy and Angry Tracking Scores were used to determine a group difference in attentional bias to negative information. Alongside the Emotion-in-Motion CBM-A manipulation, another two groups of participants were administered either a benign or negative version of the conventional Dot Probe CBM-A manipulation. This was to compare the effects of the Emotion-in-Motion CBM-A manipulation with the Dot Probe CBM-A manipulation.

The results revealed that, for the Emotion-in-Motion CBM-A manipulation, there was a significant group difference in attentional bias to negative information as the degree to which Happy Tracking Scores were larger than Negative Tracking Scores was disproportionately great in the Benign CBM-A Condition as compared to the Negative CBM-A Condition. However, the conventional Dot Probe CBM-A manipulation did not successfully induce a group difference in attentional bias. This demonstrates that not only is the Emotion-in-Motion CBM-A manipulation effective in modifying attentional bias but it is more effective than the conventional Dot Probe CBM-A manipulation. Further, unlike the previously described studies, the significant group difference in attentional bias using the Emotion-in-Motion CBM-A manipulation has also been replicated. Notebaert, Hosszu, Clarke & MacLeod (in prep.) also successfully induced a group difference in attentional bias towards negative information using this Emotion-in-Motion CBM-A manipulation. As noted by these researchers, this task may be more effective than the Dot Probe CBM-A manipulation due to the dynamic and complex presentation of stimuli, which has the advantages of better reflecting real world situations, and due to being a more engaging task. Thus far, a review of novel CBM-A procedures has presented some promising tasks that have successfully induced a group difference in attentional bias. But, to date, this Emotion-in-Motion CBM-A
manipulation perhaps offers the best alternative to the Dot Probe CBM-A manipulation because it is the only one so far that meets all the selection criteria. As such this task will be employed in the current study.

As with the previous studies in this research program, the current study was designed to determine whether a CBM-A procedure that successfully creates a group difference in selective attentional responding to negative information also serves to produce a group difference in the rate of Anxiety Dissipation following evocation of state anxiety. To fulfil the aim, the current study employed the Emotion-in-Motion CBM-A manipulation and the social stressor described in Experiment 1. Also, as with previous studies, state anxiety was monitored to measure variability in the decline of state anxiety, and as such index the rate of Anxiety Dissipation. Previously, VAMS were administered to measure state anxiety as they are a quick measure that have been shown to demonstrate adequate reliability, validity and sensitivity to the construct it is measuring (Abend, Dan, Maoz, Raz, & Bar-haim, 2014). However, it is suggested here that averaging scores across multiple VAMS assessing the same construct in different ways may be a better measure of state anxiety. Therefore, the State Trait Anxiety Inventory-Short Form (STAI-SF; Tluczek, Henriques, & Brown, 2009) was employed in the current study.

Participants were allocated to one of two experimental conditions. Participants allocated to the Benign CBM-A Condition completed the version of the Emotion-in-Motion Training Task designed to encourage an attentional bias away from negative information (i.e. target box to track contains a happy face). Those allocated to the Control CBM-A Condition completed a control variant of the Emotion-in-Motion Training Task that was configured in a manner that did not encourage a directional attentional bias (i.e. the target box contains a happy face in half of the games and an
angry face on the other half of the games). The theoretical hypothesis for this research program is that attentional bias to negative information causally contributes to diminished Anxiety Dissipation. This theoretical hypothesis generates the prediction that, if the Emotion-in-Motion CBM-A manipulation is successful in producing a group difference in selective attention towards negative information, then a group difference in the rate of Anxiety Dissipation following evocation of state anxiety will also be seen. Specifically, participants in the Benign CBM-A Condition will show a significantly greater rate of Anxiety Dissipation than will participants in the Control CBM-A Condition.

In order to evaluate this hypothesis, the same four critical requirements must be met that were required in the previous studies. First, there must be no group difference in Dispositional Anxiety prior to beginning the experiment. Second, the Emotion-in-Motion Training Task must induce a group difference in attentional bias such that participants in the Benign CBM-A Condition come to demonstrate significantly less selective attention towards negative information than is shown by participants in the Control CBM-A Condition. Third, the stressor must evoke heightened state anxiety and do so to an equivalent degree in both groups of participants. Fourth, there must be a significant decline in state anxiety across the experimental window. It is expected that with this novel CBM-A task a group difference in attentional bias will be observed and, unlike the previous studies, all requirements will be met allowing the hypothesis to be tested.

Method

Participants

This study required participants high in disposition to experience social anxiety, and 63 such participants were recruited based on their high scores on the Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998). These participants were recruited from the full first year Psychology student cohort at The University of Western Australia, who were screened on the SIAS. The students invited to participate
all scored in the top third of this sample’s SIAS score distribution (i.e. above 32). The participants, 40 of whom were female, had an average age of 20.42 years (SD=6.90). They received partial course credit in exchange for participation.

Participants were randomly allocated to one of two CBM-A Conditions. Participants assigned to the Benign CBM-A Condition completed a CBM-A Task configured to encourage selective attention towards benign information and away from negative information. Participants assigned to the Control CBM-A Condition completed a control version of this task that was not configured to modify selective attention. Participants allocated to each of the two CBM-A Conditions did not significantly differ in age, t(58)=0.65, p=.52, d=.17 or in gender ratio, χ²=.03, p=.87, w=.02.

Materials

Emotional Assessment Instruments

Social Interaction Anxiety Scale (SIAS). As in Experiment 1, the SIAS (Mattick & Clarke, 1998) was used as the screening tool that guided participant recruitment. The SIAS was also used to confirm that participants assigned to the two CBM-A Conditions did not initially differ in their disposition to experience social anxiety, in order to verify that this element of the first requirement of the study was met.

Spielberger Trait Anxiety Inventory (STAI). In line with all previous experiments, the trait version of the State-Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, & Vagg, 1983) was used to verify that participants assigned to the two CBM-A Conditions did not significantly differ in dispositional anxiety, thereby fulfilling this second element of the first requirement of the study.

Spielberger State Anxiety Inventory – Short Form (SSAI-SF). A computerized version of the Spielberger State Anxiety Inventory – Short Form (Marteau & Bekker, 1992) was used to assess anxious mood state at various points during the study. The
purpose of this was to verify that state anxiety was evoked by the stressor, as well as to provide an index of the subsequent dissipation of this evoked state anxiety, in order to fulfil the third and fourth requirements of the study. The SSAI-SF consists of 6 items taken from the original 20-item inventory (Spielberger, Gorsuch, Lushene, & Vagg, 1983), three of which are positively-keyed items and three of which are negatively-keyed items. The items describe the physical and emotional aspects of current mood state, for example “I am tense”. This state anxiety scale has been shown to have high internal reliability ($\alpha = .82$; Marteau & Bekker, 1992). For the current study a computerised version of the SSAI-SF was created. This consisted of a 15cm line, made up of points that divided the line into 4 equal portions, with consecutive labels of Not at all, Somewhat, Moderately and Very much (left). Using the mouse, participants selected their current level of state anxiety by clicking along the scale line where they considered corresponded to their current level of state anxiety. This yielded a score between 0 (not at all) to 60 (very much). The three positively keyed items were reverse scored and the average score was calculated, with higher scores demonstrating greater state anxiety.

**Experimental Stimuli**

*Facial Images.* The Emotion-in-Motion CBM-A manipulation and Attentional Bias Assessment Task employed images of faces depicting angry and happy expressions, which were selected from the Karolinska Directory of Emotional Faces (Lundqvist, Flykt & Öhman, 1998). A total of 144 pictures were selected, with an even gender split. Half of these pictures were images of 72 different individuals displaying happy expressions (36 males and 36 females), and the other half were images of those same individuals displaying angry expressions. This full set of images was separated into nine subsets of 32 images each comprising 16 individuals displaying a happy and an angry expression. One of these nine subsets was used in each of the eight games and
one final assessment. A further sixteen images were taken from the Karolinska Directory of Emotional Faces and were used for the practice trials. These showed faces of different individuals each displaying neutral expressions, again with an even gender split.

**Experimental Tasks**

*Emotion-in-Motion CBM-A Task.* This task was designed to modify attentional bias with the intention of inducing a group difference in selective attention at responding to emotionally negative stimuli (Notebaert, Grafton, Clarke, Rudaizky, Chen & MacLeod, under review). This dynamic attentional bias modification procedure involved showing participants eight boxes moving around a computer screen. These boxes initially appeared in the centre of the screen in a 4 x 2 grid and then immediately moved around the screen. The boxes moved at a speed between 30 and 50 pixels per 100ms and to begin there were four possible initial trajectories the box could move in. They then bounced off the screen edges and the other boxes at an angle of reflection matching the angle of incidence. Based on the content of the boxes, one of the eight boxes was considered the “target box” which the participants were required to track throughout the task. Each of the eight boxes contained facial images, as described earlier. On screen at all times there were always 7 images of the same emotional expression (e.g. happy) and one image of the other facial expression (e.g. angry). Whichever box this single image of differing facial expression is located within is referred to as the target box. At random intervals of 5-10 seconds the target box would switch from its current location to one of the 7 boxes surrounding it, this will be referred to as the “target box switch”. Each of the eight boxes contained one of the facial images from the first subset of 16 images, with a different individual shown in each box. The
identity of the facial images within each box changed at a random duration from 1000-2000ms and each identity only appeared in one of the boxes at any given point in time.

The Emotion-in-Motion CBM-A manipulation was presented as a series of games in which the participants scored points. The participants were told they must identify the target box at the beginning of each block and that they must track the target box with the mouse cursor. The cursor disappeared behind the target box when aligned correctly so that the facial image was not obscured. When the target box changed the participant was required to find its new location and continue tracking it. Each game began with the words “Get Ready” and a three second countdown in the centre of the screen. After the countdown the eight boxes containing facial images appeared. At the beginning of each game the identity within each box remained constant for the first 2000ms. The task consisted of eight games that each lasted three and a half minutes, with each game consisting of four blocks separated by a brief rest interval lasting three seconds. At the end of each game the participants were informed of their game results. This included their current high score and the overall points won for that game. Their score reflected the percentage of time the mouse cursor correctly tracked the target box. For participants in the Benign CBM-A Condition the target box always contained a facial image with a happy expression. This means the other seven boxes always contained a face with an angry expression. In the Control CBM-A Condition, the facial expression within the target box was determined randomly across the game with happy and angry expressions being presented an equal number of times.

**Emotion-in-Motion Assessment Task.** This task was delivered to obtain a measure of attentional bias towards negative information, as was necessary for the second requirement of the study. This task was presented as a ninth and final Emotion-in-Motion CBM-A Task game in a similar manner to the control variant of the Emotion-
in-Motion CBM-A manipulation. This assessment task consisted of 12 blocks, and the emotional expression of the facial image within the target box was counterbalanced and each block alternated between angry and happy faces. Each block consisted of five target box switches and the block was completed when the participant had successfully made the final switch. In this task, the percentage of time that the participants correctly tracked the target box with the mouse cursor was recorded. This resulted in a tracking score for each of the 12 blocks, six of which were from tracking the happy face and six of which were from tracking the angry face. The six tracking scores from tracking the happy face were averaged to compute a Happy Tracking Score, and the six tracking scores from tracking the angry face were averaged to compute an Angry Tracking Score. The Happy and Angry Tracking Scores will be used to determine a group difference in attentional bias to negative information. If the task is successful in inducing a group difference in attentional bias to negative information then the degree to which the Happy Tracking Score is larger than the Angry Tracking Score will be disproportionately great for the Benign CBM-A Condition as compared to the Control CBM-A Condition.

*State Anxiety Evocation and Dissipation Task.* This task was identical to that described in Experiment 1. The Anxiety Evocation Phase of the task was designed to elevate state anxiety, to an equivalent degree in both groups of participants, by exposing them to a speech stressor, thereby fulfilling the third requirement of the study. This involved informing participants that they would deliver a speech which would be recorded, and later shown to other students who would rate them on the degree to which they exhibited signs of emotional distress during the speech. Participants were never actually required to give a speech. State anxiety was assessed pre and post exposure to this speech stressor using SSAI-SF ratings.
The Anxiety Dissipation Phase of the task was designed to measure the subsequent rate of Anxiety Dissipation, as needed to meet the fourth requirement of the study that state anxiety must dissipate over time. To do this, state anxiety was measured at five minute intervals across a 40 minute period subsequent to the speech stressor using SSAI-SF ratings. The intervals between each SSAI-SF will be referred to as the Dissipation Phase Blocks, and (as will be discussed in the procedure) the Emotion-in-Motion CBM-A Task was delivered during these intervals. The post stressor rating and the subsequent eight SSAI-SF ratings gave rise to nine SSAI-SF ratings and revealed the rate of decline in state anxiety throughout the Anxiety Dissipation Phase.

Procedure

Participants were seated in an individual testing room and provided with an information sheet and consent form. Once their written consent to participate was given they completed the SIAS and STAI questionnaires, and received instructions for completing the Emotion-in-Motion CBM-A manipulation and the SSAI-SF ratings. They then completed a short practice task, which consisted of one game of four block in which neutral faces were used. Participants were told that each game would show 8 images, 7 of which were faces of one gender and one of the other, and the target box was the one that contained the face that differed in gender from all the other boxes. Immediately following this practice, participants were administered the Anxiety Evocation Phase of the Anxiety Evocation and Dissipation Task. Then, across the Anxiety Dissipation Phase of the Anxiety Evocation and Dissipation Task they completed the Emotion-in-Motion CBM-A Task. Specifically, an Emotion-in-Motion CBM-A Task block was delivered during each of the eight Anxiety Dissipation Phase Blocks. Following this, participants completed the Emotion-in-Motion Assessment Task
as the final game of the computer task. Finally, participants were debriefed about the aim and design of the study.

**Results**

The analyses in this section were run with 31 participants in the Benign CBM-A Condition and 32 participants in Control CBM-A Condition. This results section will first report on the baseline dispositional and state anxiety characteristics of the participants. It will then report whether the Emotion-in-Motion CBM-A Task induced the required group difference in selective attention to negative socially relevant information. Next it will report the effect of the speech stressor on evoking heightened state anxiety, and finally the effect of the Emotion-in-Motion CBM-A Task on Anxiety Dissipation. Prior to each analysis the assumptions of normality of distribution and homogeneity of variance were tested. Normality of distribution for each set of data was tested by considering tests of kurtosis and skewness with cutoff scores for both of above 3.29 as recommended by Field (2009). Homogeneity of variance was tested with Levene’s Test for Equality of Variances.

**Participant Characteristics at Test Time**

Anxiety scores obtained by participants are shown in Table 1. These anxiety scores were found to be normally distributed and the assumption of equality of variances was met. As shown in the final column of Table 1, participants assigned to the two CBM-A Conditions did not significantly differ on any of these anxiety measures. Therefore, anxiety was not confounded with CBM-A Condition.

*Table 1. Participant Characteristics at Test Time*
The tracking scores were found to be normally distributed, and assumptions of sphericity and homogeneity of variance were met. Tracking scores are an average of the tracking score percentages for each happy and angry game and are shown in Table 2.

Table 2. Tracking Scores for Each Target Type

<table>
<thead>
<tr>
<th>Target Type</th>
<th>Benign CBM-A Mean (SD)</th>
<th>Control CBM-A Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happy Target</td>
<td>48.41 (9.13)</td>
<td>49.41 (8.24)</td>
</tr>
<tr>
<td>Angry Target</td>
<td>44.91 (9.99)</td>
<td>48.03 (9.01)</td>
</tr>
</tbody>
</table>

To examine whether the manipulation within the Emotion-in-Motion CBM-A Task successfully induced a group difference in attentional bias to negative information, the second requirement of the study, the tracking scores were subjected to a 2x2 repeated measures ANOVA with Target Type (Happy vs. Angry) and the within subjects factor, and CBM-A Condition as the between subjects factor. If the Emotion-in-Motion CBM-A Task successfully induced a group difference in attentional bias to negative information, then the tracking scores would show a statistically significant difference between the Benign and Control CBM-A conditions.
The in-Motion CBM-A manipulation was successful in inducing a group difference in attential bias, then the degree to which the Tracking Score is larger for happy targets than angry targets will be disproportionately great for the Benign CBM-A Condition as compared to the Control CBM-A Condition. This analysis revealed a significant main effect of Target Type, $F(1, 61) = 20.16$, $p < .05$, partial-$\eta^2 = .25$, which reflected a larger tracking score for Happy Targets ($M = 48.91$, $SD = 8.69$) than Negative Targets ($M = 48.72$, $SD = 9.51$). More importantly, the interaction between Target Type and CBM-A Condition approached significance, $F(1, 61) = 3.80$, $p = .06$, partial-$\eta^2 = .06$. While using a two-tailed test the significance of this group difference fell just outside conventional significance, the directional prediction generated by the central hypothesis justifies increasing the power to detect this group difference by conducting a one-tailed test. Therefore, the results suggest that a significant effect is likely to be present when using a one tailed test, indicating that the degree to which the tracking score was larger for happy targets than angry targets was disproportionately great for the Benign CBM-A Condition as compared to the Control CBM-A Condition.

**Did the Stressor Evoke Heightened State Anxiety?**

The state anxiety SSAI-SF ratings pre and post the speech stressor were found to be normally distributed and assumptions of sphericity and homogeneity of variance were met. The third requirement of this study was that the stressor must evoke heightened state anxiety, and do so to an equivalent degree for participants assigned to each of the two CBM-A Conditions. The state anxiety SSAI-SF ratings obtained before and after the speech stressor are presented in Table 2.

*Table 3. Pre and Post Stressor Mean SSAI-SF Ratings (SD’s in brackets)*
These SSAI-SF state anxiety ratings were subjected to a 2x2 repeated measures ANOVA with CBM-A Condition (Benign vs. Control) as the between subjects factor and Assessment Point (Pre vs. Post Stressor) as the within subjects factor. This revealed a significant main effect of Assessment Point, F(1, 60)=16.11, p<.01, partial-η²=.21, reflecting the fact that state anxiety SSAI-SF ratings were significantly higher post stressor (M=24.87, SD=7.71) than pre stressor (M=21.34, SD=7.10), indicating that the speech stressor evoked heightened state anxiety. No other effects were found to be significant. Of particular relevance, there was no significant interaction between Assessment Point and CBM-A Condition, F(1, 60)=3.32, p=.07, partial-η²=.05. This indicates that participants in each of the CBM-A Conditions did not experience differential elevation of state anxiety in response to the stressor prior to beginning the Emotion-in-Motion CBM-A manipulation, as was required for the study.

**Did the Emotion-in-Motion CBM-A Manipulation Affect the Rate of Anxiety Dissipation?**

The nine state anxiety SSAI-SF ratings subsequent to the speech stressor for each of the two CBM-A Conditions were found to be normally distributed and the assumption of homogeneity of variance was met. However, the assumption of sphericity was violated so Greenhouse-Geisser corrected tests are reported. The main aim of the current study was to determine whether a CBM-A procedure that was successful in
creating a group difference in selective attention towards negative information also
serves to produce a group difference in the rate of Anxiety Dissipation following
evocation of state anxiety. Having had a strong trend showing a group difference in
attentional bias following the Emotion-in-Motion CBM-A manipulation, the next step
will be taken to see if that was associated with a group difference in Anxiety
Dissipation. Average state anxiety SSAI-SF ratings for each assessment point across the
Anxiety Dissipation Phase are presented in Figure 1.

![Graph showing average state anxiety SSAI-SF ratings across nine assessment points](image)

**Figure 1.** Average state anxiety SSAI-SF ratings across the nine assessment points

The nine SSAI-SF state anxiety ratings were subjected to a 2 x 9 Repeated
Measures ANOVA with Assessment Point (nine Post Stressor time points) as the within
subjects factor and CBM-A Condition (Benign vs. Control) as the between subjects factor. The fourth requirement of this study stipulates that state anxiety must decline across time, to an equivalent degree in each of the experimental groups. This will be seen as a progressive decline in state anxiety across time, as indicated by a main effect of Assessment Point that is either linear or quadratic in nature. The only significant effect found was the main effect of Assessment Point, F(4.35, 265.31)=2.57, p<.01, partial-η²=.04. A trend analysis revealed that there were no significant trends in this data suggesting that there was no progressive decline in state anxiety over time. As such, it is evident that the main effect identified a change that does not reflect Anxiety Dissipation. Therefore, the fourth requirement of the study, namely that the induced state anxiety dissipated across the experimental window, was not fulfilled. No other effects were found to be significant, but of importance the interaction between Assessment Point and CBM-A Condition did not approach significance, F(4.35, 265.31)=1.42, p=.22, partial-η²=.02 (not significant with a one tailed test). This indicates there was no difference between the two CBM-A Conditions in changes to state anxiety.

**Discussion**

The current study aimed to determine whether attentional bias to negative information causally contributes to diminished Anxiety Dissipation using the Emotion-in-Motion Training Task. This was determined by examining whether successfully inducing a group difference in selective attentional responding to socially negative information also serves to produce a group difference in the rate of Anxiety Dissipation following evocation of state anxiety. This aim was pursued by introducing a newly developed CBM-A procedure that has been shown to be effective in inducing a group
difference in attentional bias to negative information. In order to test the theoretical hypothesis, as in the previously reported studies, four requirements had to be met.

The first requirement, that there could be no group difference in Dispositional Anxiety prior to beginning the experiment was met. No group difference between the Benign CBM-A Condition and the Control CBM-A Condition was observed in general Dispositional Anxiety or in the specific disposition to experience social anxiety, at the beginning of the experiment. Thus, Dispositional Anxiety was not confounded with CBM-A Condition. The second requirement of this study, that the Emotion-in-Motion Training Task had to induce a group difference in selective attention towards negative information, was also met. Using a one tailed-test, it was shown that participants in the Control CBM-A Condition showed a significantly greater attentional bias to angry faces post training, as compared to participants in the Benign CBM-A Condition. This suggests that the experimental manipulation of the Emotion-in-Motion CBM-A manipulation induced a group difference in selective attention towards negative socially relevant information. The third requirement of the study, that the speech stressor had to evoke heightened state anxiety to an equivalent degree in both groups of participants, was met. However, the fourth requirement of the study, that there had to be a significant decline in state anxiety across the experimental window, was not met. The theoretical hypothesis can only be tested if there is a significant decline in state anxiety across the experimental window to enable observing any group difference in this decline. But, the results showed that heightened state anxiety did not decline significantly across the duration of the study and as such the hypothesis cannot be tested.

A particularly important finding in the current study is that the Emotion-in-Motion CBM-A manipulation has been successful in producing a group difference in attentional bias, as the previous studies in this research program have failed to do this
using the Dot Probe CBM-A manipulation. Caution is necessary when interpreting the one-tailed test and future studies may need to increase the power to allow detection of a group difference in attentional bias with a two-tailed test. However, the current findings support the notion that the Emotion-in-Motion CBM-A manipulation is more effective than the Dot Probe CBM-A manipulation. Notebaert et al. (under review) employed this same task and assessed the impact of modifying attentional bias on Anxiety Reactivity. Their results demonstrated reduced attentional bias to negative information was significantly greater in the Benign CBM-A Condition than the Negative CBM-A Condition. There is clear potential for the Emotion-in-Motion CBM-A manipulation to be a more reliable alternative to the Dot Probe CBM-A approach as means of modifying attentional bias to negative information. As the Emotion-in-Motion task has only recently been developed further research is necessary to determine the optimal task parameters for measuring and manipulating attentional bias using this method. Therefore, it will be informative for future studies to include both the Emotion-in-Motion and the Dot Probe methods. To do this, studies can employ one CBM-A approach and then assess attentional bias to negative information using both approaches. The results will inform as to which approach is more effective at both manipulating and assessing attentional bias.

Although this task is very promising as an effective CBM-A procedure, the failure for heightened state anxiety to dissipate across the experimental means the hypothesis cannot be tested. It is important now to consider why this failure for heightened state anxiety to dissipate may have occurred. The fact that this CBM-A procedure is a more dynamic and engaging task may be making it more stressful in such a way that state anxiety is maintained across the experimental window. Therefore, it is likely that a feature of the Emotion-in-Motion CBM-A manipulation is preventing the
dissipation of heightened state anxiety. The key features that distinguish the Emotion-
in-Motion CBM-A manipulation from the Dot Probe CBM-A manipulation is the use of
performance feedback in the form of scores for each game and the movement of the
stimuli around the screen to better reflect real life environments. These will each be
discussed in turn.

There are few studies that demonstrate the impact of moving stimuli on
emotional arousal. However, there is some evidence to suggest that movement of
emotive stimuli increases state anxiety (Parsons et al., 2017; Sato & Yoshikawa, 2007;
Trautmann, Fehr, & Herrmann, 2009). For example, Courtney, Dawson, Schell, Iyer, &
Parsons (2010) examined the physiological and self-reported effect of moving and static
emotive stimuli on negative affect. Participants who scored high and low in spider
phobia viewed snakes and spiders in three different media types: static images,
computer generated videos and computer generated still images. The results revealed
that the computer generated videos elicited greater physiological and self-report arousal
responses than the static and computer generated still images. The authors highlighted
the integral role of motion in eliciting fear responses in the study of emotion. While this
study differs from the current study in that videos were used rather than still images
moving around a screen, it gives reason to assume that movement of emotive stimuli
may heighten state anxiety. There are also many studies that have assessed the impact of
dynamic versus static faces on emotional arousal (see Krumhuber, Kappas, &
Manstead, 2013 for review). These studies have typically employed brain imaging
techniques to show, firstly, that dynamic faces enhance emotional experiences. This
supports the argument that heightened state anxiety is maintained by moving emotive
stimuli. These studies have also shown that dynamic faces enhance recognition of
emotional expressions. This suggests that moving emotive stimuli may improve
processing of the emotional valence of the stimuli. This provides an explanation for the findings in the current study whereby the use of moving emotive stimuli allowed for better processing of the emotional valence resulting in successful modification of attentional bias. However, this also resulted in no dissipation of heightened state anxiety because the moving emotive stimuli enhanced participant’s emotional experience. It is evident that there are both benefits and costs to employing moving emotive stimuli in place of static stimuli in CBM-A procedures, with the obvious cost being the potential maintenance of heightened state anxiety. However, there is also plenty of evidence that supports having increased complexity in computer tasks to enhance learning and cognitive performance (Deveau, Jaeggi, Zordan, Phung, & Seitz, 2015; Green & Seitz, 2015; Lumsden, Edwards, Larence, Coyle, & Munafo, 2016).

Another aspect of the Emotion-in-Motion CBM-A manipulation that may have contributed to a lack of Anxiety Dissipation is the feedback feature which provides a game score and overall score at the end of each game. Locating the target box quickly and tracking the target box consistently in this task is quite difficult, as can be seen from the relatively small mean percentage of time tracking the target box. Therefore, it is possible that the feedback may have elicited heightened state anxiety in participants, as such preventing Anxiety Dissipation from occurring. Individuals high in Dispositional Anxiety, and high in disposition to experience social anxiety in particular, are known to have perfectionist traits associated with constructs such as concerns about making mistakes and doubts about their actions (Kawamura, Hunt, Frost, & Dibartolo, 2001; Rosser, Issakidis, & Peters, 2010). Providing scores at the end of each game was intended to increase motivation to complete the task. However, it is also possible that the feedback placed pressure on the participants to do well and so induced a fear of
making mistakes. In turn, this may have acted to increase participants’ stress resulting in heightened state anxiety which will be discussed further in the General Discussion.

One other aspect of this experiment that warrants further exploration into its effect on the absence of a decline in state anxiety is the use STAI-SF rather than VAMS. The STAI-SF was included in the current study as an experimental way of potentially improving the measurement of state anxiety. Essentially, the STAI-SF consists of multiple VAMS that assess the same construct, and so it was expected that multiple VAMS would be more representative of state anxiety than one. This study showed no decline in state anxiety and which could have occurred because there was genuinely no significant decline in state anxiety, for the reasons described above. However, it is also possible that participants’ state anxiety did decline, but that the STAI-SF was not sensitive enough in assessing state anxiety. This may be because the six items made assessing mood lengthier and participants may have grown tired of the items and as such not taken as much time to reflect on their emotions in that moment. Thus, the resulting scores may not have been an accurate representation of their current mood. Also, there were positively keyed items included for reverse scoring. While the STAI-SF has good reliability and validity in measuring the same construct as the STAI-S this does not necessarily mean that it is effectively measuring Anxiety Dissipation. Perhaps this is because of the inclusion of these positive items. Therefore, future research should consider implementing VAMS or, other instruments and methods of measuring state anxiety must be implemented. This may include biological methods such as heart rate and skin conductance. It will also be interesting to explore further the role of assessing positive emotions. However, the results from the current research projects suggest that for future research planning to assess Anxiety Dissipation the best
circumstances to carry this out is to use VAMS at regular intervals of five minutes over at least a 30 minute dissipation period.

In conclusion, this study was successful in inducing a group difference in attentional bias to negative information using the Emotion-in-Motion CBM-A manipulation. This provides further support that this task is more effective than the Dot Probe CBM-A manipulation and future research intending to modify attentional bias should consider employing this task. However, the hypothesis that attentional bias to negative information causally contributes to diminished Anxiety Dissipation was not able to be tested in this study because there was no evidence of state anxiety dissipating across the experimental window. This means that further research is required to determine the optimal task features for both modifying attentional bias to negative information and increasing Anxiety Dissipation. Also, it will be necessary in future research to address the features of the Emotion-in-Motion CBM-A manipulation when designing a study that measures Anxiety Dissipation.
Chapter 5: Does Negative Interpretation Bias Causally Contribute to Diminished Anxiety Dissipation in Socially Anxious Individuals?
CHAPTER 5

As described in the General Introduction, the aim of this research program is to address two questions, one is whether attentional bias to negative information causally contributes to diminished Anxiety Dissipation, and the other is whether a more negative interpretation bias causally contributes to diminished Anxiety Dissipation. Until now this research program has focused on the first research question, by examining the impact of modifying patterns of attentional bias on diminished Anxiety Dissipation. The research project will now turn to the second research question and focus on examining the impact of modifying negative interpretation bias on diminished Anxiety Dissipation. This line of research will follow the approach adopted for the first research question but will implement a Cognitive Bias Modification for Interpretation Bias (CBM-I) procedure instead of a CBM-A procedure.

In the General Introduction there was a review of clinical cognitive models of anxiety that proposed the hypothesis that individuals high in Dispositional Anxiety have a tendency to interpret ambiguous information as negative in nature. The literature examined then explained how individuals high in Dispositional Anxiety do indeed have a heightened tendency to favour negative interpretations of ambiguous information (Eysenck et al., 1991) and this bias favouring negative interpretations functionally contributes to elevated Dispositional Anxiety (A. Mathews, 2012). As reviewed in the General Introduction, it is well established that negative interpretation bias causally contributes to increased Anxiety Reactivity (Mackintosh, Mathews, Yiend, Ridgeway, & Cook, 2006; A. Mathews, 2012; Salemink, van den Hout, & Kindt, 2007; Standage, Ashwin, & Fox, 2010). However, the literature examining the relationship between Dispositional Anxiety and selective negative interpretation bias is yet to examine
whether increased negative interpretations of ambiguous information causally contributes to diminished Anxiety Dissipation.

Cognitive Bias Modification for Interpretation (CBM-I) procedures have been shown capable of successfully modifying interpretation bias to favour more benign interpretations (Menne-Lothmann et al., 2014), as was reviewed in the “Manipulating interpretation bias to reduce dispositional anxiety” section of the General Introduction. The most commonly used CBM-I procedure was developed by Mathews & Mackintosh (2000), and as such will be employed in the current research line. This CBM-I procedure exposes participants to ambiguous information in a task configured such that performance benefits from resolving ambiguity with a particular interpretation imposed on that ambiguity (for example, benign over negative interpretations of the ambiguous information). Specifically, participants are required to read an ambiguous passage that ends in a word fragment derived from a word that provides a meaningful ending to the passage but only if the ambiguity is resolved in one particular way. Participants must resolve the word fragment using the context of the passage. The passages describe events that are emotionally ambiguous in meaning and the alternative possible word fragments are created from words that differ in whether they resolve the ambiguity in a benign or negative manner. In the Benign CBM-I Training condition the final word fragments always resolve the ambiguity of the passage in a benign manner. Hence, in this condition, participants’ ability to complete the task easily and efficiently would be enhanced by adopting a benign interpretive style, as this would enable correct anticipation of the meaning of the final word from which the word fragment was created. This is intended to encourage participants to adopt a benign interpretation bias when processing the ambiguity. The control variant of this task does not encourage one particular type of interpretation. Rather, half the trials in the task end with a word
fragment that when completed resolves the ambiguity of the passage in a benign manner. The other half of the trials end in a word fragment that when completed resolves the ambiguity of the passage in a negative manner. So, neither a negative nor a benign interpretation bias is encouraged.

The most frequently used task to assess whether a CBM-I manipulation successfully modifies interpretation bias is the Recognition Task and this will be implemented in the current research line to assess whether the CBM-I procedure induces a group difference in interpretation bias. The Recognition Task is an interpretation bias assessment task that can be used to determine whether the intended interpretation bias manipulation does induce a group difference in interpretation bias. This task exposes participants to ambiguous information and then assesses the meaning they imposed on that ambiguity. This is done by measuring whether participants judge candidate benign interpretations of the preceding ambiguity to be more similar to the meaning of the original passage than candidate negative interpretations. Specifically, participants are presented with ten ambiguous passages, then for each of the ten passages participants are presented with four alternative Test Sentences. This set of four includes two target sentences, one of which the meaning of the sentence is consistent with a benign interpretation of the original passage and one of which the meaning of the sentence is consistent with a negative interpretation of the original passage. It may be the case that individuals high in Dispositional Anxiety have a tendency to rate any negative sentence as more similar to the preceding ambiguous information, and as such the foil sentences are included to assess for a response bias. Therefore, the Test Sentences also include two foil sentences that describe events unrelated to either possible interpretation of the ambiguity, one that is benign in meaning and one that is negative in meaning. Participants are required to rate how similar each sentence is to the
meaning of the original passage and these are referred to as Similarity Ratings. Any tendency to rate foil sentences of one type of valence as more similar to the original passage than foil sentences of the other type of valence would reflect a response bias. If a tendency to rate one type of valence as more similar is also found on the target sentences then this could again be attributed to a response bias. However, if this tendency is seen only on the target sentences or is evident to a greater degree on target sentences than the foil sentences then this will reflect an interpretation bias. So, a more benign interpretation bias will be indicated by an interaction showing benign target sentences rated as more similar to the original passage than the negative target sentences, and this will be to a greater degree than is the case for foil sentences. Also, if the intended interpretation bias manipulation is effective then this interaction will be significantly greater for participants in the Benign CBM-I Condition than the Control CBM-I Condition.

Mathews & Mackintosh’s (2000) CBM-I manipulation, and others like it, have now been used widely in research modifying interpretation bias in order to explore the causal contribution of interpretation bias to elevated Dispositional Anxiety. Typical studies of this sort require one group of participants to complete a Benign CBM-I Condition while another group completes a Control CBM-I Condition, before all participants are then exposed to a stressor. Measures of state anxiety are taken prior to and following the stressor. It has been found that individuals in the Benign CBM-I Condition show a significantly lower state anxiety reaction to the stressor compared to the Control CBM-I Condition. Therefore, this finding supports the hypothesis that negative interpretation bias causally contributes to increased Anxiety Reactivity (see: Macleod, 2012). This research provides evidence that interpretation bias can be manipulated and that it makes a causal contribution to elevated Dispositional Anxiety.
However, earlier studies demonstrate only that negative interpretation bias causally contributes to increased Anxiety Reactivity. It is possible that negative interpretation bias may also causally contribute to diminished Anxiety Dissipation, but this is yet to be explored.

As no research to date has examined whether CBM-I can increase the rate of Anxiety Dissipation following evocation of heightened state anxiety, the current study aimed to test the hypothesis that negative interpretation bias causally contributes to diminished Anxiety Dissipation. Participants selected to take part in the current study were individuals with heightened disposition for social anxiety, in order to maximise the capacity of the speech stressor to evoke state anxiety. Participants allocated to the Benign CBM-I Condition completed a CBM-I manipulation designed to encourage benign interpretations of ambiguous social situations. Those allocated to the Control CBM-I Condition completed a control variant of the CBM-I manipulation that was not configured to modify selective interpretations of ambiguous social situations. The CBM-I procedure was taken directly from Mathews & Mackintosh (2000). A lab-based speech stressor was introduced to all participants and state anxiety was measured across the experimental window to measure variability in the dissipation of this state anxiety, and so index the rate of Anxiety Dissipation.

The proposed hypothesis generates the prediction that if the CBM-I procedure is successful in producing a group difference in negative interpretations of ambiguous social situations, then this will also serve to induce a group difference in the rate of Anxiety Dissipation following evocation of state anxiety. Specifically, if it is the case that negative interpretation bias causally contributes to diminished Anxiety Dissipation, then participants in the Benign CBM-I Condition will show a significantly greater rate of Anxiety Dissipation than will participants in the Control CBM-I Condition. In order
to adequately evaluate the hypothesis under examination the same four critical requirements, as were needed to be met in the previous studies of this research program, need to be specified. First, there must be no group difference in Dispositional Anxiety prior to beginning the experiment. Second, the CBM-I procedure must induce a group difference in interpretation bias such that participants in the Benign CBM-I Condition come to demonstrate significantly less negative interpretations than participants in the Control CBM-I Condition. Third, the stressor must evoke heightened state anxiety and do so to an equivalent degree in both groups of participants prior to delivery of the CBM-I procedure. Fourth, there must be a significant decline in this elevated state anxiety across the experimental window. Should these requirements be met then it will be possible to determine whether negative interpretation bias causally contributes to diminished Anxiety Dissipation, by testing whether participants in the Benign CBM-I Condition show a significantly greater rate of Anxiety Dissipation than participants in the Control CBM-I Condition.

**Method**

**Participants**

This study required participants high in disposition to experience social anxiety, and so 64 participants were recruited based on their high scores on the Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998). These participants were recruited from the full first year Psychology student cohort at The University of Western Australia, who were all screened on the SIAS. The students invited to participate all scored in the top third of this sample’s SIAS score distribution (i.e. above 30). Participants, of whom 52 were female, had an average age of 18.98 years (SD=2.87), and received partial course credit in exchange for participation.
Participants were randomly allocated to one of two CBM-I Conditions. Participants assigned to the Benign CBM-I Condition completed a CBM-I manipulation configured to encourage benign interpretations of emotionally ambiguous social situations. Participants assigned to the Control CBM-I Condition completed a control variant of the CBM-I manipulation that was not configured to modify selective interpretations of ambiguous social situations. Participants assigned to each of the two CBM-I Conditions did not significantly differ in age, \( t(62) = -1.36, p = .18, d = .34 \), or in gender ratio, \( \chi^2 = .00, p = 1.00, \omega = .00 \).

**Materials**

**Emotional Assessment Instruments.**

*Social Interaction Anxiety Scale (SIAS).* As in Experiment 1 and 3, the SIAS (Mattick & Clarke, 1998) was used as the screening tool that guided participant recruitment. The SIAS was also used to confirm that participants assigned to the two CBM-I Conditions did not initially differ in their disposition to experience social anxiety, in order to verify that this element of the first requirement of the study was met.

*Spielberger Trait Anxiety Inventory (STAI).* In line with all previous experiments, the trait version of the State-Trait Anxiety Inventory (Spielberger et al, 1983) was used to verify that participants assigned to the two CBM-I Conditions did not significantly differ in dispositional anxiety, thereby fulfilling this second and final element of the first requirement of the study.

*Visual Analogue Mood Scale (VAMS).* As in Experiments 1 and 2, a visual analogue mood scale (VAMS; Wilson et al., 2006b) was used to assess anxious mood state at various points during the study. The purpose of this was to verify that state anxiety was evoked by the stressor, as well as to provide an index of the subsequent dissipation of.
this evoked state anxiety, in order to fulfill the third and fourth requirements of the study. This scale consisted of a 15cm line, made up of points that divided the line into 60 equal portions and with end labels anxious (right) and relaxed (left). Using the mouse, participants selected their current level of state anxiety by clicking on the point along the scale line they considered to correspond to their current level of state anxiety. This yielded a score between 0 (relaxed) to 60 (anxious).

**Experimental Stimuli**

**CBM-I Manipulation Ambiguous Passages.** The CBM-I manipulation employed 96 ambiguous passages, that each described social situations, and were a subset drawn from those developed for the CBM-I manipulation employed by Mathews & Mackintosh (2000). They were all constructed in a manner that allowed them to be interpreted in either a negative manner or a benign manner. The ambiguous passages consisted firstly of three lines of text describing a social scenario, the descriptive passages. Each descriptive passage ended with one of two words, one that was consistent with interpreting the ambiguity of the passage in an emotionally benign manner which is called the Benign Final Word. The other word was consistent with interpreting the ambiguity of the passage in a negative manner which is called the Negative Final Word. From each of these final words a word fragment was created that could only be completed to yield the specific word it was derived from. A Benign Word Fragment was created for the Benign Final Word and a Negative Word Fragment was created for the Negative Final Word. An example of an ambiguous passage is as follows:

> You invite work colleagues to your house for a formal dinner party, although you know they don’t always get on.
As you are clearing up afterwards you think that the evening was

ent--t---i-g (Benign Word Fragment) / dis--tr--s (Negative Word Fragment)

In this example, the ambiguity reflects the fact that the text permits participants to interpret passage in one of two ways. One possibility is that everyone enjoyed themselves and the night was a success. This is the benign interpretation of the situation. The Benign Word Fragment was “ent--t---i-g”, yielding the final word “entertaining”, which is consistent with the benign interpretation of the ambiguity. The alternative possibility is that the dinner party was a failure and nobody enjoyed themselves. This is the negative interpretation of the situation. The Negative Word Fragment was “dis--tr--s”, yielding the final word “disastrous”, which is consistent with the negative interpretation of the ambiguity.

For each passage a question was created, and requiring participants to answer this question served to ensure that they understood the meaning of the passage. This will be referred to as the comprehension question. The answer to the comprehension question depended on the information provided by the earlier passage. For example, in the dinner party example it asked “Did you enjoy yourself at your dinner party?” After responding to the question the participants were provided feedback concerning the accuracy of their response. One comprehension question was created for each of the 96 ambiguous passages.

**Interpretation Bias Assessment Task Stimuli.** The task assessing interpretation bias did so by measuring the interpretation that participants imposed on a new set of ambiguous passages, the Interpretation Bias Assessment Task Ambiguous Passages. Interpretation was measured by rating the similarity of subsequent Test Sentences to the original passages. Therefore 10 subsets of stimuli were created each containing an
For each subset of stimuli a title was created. This was to provide a context for the participants to remember the ambiguous passage in the subsequent rating task. Ten ambiguous passages were created for use in the assessment procedure designed to measure interpretation bias which will be referred to as the Interpretation Bias Assessment Task Ambiguous Passages. These passages were identical to those Mathews and Mackintosh (2000) used for their Interpretation Bias Assessment Task. These ambiguous passages again consisted of a descriptive passage describing a social situation that could be interpreted in either an emotionally negative manner or a benign manner. Each passage ended in a final word, but here only one final word was created that was compatible with both the benign and negative interpretations of the ambiguous passages. A word fragment was created from this final word such that the fragment could only be completed to yield the specific word it was derived from. An example of an Interpretation Bias Assessment Task Ambiguous Passage is as follows:

“The wedding reception”

Your friend asks you to give a speech at her wedding reception.

You prepare some remarks and when the time comes, get to your feet.

As you speak, you notice some people in the audience start to

l--gh

laugh

In this example the ambiguity reflects the uncertainty concerning why the audience are laughing. One possibility is that the audience have enjoyed your speech, finding you to be funny, and this is the benign interpretation of the situation. However, another possibility is that the people were laughing at you because you are not doing a
good job, the negative interpretation of the situation. A comprehension question was created for each of these Interpretation Bias Assessment Task Ambiguous Passages. To correctly answer the comprehension question required the participants to have read the passage for meaning. The question for the above example read: “Did you stand up to speak?”

For each of these passages a set of four Test Sentences were created. This included two target sentences, one that stated a benign candidate interpretation of the ambiguity and one that stated a negative candidate interpretation of the ambiguity. The Test Sentences also included two foil sentences that described events unrelated to either possible interpretation of the ambiguity but one was benign in meaning and one was negative in meaning. As with the ambiguous passages the Test Sentences were also taken from Mathews & Mackintosh (2000). Below is an example of the Test Sentences that correspond to the above example passage:

[Benign Target] As you speak, people in the audience laugh appreciatively.
[Negative Target] As you speak, people in the audience find your efforts laughable.
[Benign Foil] As you speak, people in the audience applaud your comments.
[Negative Foil] As you speak, some people in the audience start to yawn.

**Experimental Tasks**

**CBM-I Manipulation.** This task was intended to induce a group difference in the selective interpretation of ambiguous situations. The methodology for this CBM-I manipulation was identical to that employed by Mathews & Mackintosh (2000). At the start of each trial the words ‘next passage’ appeared on screen. Participants were then required to press the space bar to reveal the first line of a CBM-I manipulation
Ambiguous Passage. Each time the space bar was pressed the next line of the passage appeared, and the previous line was blanked out. When the participants reached the final line they were required to complete the word fragment by typing the first missing letter of the word into the keyboard. This remained a fragment and the trial did not move forward until the correct letter was entered. When the correct letter was entered into the keyboard, all missing letters were automatically filled in and the complete word remained on screen for 1000ms, after which it was blanked out. The same CBM-I manipulation Ambiguous Passages were used for both the Benign CBM-I and Control CBM-I Conditions. However, the word fragments presented differed depending on CBM-I Condition. In the Benign CBM-I Condition the Benign Word Fragments were always presented. Hence, in this condition participant’s ability to complete the task easily and efficiently would be enhanced by adopting a benign interpretive style, as this would enable correct anticipation of the meaning of the final word from which the word fragment was created. Therefore, by providing final words that were always consistent with a benign interpretation, this was intended to encourage the participants to adopt a benign interpretation bias. The Control CBM-I Condition was not configured to encourage any change in interpretation bias. In this condition the Benign Word Fragments were used on half the trials and the Negative Word Fragments were used on the other half of the trials. Thus, participants could not adopt an interpretive style that would enable them to anticipate the meaning of the final word from which the word fragment was created, and neither a negative nor a benign interpretation bias was encouraged.

Following correct completion of the word fragment, the comprehension question appeared below the position of the word fragment. Participants were required to press the left mouse button to answer ‘no’ and the right mouse button to answer ‘yes’.
Depending on the participant’s response to the comprehension question the words “incorrect” or “correct” were then presented for 1000ms. The accuracy of these comprehension question answers was recorded to verify that participants correctly understood the meaning of the passage. As reading for meaning is necessary before the procedure could induce interpretive bias, it was required that participants displayed an accuracy level substantially above chance (50%) on these comprehension questions. Therefore, the inclusion criterion was set at 75% accuracy for comprehension questions, and participants who fell below this accuracy level were excluded from analysis. One trial consisted of reading an ambiguous passage, completing the word fragment and answering the comprehension question. The task consisted of 6 blocks of 16 trials and participants were given an opportunity to rest after each block.

**Interpretation Bias Assessment Task.** The Interpretation Bias Assessment Task consisted of two sections. The first section involved presenting the Interpretation Bias Assessment Task Ambiguous Passages. This was done in the same manner as the CBM-I manipulation. Following this, the participants completed a 3 minute filler task, as in Mathews & Mackintosh’s (2000) study. This permitted the decay of literal memory for the exact wording of the passage, but was brief enough to permit retention of the encoded meaning of the passage. During this filler task, participants were presented strings each comprising three numbers. They were required to identify whether more odd or even numbers were present in each string, and indicate this by clicking the left mouse button for odd and right mouse button for even. An equal amount of number strings had more odd and even numbers and the numbers were randomly selected.

The second section of the Interpretation Bias Assessment Task involved presenting the sets of four Test Sentences and required participants to rate each of the four Test Sentences, independently of each other, on how similar in meaning they were
to the meaning of the original passage. Participants were initially presented with the identifying title of the original passage at the top of the screen to assist them in remembering which scenario was being referred to, and a visual analogue scale at the bottom of the screen. They were required to press the space bar to reveal the first Test Sentence. Participants rated each Test Sentence using the visual analogue scale. This scale consisted of a 15cm line, made up of points that divided the line into 60 equal portions and with end labels very different in meaning (right) and very similar in meaning (left). Using the mouse, participants clicked on the point along the scale line and this yielded a score between 0 (very different in meaning) to 60 (very similar in meaning). These scores will be referred to as the Similarity Ratings. Once the participants had rated the first of the four Test Sentences it disappeared and a second Test Sentence appeared in the position below the first. This was repeated for the third and fourth Test Sentences. Participants were required to complete these ratings for each of the ten passages. The order in which the passages, the sets of Test Sentences, and the Test Sentences within each set, were delivered was randomised.

**State Anxiety Evocation and Dissipation Task.** This task consisted of two phases. The first phase of the task was designed to elevate state anxiety, to an equivalent degree in both groups of participants, by exposing them to a stressor, thereby fulfilling the third requirement of the study. This will be referred to as the Anxiety Evocation Phase. The stressor employed in this phase was identical to that used in Experiment 1. That is, participants were given a speech stressor that involved informing participants they would deliver a speech which would be recorded, and later shown to other students who would rate them on the degree to which they exhibited signs of emotional distress during the speech. Participants were never actually required to give a speech. State anxiety was assessed pre and post exposure to this speech stressor using VAMS ratings.
The second phase of the task was designed to measure the subsequent rate of state Anxiety Dissipation, as needed to meet the fourth requirement of the study that state anxiety must dissipate. To do this, state anxiety was measured at five minute intervals across a 35 minute period subsequent to the speech stressor using VAMS. This will be referred to as the Anxiety Dissipation Phase. The intervals between each VAMS will be referred to as the Dissipation Phase Blocks, and (as will be discussed in the procedure) these were used to deliver the CBM-I manipulation. The post stressor rating and the subsequent 6 VAMS ratings gave rise to seven VAMS ratings and revealed the rate of decline in state anxiety throughout the Anxiety Dissipation Phase.

Procedure

Participants were seated in an individual testing room and provided with an information sheet and consent form. Once their written consent to participate was given, participants completed the SIAS and STAI questionnaires, and received instructions for completing the CBM-I manipulation and the VAMS ratings. They then completed a short practice task, which consisted of four trials presenting unambiguous passages in the same manner as the CBM-I manipulation, preceded and followed by a VAMS rating. Immediately following this practice, participants were administered the Anxiety Evocation Phase of the Anxiety Evocation and Dissipation Task. Then, across the Anxiety Dissipation Phase of the Anxiety Evocation and Dissipation Task they completed the CBM-I manipulation. Specifically, a CBM-I manipulation block was delivered during each of the six Anxiety Dissipation Phase Blocks. Following this, participants were given instructions for the Interpretation Bias Assessment Task and they then completed this task. Finally, participants were debriefed about the aim and design of the study.
**Results**

The comprehension questions in the CBM-I manipulation assessed whether the reader understood the meaning of the passages and permitted exclusion of participants who failed to show at least 75% correct responses. This resulted in the exclusion of three participants, all from the Control CBM-I Condition. Therefore, analyses were run with 32 participants in the Benign CBM-I Condition, and 29 participants in the Control CBM-I Condition. This results section will first report on the baseline dispositional and state anxiety characteristics of these participants. It will then report whether the CBM-I procedure induced a group difference in interpretations of socially relevant ambiguous situations. The results section will then report the effect of the speech stressor on evoking heightened state anxiety, and finally the effect of the CBM-I manipulation on Anxiety Dissipation. Prior to each analysis the assumptions of normality of distribution and homogeneity of variance were tested. Normality of distribution was tested by considering tests of kurtosis and skewness with cutoff scores for both of above 3.29 as recommended by Field (2009). Homogeneity of variance was tested with Levene’s Test for Equality of Variances.

**Participant Characteristics at Test Time**

Anxiety scores obtained by participants are shown in Table 1. These anxiety scores were found to be normally distributed and the assumption of equality of variances was met. As shown in the final column of Table 1, participants in the two CBM-I Conditions did not significantly differ on any of these anxiety measures. Therefore, anxiety was not confounded with CBM-I Condition.
Table 1. Participant Characteristics at Test Time

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Benign CBM-I</th>
<th>Control CBM-I</th>
<th>t (df)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Condition Mean (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spielberger Trait Anxiety Inventory score</td>
<td>53.78 (7.07)</td>
<td>51.97 (6.48)</td>
<td>1.04 (59)</td>
<td>.30</td>
</tr>
<tr>
<td>Social Interaction Anxiety Scale</td>
<td>39.47 (10.80)</td>
<td>39.03 (9.57)</td>
<td>0.17 (59)</td>
<td>.87</td>
</tr>
<tr>
<td>Baseline State Anxiety</td>
<td>29.58 (12.60)</td>
<td>25.00 (14.64)</td>
<td>1.30 (58)</td>
<td>.20</td>
</tr>
</tbody>
</table>

Did the CBM-I Procedure Successfully Induce a Group Difference in Negative Interpretation Bias?

The similarity ratings assigned to Test Sentences from the Interpretation Bias Assessment Task were found to be normally distributed and assumptions of sphericity and homogeneity of variance were met. Initial data cleaning removed any similarity ratings identified as outliers using a 95% confidence interval (i.e. fell more than 1.96 standard deviations from the participant’s mean similarity rating for that Test Sentence Type.) The average similarity ratings assigned to Test Sentences are presented in Table 2.
Table 2. Similarity Ratings for Test Sentences in Each CBM-I Condition

<table>
<thead>
<tr>
<th></th>
<th>Benign CBM-I Condition</th>
<th>Control CBM-I Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Benign Target</td>
<td>31.45 (5.56)</td>
<td>24.69 (4.97)</td>
</tr>
<tr>
<td>Negative Target</td>
<td>19.47 (6.81)</td>
<td>23.09 (5.35)</td>
</tr>
<tr>
<td>Benign Foil</td>
<td>15.21 (6.79)</td>
<td>14.59 (5.64)</td>
</tr>
<tr>
<td>Negative Foil</td>
<td>7.05 (4.52)</td>
<td>13.06 (6.65)</td>
</tr>
</tbody>
</table>

The second requirement of this study was that the CBM-I procedure induced a group difference in interpretation bias for negative interpretations of socially ambiguous information. To examine whether the CBM-I manipulation successfully induced a group difference in interpretation bias, these similarity ratings were subjected to a 2x2x2 repeated measures ANOVA with CBM-I Condition (Benign vs. Control) as the between subjects factor and Test Sentence Type (Target vs. Foil Sentence) and Test Sentence Valence (Benign vs. Negative) as the within subjects factors. A tendency to rate Negative Test Sentences as more similar to the original passage than Benign Test Sentences will be revealed by a main effect of Test Sentence Valence. If this tendency is significantly smaller for participants in the Benign CBM-I Condition than for participants in the Control CBM-I Condition then there will be a two way interaction. This two way interaction should reflect the fact that the degree to which similarity ratings are higher for Benign Test Sentences relative to Negative Test Sentences will be disproportionately great for the Benign CBM-I Condition compared to the Control CBM-I Condition. If the CBM-I manipulation serves to induce a genuine change in interpretation bias, rather than eliciting a response bias, then this two way interaction will be disproportionately greater in the Target Test Sentences as compared to Foil Test Sentences.
Sentences. This will be seen as a three way interaction in which the two way interaction described above will be significantly greater on Target Test Sentences relative to the Foil Test Sentences.

Results revealed a significant main effect of Test Sentence Type $F(1, 59)=183.50$, $p<.01$, partial-$\eta^2=.76$, reflecting higher similarity ratings for Target (M=24.68, SD=4.32) than for Foil Test Sentences (M=12.48, SD=5.11). This shows that participants retained memory of the original passages. There was also a significant main effect of Test Sentence Valence, $F(1, 59)=64.03$, $p<.01$, partial-$\eta^2=.52$, indicating participants gave higher similarity ratings to Benign Test Sentences (M=21.49, SD=4.27) than Negative Test Sentences (M=15.67, SD=4.23). The ANOVA yielded a trend towards a Test Sentence Type x Test Sentence Valence interaction, $F(1, 59)=3.70$, $p=.06$, partial-$\eta^2=.06$, showing that the degree to which the Target Test Sentences have a higher similarity ratings than the Foil Test Sentences, suggesting memory for the original passage, was disproportionately better for Benign Test Sentences than for Negative Test Sentences. More importantly there was a significant Test Sentence Type x CBM-I Condition interaction, $F(1, 59)=5.60$, $p=.02$, partial-$\eta^2=.09$, indicating that the degree to which participants gave higher similarity ratings to Target Test Sentences than to Foil Test Sentences was disproportionately greater in the Benign CBM-I Condition as compared to the Control CBM-I Condition.

Of most importance there was a Test Sentence Valence x CBM-I Condition interaction effect, $F(1, 59)=34.27$, $p<.01$, partial-$\eta^2=.37$. This indicates that the degree to which the tendency to rate Benign Test Sentences as more similar to the original passage than Negative Test Sentences was larger in the Benign CBM-I Condition as compared to the Control CBM-I Condition. The nature of this interaction is shown in Figure 1. This effect could potentially result from a response bias reflecting an increased
tendency to rate Benign Test Sentences as more similar to the original passage than Negative Test Sentences for participants in the Benign CBM-I Condition to a significantly greater degree than for participants in the Control CBM-I Condition. Alternatively, this effect could result from an interpretation bias reflecting a greater tendency for participants in the Benign CBM-I Condition to impose benign interpretations on ambiguous information as compared to participants in the Control CBM-I Condition. If the latter is the case, then this two way interaction of Test Sentence Valence and CBM-I Condition will be further modified by Test Sentence Type. This will be seen as the degree to which Benign Test Sentences are rated more similar than Negative Test Sentences to a greater degree in the Benign CBM-I Condition than the Control CBM-I Condition, being significantly greater in the Target Test Sentences as compared to the Foil Test Sentences.

![Figure 1. Similarity ratings of each Test Sentence Valence for both CBM-I Conditions](image)

Figure 1. Similarity ratings of each Test Sentence Valence for both CBM-I Conditions

The three way interaction effect of CBM-I Condition, Test Sentence Valence, and Test Sentence Type did indeed approach significance, $F(1, 59)=3.45$, $p=.07$, partial-$\eta^2=.06$. While using a two-tailed test the significance of this effect fell just outside
conventional significance, the directional prediction generated by the central hypothesis justifies increasing the power to detect this effect by conducting a one-tailed test. As such, using a one-tailed test the results indicate a significant effect. If this is the case then the two-way interaction of Test Sentence Valence and CBM-I Condition was modified by Test Sentence Type. This shows that the degree to which Benign Test Sentences were rated significantly more similar to the original passage than Negative Test Sentences, was disproportionately great in the Benign CBM-I Condition as compared to the Control CBM-I Condition. Further, this effect was significantly greater in the Target Test Sentences than the Foil Test Sentences. The nature of this three-way interaction is consistent with an interpretation bias and is presented in Figure 2.

Figure 2. Similarity Ratings for each Sentence Valence in the Target and Foil Sentences for both CBM-I Conditions
Did the Stressor Evoke Heightened State Anxiety?

The state anxiety VAMS ratings for both conditions pre and post the speech stressor were found to be normally distributed and assumptions of sphericity and homogeneity of variance were met. The third requirement of this study was that the speech stressor must evoke heightened state anxiety, and do so to an equivalent degree for participants assigned to each of the two CBM-I Conditions. The state anxiety VAMS ratings obtained before and after the speech stressor are presented in Table 3.

Table 3. Pre and Post Stressor Mean VAMS ratings (SDs in brackets)

<table>
<thead>
<tr>
<th></th>
<th>Benign CBM-I Condition</th>
<th>Control CBM-I Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Stressor</td>
<td>29.58 (12.60)</td>
<td>25.00 (14.64)</td>
</tr>
<tr>
<td>Post Stressor</td>
<td>40.22 (11.30)</td>
<td>32.52 (14.22)</td>
</tr>
</tbody>
</table>

These state anxiety VAMS ratings were subjected to a 2x2 repeated measures ANOVA with Assessment Point (Pre vs. Post Stressor) as the within subject factor and CBM-I Condition (Benign vs. Control) as the between subject factor. This revealed a significant main effect of Assessment Point, \(F(1, 58)=47.40, p<.05, \text{partial-}\eta^2=.45\) indicating that state anxiety was significantly elevated post stressor (\(M=36.40, SD=9.98\)) as compared to pre stressor (\(M=23.61, SD=10.89\)). No other significant effects emerged from this analysis. Of particular relevance, there was no significant interaction between Assessment Point and CBM-I Condition, \(F(1, 58)=1.45, p=.23, \text{partial-}\eta^2=.02\), indicating that participants in each of the CBM-I Conditions did not experience differential elevation of state anxiety in response to the stressor. These results provide evidence that participants in both groups were experiencing heightened
state anxiety to an equivalent degree prior to beginning the CBM-I manipulation, as was required for the study.

**Did the CBM-I Manipulation Affect the Rate of Anxiety Dissipation?**

The seven state anxiety VAMS ratings subsequent to the speech stressor for each of the two CBM-I Conditions were found to be normally distributed and assumptions of sphericity and homogeneity of variance were met. The main aim of the current study was to determine whether a CBM-I procedure, that successfully creates a group difference in interpretation bias for negative interpretations of emotionally ambiguous social situations, also serves to produce a corresponding group difference in the rate of Anxiety Dissipation following evocation of state anxiety. Average state anxiety VAMS ratings on each state anxiety assessment point across the Anxiety Dissipation Phase are presented in Figure 3.

![Figure 3. Average state anxiety VAMS ratings across the seven assessment points](image-url)
These state anxiety VAMS were subjected to a 2 x 7 Repeated Measures ANOVA with Assessment Point (seven Post Stressor time points) as the within subjects factor, and CBM-I Condition (Benign vs. Control) as the between subjects factor. The fourth requirement of this study stipulates that state anxiety must decline across time, to an equivalent degree in each of the experimental groups. This will be seen as a progressive decline in state anxiety across time, as indicated by a main effect of Assessment Point. Here, the main effect of Assessment Point was significant, F(6, 54)=2.86, p<.05, partial-η²=.24, reflecting a decrease in state anxiety over time as evidenced by a significant linear trend, F(1, 59)=6.81, p<.05, partial-η²=.10. This linear trend, as seen in Figure 3, demonstrates a gradual decrease in state anxiety which fulfils the fourth requirement of the study. No other effects were significant. Of most importance to the issues under investigation is that the interaction between Assessment Point and CBM-I Condition did not approach significance, F(6, 54)=.67, p=0.68, partial-η²=.07. This indicates there was no difference between the two CBM-I Conditions in the rate in which the heightened state anxiety dissipated.

Discussion

The current study aimed to determine whether negative interpretation bias causally contributes to Anxiety Dissipation. This was pursued by examining whether a CBM-I procedure, that successfully creates a group difference in selective negative interpretations of ambiguous information, also serves to produce a group difference in the rate of Anxiety Dissipation following evocation of state anxiety. The theoretical hypothesis was that a more negative interpretation bias causally contributes to diminished Anxiety Dissipation. This generates the prediction that, if the CBM-I procedure is successful in producing a group difference in selective interpretations of emotionally ambiguous social situations, then the rate of Anxiety Dissipation following
evocation of state anxiety will be greater for the Benign CBM-I Condition than the Control CBM-I Condition. In order to test the hypothesis, four requirements had to be met in this study. First, there must be no group difference between the Benign CBM-I Condition and the Control CBM-I Condition in Dispositional Anxiety prior to beginning the experiment. Second, the CBM-I procedure must induce a group difference in selective attention towards negative socially relevant information. Third, the speech stressor must evoke heightened state anxiety to an equivalent degree in both groups of participants. Fourth, there must be a significant decline in state anxiety across the experimental window. All of these requirements were met as will be discussed below.

The results demonstrated that the first requirement was met, as no group difference was observed in either general Dispositional Anxiety or in the specific disposition to experience social anxiety, at the beginning of the experiment. Thus, Dispositional Anxiety was not confounded with CBM-I Condition. The second requirement of this study was also met as the degree to which Benign Test Sentences were rated significantly more similar to the original passage than Negative Test Sentences, was disproportionately great in the Benign CBM-I Condition as compared to the Control CBM-I Condition. Further, this effect was significantly greater in the Target Test Sentences than the Foil Test Sentences, indicative of a group difference in interpretation bias. The third requirement of the study was met, as the introduction of the stressor significantly heightened state anxiety to an equivalent degree across all participants. Finally, the fourth requirement of the study was met as this heightened state anxiety significantly declined across the duration of the study.

Given that all the requirements were met, it was possible to test the hypothesis by examining whether there was a group difference in the dissipation of heightened state anxiety such that the dissipation was greater for the Benign CBM-I Condition than
the Control CBM-I Condition. Having met the conditions to be able to adequately test the theoretical hypothesis, the results provided no evidence to support the prediction that negative interpretation bias causally contributes to Anxiety Dissipation when a social stressor was introduced, as no group difference in Anxiety Dissipation was evidenced. Of course, the results in the current study will have to be replicated before such a conclusion can be drawn with confidence. However, the theoretical implication of having induced a group difference in interpretation bias without a subsequent group difference in Anxiety Dissipation is that negative interpretation bias causally contributes to Anxiety Reactivity alone, and not to Anxiety Dissipation. This then presents the applied implication that the focus of therapeutic interventions involving interpretation bias should be targeted at decreasing Anxiety Reactivity. As the effectiveness of CBM-I in reducing Anxiety Reactivity has already been well-established in previous literature, future research should now focus on implementing these CBM-I procedures in clinical populations. Further, it should be determined whether CBM-I is effective as a standalone treatment or whether it must only be used in conjunction with current evidence based methods of treating anxiety disorders.

As was outlined in the General Introduction, it is also important to replicate the findings of the current study with other stressors to determine whether the implications drawn in this study generalise to other types of anxiety. Differences in stressors may introduce variation in the dissipation of heightened state anxiety, so the social stressor used in this study might be different to other stressors in ways that does not create variance in Anxiety Dissipation. One way in which it is different that may have affected the outcome of the study is how ambiguous the stressor is. It can be assumed that if the CBM-I manipulation successfully induced differential resolutions of ambiguity (the ambiguous passages), then this means that participants have been trained to respond to
ambiguity. Therefore, the likelihood of seeing a difference in Anxiety Dissipation will be greater if the stressor has a greater degree of ambiguity. One could argue that the social stressor, which presents the threat of delivering a speech in about 30 minutes time, does not have a great degree of ambiguity as participants are fully aware of their current capabilities. This is in contrast to a more ambiguous stressor, for example the exam stressor as this asks participants to worry about an exam that is about one week from that moment in time. This big window of time between the stressor and the threatening event allows for more uncertainty about how they will perform on the exam, and as such this stressor has a greater degree of ambiguity. This hypothesis can be tested in future studies by repeating the current study with two different stressor types, one condition that has a stressor that is not ambiguous, and one condition that has a more ambiguous stressor. One way in which to do this is to have participants watch stressful videos with the non-ambiguous condition seeing videos that have a clear emotional tone, and the ambiguous condition seeing videos of which the emotional valence is ambiguous. By comparing the effect of CBM-I on the rate of Anxiety Dissipation in each of these stressor conditions it will be possible to determine whether the use of a non-ambiguous stressor prevented observation of a differential dissipation of heightened state anxiety.

Future research could also explore how the different ways in which individuals interpret ambiguous information affects Anxiety Dissipation. In the attentional bias literature a distinction has been made between the selective engagement of attention and selective disengagement of attention as independent characteristics of elevated Dispositional Anxiety (P. J. F. Clarke, Hart, & MacLeod, 2014; Grafton & MacLeod, 2014; Rudaizky, Basanovic, & MacLeod, 2014). It is suggested here that a similar process occurs in interpretation bias with interpretation bias referring to the initial
interpretation of some ambiguous information. Then, re-interpretation may happen, which refers to a later reappraisal of the ambiguous information that either confirms or contradicts the initial interpretation. It has been suggested in the attentional bias literature that engagement bias may serve to increase Anxiety Reactivity and disengagement bias may serve to impair Anxiety Dissipation (Rudaizky et al., 2014). Therefore, it is possible that the same theory can be applied to interpretation bias. Anxiety Reactivity may be more influenced by the initial interpretation and Anxiety Dissipation may be more influenced by re-interpretation. It would be interesting for future research to examine the hypothesis that Anxiety Dissipation is driven by re-interpretation.

To conclude, the results of the current study did not support the hypothesis that negative interpretation bias causally contributes to diminished Anxiety Dissipation. This implies that negative interpretation bias causally contributes only to increased Anxiety Reactivity and so this should be the focus of therapeutic interventions involving CBM-I procedures. However, before drawing this conclusion the hypothesis of the current study can be revisited with the exam stressor to determine whether these findings are generalisable to other types of stressor. As such, the following study will seek to determine whether manipulating CBM-I can subsequently create a differential decline in Anxiety Dissipation when an exam stressor is used to evoke heightened state anxiety.
Chapter 6: Does Negative Interpretation Bias Causally Contribute to Diminished Anxiety Dissipation in Test Anxious Individuals?
As was described in the General Introduction, the approach taken in this research project was to examine the causal contribution of negative interpretation bias to diminished Anxiety Dissipation by evoking heightened state anxiety, administering a CBM-I procedure and measuring the decline in state anxiety. One study was designed to heighten state anxiety by introducing a social stressor and another study was designed to heighten state anxiety by introducing an exam stressor. These two stressor types are included to determine whether any observed effects are generalisable across different types of stressors. The previous study delivered the social stressor to evoke heightened state anxiety, and the results did not provide support for the theoretical hypothesis that negative interpretation bias causally contributes to diminished Anxiety Dissipation. The current study will now examine the same theoretical hypothesis but with an exam stressor. To carry out this experiment, the same methodology as in the previous study was employed. However, in the current study the exam stressor, as described in Experiment 2, was administered to evoke heightened state anxiety in individuals with heightened disposition to experience test anxiety.

There are few studies that have examined the causal relationship between disposition to experience heightened test anxiety and negative interpretation bias. There is some evidence to suggest that test anxiety is characterised by a negative interpretation bias (e.g. Calvo, Eysenck, & Castillo, 1997, Putwain & Best, 2011). However, there is very little research exploring the impact of CBM-I on elevated disposition to experience test anxiety. One study that has examined this, from Sportel, Hullu, Jong, & Nauta, (2013), recruited participants high in either social anxiety and/or test anxiety. Participants were allocated to either a Cognitive Behavioural Therapy (CBT) condition,
Interpretation Bias and Test Anxiety

a CBM condition or a control condition that received no treatment. The CBM condition consisted of 10 consecutive days of completing a CBM-A task directly followed by a CBM-I manipulation, and the tasks were delivered in the participants home via the internet. Both the CBM-A and CBM-I manipulations consisted of the benign variants of the task, in that participants were trained to adopt an attentional bias towards benign information and to interpret ambiguous information in a benign manner. The CBT condition consisted of 10 group sessions of Cognitive Behavioural Therapy that were delivered at the participant’s school by a psychologist, plus homework. Interpretation bias and disposition to experience test anxiety were measured before and after the 10 days of delivering either CBM or CBT for all three conditions. Results from the Recognition Task used to assess interpretation bias demonstrated that participants in the CBM condition showed a bias towards benign interpretations to a significantly greater degree than interpretations made by participants in both the CBT and control conditions. The results also showed that, in both the CBT and CBM conditions, participants’ disposition to experience test anxiety was significantly reduced from pre to post treatment. These results suggest that the CBM procedure impacted emotion in such a way that disposition to experience test anxiety was reduced. However, a limitation of this study is that both CBM-A and CBM-I were delivered so it is not possible to discern whether one procedure had a larger impact on mood than the other.

This above-mentioned study showed that interpretation bias can be effectively manipulated in test anxious participants, which provides confidence that employing a CBM-I manipulation in the current study will induce a group difference in interpretation bias. However, along with the limitation mentioned above, the task was not tailored specifically for test anxious participants by using content specific stimuli. As in the attentional bias literature there is also evidence in the interpretation bias literature that a
greater degree of congruency between the content of the stimuli and the type of anxiety in question, improves the effectiveness of the CBM-I. In a study conducted by Mackintosh, Mathews, Eckstein, & Hoppitt (2013) different types of stimuli were employed in CBM-I manipulations to observe whether this influenced the impact of CBM-I on Anxiety Reactivity. In one of the CBM-I procedures the content of the ambiguous passages was congruent to the concerns of the type anxiety in question. In another CBM-I procedure the content of the ambiguous passages was not congruent with the type of anxiety in question. The results revealed that when the content of the ambiguous passages was not congruent with the concerns of people with the type of anxious disposition in question, a significant group difference was not induced in interpretation bias. Further, there was no subsequent group difference in Anxiety Reactivity. Importantly, the study found that when the content of the ambiguous passages was congruent with the concerns of people with the type of anxious disposition in question there was a significant group difference in interpretation bias following the CBM-I procedure. There was also evidence of a subsequent group difference in Anxiety Reactivity. This demonstrates that matching the content of the ambiguous passages to the specific concerns of the type of anxiety in question is necessary for the CBM-I procedure to be effective. The current study will be running a CBM-I procedure specifically for participants high in disposition to experience test anxiety. For this reason, new ambiguous scenarios were created for the current study to reflect situations related directly to exam or test scenarios, and that included word fragments that resolved these scenarios in a negative and benign manner.

Once again, this study aimed to determine whether negative interpretation bias causally contributes to diminished Anxiety Dissipation. This study was designed to determine whether a CBM-I procedure that successfully creates a group difference in
selective negative interpretations of ambiguous test relevant information also serves to produce a group difference in the rate of Anxiety Dissipation following evocation of state anxiety using an exam stressor. To fulfil this aim, participants were first allocated to one of two CBM-I conditions. Participants allocated to the Benign CBM-I Condition completed a CBM-I manipulation designed to encourage benign interpretations of emotionally ambiguous test relevant passages. Those allocated to the Control CBM-I Condition completed a control variant of the CBM-I manipulation that was not configured to modify selective interpretations of ambiguous passages. All participants were delivered the exam stressor that was described in Experiment 2 which involved a five-minute worry period in which participants engaged in worrying thoughts, feelings and behaviours about the upcoming exams. As with Experiment 2, this experiment was run in the two weeks prior to the university’s exam period. The theoretical hypothesis is that a more negative interpretation bias causally contributes to diminished Anxiety Dissipation. This hypothesis generates the experimental prediction that if the CBM-I procedure is successful in producing a group difference in selective interpretations of emotionally ambiguous passages, then this will serve to induce a group difference in the rate of Anxiety Dissipation following evocation of heightened state anxiety using an exam stressor. Specifically, if it is the case that negative interpretation bias causally contributes to diminished Anxiety Dissipation, then participants in the Benign CBM-I Condition will show a significantly greater rate of Anxiety Dissipation than participants in the Control CBM-I Condition.

In order to adequately evaluate the hypothesis under examination the same four critical requirements need to be met. First, there must be no group difference in Dispositional Anxiety prior to beginning the experiment. Second, the CBM-I procedure must induce a group difference in interpretation bias such that participants in the Benign
CBM-I Condition demonstrate significantly less negative interpretations than participants in the Control CBM-I Condition. Third, the stressor must evoke heightened state anxiety and do so to an equivalent degree in both groups of participants prior to delivery of the CBM-I procedure. Fourth, there must be a significant decline in state anxiety across the experimental window. This CBM-I procedure has never been run with the newly created stimuli, but it is expected that this task will be successful in inducing a group difference in interpretation bias. Therefore, it is expected that all the requirements will be met and it will possible to test the experimental predictions.

**Method**

**Participants**

This study required participants high in disposition to experience test anxiety, and so 48 participants were recruited based on their high scores on the Revised Test Anxiety Scale (RTAS; Benson, et al., 1992). These participants were recruited from the full first year Psychology student cohort at The University of Western Australia, who were all screened on the RTAS. The students invited to participate all scored in the top third of this sample’s RTAS score distribution (i.e. above 47). Participants, of whom 41 were female, had an average age of 18.87 years (SD=2.24), and received partial course credit in exchange for participation.

Participants were randomly allocated to one of two CBM-I Conditions. Participants assigned to the Benign CBM-I Condition completed a CBM-I manipulation configured to encourage benign interpretations of emotionally ambiguous test situations. Participants assigned to the Control CBM-I Condition completed a control variant of the CBM-I manipulation that was not configured to modify selective interpretations of ambiguous test situations. Participants assigned to each of the two
CBM-I Conditions did not significantly differ in age, $t(43)=.96$, $p=.34$, $d=.29$ or in gender ratio, $\chi^2=1.50$, $p=.22$, $w=.18$.

**Materials**

**Emotional Assessment Instruments.**

*Revised Test Anxiety Scale (RTAS).* As in Experiment 2, the RTAS (Benson, et al., 1992) was used as the screening tool that guided participant recruitment. The RTAS was also used to confirm that participants assigned to the two CBM-I Conditions did not initially differ in their disposition to experience test anxiety, in order to verify that this element of the first requirement of the study was met.

*Spielberger Trait Anxiety Inventory (STAI).* In line with all previous experiments, the trait version of the State-Trait Anxiety Inventory (Spielberger et al, 1983) was used to verify that participants assigned to the two CBM-I Conditions did not significantly differ in dispositional anxiety, thereby fulfilling this second and final element of the first requirement of the study.

*Visual Analogue Mood Scale (VAMS).* As in Experiments 1, 2 and 4, a VAMS was used to assess anxious mood state at various points during the study. The purpose of this was to verify that state anxiety was evoked by the stressor, as well as to provide an index of the subsequent dissipation of this evoked state anxiety, in order to fulfil the third and fourth requirements of the study. State anxiety on each VAMS yielded a score between 0 (relaxed) to 60 (anxious).

**Experimental Stimuli**

The experimental stimuli were designed in an identical manner to Experiment 4. This included stimuli for both the CBM-I manipulation and the Interpretation Bias Assessment Task.
**CBM-I Manipulation Ambiguous Passages.** For each of the ambiguous passages a descriptive passage, final word, word fragment and a comprehension question were created. As in Experiment 4, the CBM-I manipulation employed a subset of 96 ambiguous passages drawn from those developed by Mathews & Mackintosh (2000). The critical difference in stimuli in this experiment as compared to Experiment 4 relates to the content of the passages. Those chosen were passages associated with test or assessment situations, some of which involve evaluation. Also, as in Experiment 4, the descriptive passages ended in either a Benign Final Word or a Negative Final Word, and for each of these final words a word fragment was created, consecutively a Benign Word Fragment or a Negative Word Fragment. Finally, a comprehension question was also created for each of the ambiguous passages. An example of a CBM-I manipulation Ambiguous Passage is:

You struggle to solve even a few of the items in a test you just completed.

Afterwards you compare notes with others and find that

compared with you, the others were considerably more

cha--e-g-d (Benign Word Fragment) / cl-v-r (Negative Word Fragment)

(challenged / clever)

Did you do better than the others on the previous occasion?

yes/no

**Interpretation Bias Assessment Task Stimuli.** As in Experiment 4, the task assessing interpretation bias did so by measuring the interpretation that participants imposed on a new set of ambiguous passages, the Interpretation Bias Assessment Task Ambiguous Passages. Interpretation was measured by rating the similarity of subsequent Test Sentences to the original passages. Therefore 10 subsets of stimuli were
created each containing an identifying title, an ambiguous passage with comprehension question, and four Test Sentences.

For each subset of stimuli a title was created. This was to provide a context for the participants to remember the ambiguous passage in the subsequent rating task. Ten ambiguous passages were created for use in the assessment procedure designed to measure interpretation bias which will be referred to as the Interpretation Bias Assessment Task Ambiguous Passages. These passages were identical to those employed by Mathews & Mackintosh (2000). The comprehension question created required the participants to have read the passage for meaning. An example of an Interpretation Bias Assessment Task Ambiguous Passage is as follows:

“Selecting Teaching Sets”

Your tutor writes questions on the board and the final set of questions was hard.

Next day the tutor has results and allocates everyone to an ability group.

Discussing with your fellow students after the test you find yourself in the group ex--ct--d (expected)

Did the tutor allocate you to a group based on ability?

For each of these passages a set of four Test Sentences were created. This included two target sentences, one that stated a benign candidate interpretation of the ambiguity and one that stated a negative candidate interpretation of the ambiguity. The Test Sentences also included two foil sentences that described events unrelated to either possible interpretation of the ambiguity but one was benign in meaning and one was negative in meaning. As with the ambiguous passages the Test Sentences were also taken from Mathews & Mackintosh (2000). Below is an example of the Test Sentences that correspond to the above example passage:
[Benign Target] Relative to your classmates you did well and are allocated to a set of high ability

[Negative Target] Relative to your classmates you did badly and are allocated to a set of low ability

[Benign Foil] Your fellow students are fun and you find the course interesting

[Negative Foil] Your fellow students do not like you and you do not enjoy this course

Experimental Tasks

**CBM-I Manipulation.** In a methodology identical to Experiment 5, the CBM-I manipulation was intended to induce a group difference in the selective interpretation of ambiguous situations. Participants were presented with the CBM-I manipulation Ambiguous Passages line by line ending in a word fragment. The same CBM-I manipulation Ambiguous Passages were used for both the Benign CBM-I and Control CBM-I Conditions. However, the word fragments presented differed depending on CBM-I Condition. In the Benign CBM-I Condition the Benign Word Fragments were always presented. Hence, in this condition participant’s ability to complete the task easily and efficiently would be enhanced by adopting a benign interpretive style, as this would enable correct anticipation of the meaning of the final word from which the word fragment was created. Therefore, by providing final words that were always consistent with a benign interpretation, this was intended to encourage the participants to adopt a benign interpretation bias. The Control CBM-I Condition was not configured to encourage any change in interpretation bias. In this condition the Benign Word Fragments were used on half of the trials and the Negative Word Fragments were used on the other half of the trials. Thus, participants could not adopt an interpretive style that would enable them to anticipate the meaning of the final word from which the word
fragment was created, and neither a negative nor a benign interpretation bias was encouraged.

Following correct completion of the word fragment, the comprehension question appeared below the position of the word fragment. Participants were required to press the left mouse button to answer ‘no’ and the right mouse button to answer ‘yes’. Depending on the participant’s response to the comprehension question the words “incorrect” or “correct” were then presented for 1000ms. The accuracy of these comprehension question answers was recorded to verify that participants correctly understood the meaning of the passage. As reading for meaning is necessary before the procedure could induce interpretive bias, it was required that participants displayed an accuracy level substantially above chance (50%) on these comprehension questions. Therefore, the inclusion criterion was set at 75% accuracy for comprehension questions, and participants who fell below this accuracy level were excluded from analysis. One trial consisted of reading an ambiguous passage, completing the word fragment and answering the comprehension question. The task consisted of 6 blocks of 16 trials and participants were given an opportunity to rest after each block.

**Interpretation Bias Assessment Task.** The Interpretation Bias Assessment Task consisted of two sections. The first section involved presenting the Interpretation Bias Assessment Task Ambiguous Passages. This was done in the same manner as the CBM-I manipulation. Following this, the participants completed a 3 minute filler task, as in Mathews & Mackintosh’s (2000) study. This permitted the decay of literal memory for the exact wording of the passage, but was brief enough to permit retention of the encoded meaning of the passage. During this filler task, participants were presented strings each comprising three numbers. They were required to identify whether more odd or even numbers were present in each string, and indicate this by clicking the left
mouse button for odd and right mouse button for even. An equal amount of number strings had more odd and even numbers and the numbers were randomly selected.

The second section of the Interpretation Bias Assessment Task involved presenting the sets of four Test Sentences and required participants to rate each of the four Test Sentences, independently of each other, on how similar in meaning they were to the meaning of the original passage. Participants were initially presented with the identifying title of the original passage at the top of the screen to assist them in remembering which scenario was being referred to, and a visual analogue scale at the bottom of the screen. They were required to press the space bar to reveal the first Test Sentence. Participants rated each Test Sentence using the visual analogue scale. This scale consisted of a 15cm line, made up of points that divided the line into 60 equal portions and with end labels very different in meaning (right) and very similar in meaning (left). Using the mouse, participants clicked on the point along the scale line and this yielded a score between 0 (very different in meaning) to 60 (very similar in meaning). These scores will be referred to as the Similarity Ratings. Once the participants had rated the first of the four Test Sentences it disappeared and a second Test Sentence appeared in the position below the first. This was repeated for the third and fourth Test Sentence. Participants were required to complete these ratings for each of the ten passages. The order in which the passages, the sets of Test Sentences, and the Test Sentences within each set, were delivered was randomised.

**State Anxiety Evocation and Dissipation Task.** This task consisted of two phases. The first phase of the task was designed to elevate state anxiety, to an equivalent degree in both groups of participants, by exposing them to a stressor, thereby fulfilling the third requirement of the study. This will be referred to as the Anxiety Evocation Phase. The stressor employed in this phase was identical to that used in Experiment 2.
That is, the exam stressor, during which the participants were required to engage in intense worry about their upcoming exams for a five minute period. State anxiety was assessed pre and post exposure to this exam stressor using VAMS ratings.

The second phase of the task was designed to measure the subsequent rate of state Anxiety Dissipation, as needed to meet the fourth requirement of the study that state anxiety must dissipate. To do this, state anxiety was measured at five minute intervals across a 35 minute period subsequent to the exam stressor using VAMS. This will be referred to as the Anxiety Dissipation Phase. The intervals between each VAMS will be referred to as the Dissipation Phase Blocks, and (as will be discussed in the procedure) these were used to deliver the CBM-I manipulation. The post stressor rating and the subsequent 6 VAMS ratings gave rise to seven VAMS ratings and revealed the rate of decline in state anxiety throughout the Anxiety Dissipation Phase.

**Procedure**

Participants were seated in an individual testing room and provided with an information sheet and consent form. Once their written consent to participate was given, participants completed the RTAS and STAI questionnaires, and received instructions for completing the CBM-I manipulation and the VAMS ratings. They then completed a short practice task, which consisted of four trials presenting unambiguous passages in the same manner as the CBM-I manipulation, preceded and followed by a VAMS rating. Immediately following this practice, participants were administered the Anxiety Evocation Phase of the Anxiety Evocation and Dissipation Task. Then, across the Anxiety Dissipation Phase of the Anxiety Evocation and Dissipation Task they completed the CBM-I manipulation. Specifically, a CBM-I manipulation block was delivered during each of the six Anxiety Dissipation Phase Blocks. Following this, participants were given instructions for the Interpretation Bias Assessment Task and
they then completed this task. Finally, participants were debriefed about the aim and design of the study.

**Results**

The comprehension questions in the CBM-I manipulation assessed whether the reader understood the meaning of the passages and permitted exclusion of participants who failed to show at least 75% correct responses. This resulted in the exclusion of two participants from the Benign CBM-I Condition and four participants from the Control CBM-I Condition. Therefore, analyses were run with 22 participants in the Benign CBM-I Condition, and 20 participants in the Control CBM-I Condition. This results section will first report on the baseline dispositional and state anxiety characteristics of these participants. It will then report whether the CBM-I procedure induced a group difference in interpretations of test relevant ambiguous situations. The results section will then report the effect of the exam stressor on evoking heightened state anxiety, and finally the effect of the CBM-I manipulation on Anxiety Dissipation. Prior to each analysis the assumptions of normality of distribution and homogeneity of variance were tested. Normality of distribution was tested by considering tests of kurtosis and skewness with cutoff scores for both of above 3.29 as recommended by Field (2009). Homogeneity of variance was tested with Levene’s Test for Equality of Variances.

**Participant Characteristics at Test Time**

Anxiety scores obtained by participants are shown in Table 1. These anxiety scores were found to be normally distributed and the assumption of equality of variances was met. As shown in the final column of Table 1, participants in the two CBM-I Conditions did not significantly differ on any of these anxiety measures. Therefore, anxiety was not confounded with CBM-I Condition.
Table 1. Participant Characteristics at Test Time

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Benign CBM-I</th>
<th>Control CBM-I</th>
<th>t (df)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Condition Mean (SD)</td>
<td>Condition Mean (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speilberger Trait Anxiety</td>
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<td>46.30 (9.67)</td>
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<td>.37</td>
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<td>Inventory score</td>
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<tr>
<td>Revised Test Anxiety</td>
<td>51.81 (8.25)</td>
<td>49.45 (7.78)</td>
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<td>Scale score</td>
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<tr>
<td>Baseline State Anxiety</td>
<td>21.18 (13.81)</td>
<td>19.95 (16.30)</td>
<td>.27 (40)</td>
<td>.79</td>
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</tbody>
</table>

Did the CBM-I Procedure Successfully Induce a Group Difference in Negative Interpretation Bias?

The similarity ratings assigned to Test Sentences from the Interpretation Bias Assessment Task were found to be normally distributed and assumptions of sphericity and homogeneity of variance were met. Initial data cleaning removed any similarity ratings identified as outliers using a 95% confidence interval (i.e. fell more than 1.96 standard deviations from the participant’s mean similarity rating for that Test Sentence Type.) The average similarity ratings assigned to Test Sentences are presented in Table 2.
Table 2. Similarity Ratings for Test Sentences in Each CBM-I Condition

<table>
<thead>
<tr>
<th></th>
<th>Benign CBM-I Condition</th>
<th>Control CBM-I Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Benign Target</td>
<td>26.96 (3.67)</td>
<td>23.08 (4.90)</td>
</tr>
<tr>
<td>Negative Target</td>
<td>14.83 (8.14)</td>
<td>20.26 (4.28)</td>
</tr>
<tr>
<td>Benign Foil</td>
<td>20.46 (3.48)</td>
<td>17.32 (7.22)</td>
</tr>
<tr>
<td>Negative Foil</td>
<td>11.17 (6.04)</td>
<td>12.59 (6.16)</td>
</tr>
</tbody>
</table>

The second requirement of this study was that the CBM-I procedure induced a group difference in interpretation bias for negative interpretations of ambiguous test related information. To examine whether the CBM-I manipulation successfully induced a group difference in interpretation bias, these similarity ratings were subjected to a 2x2x2 repeated measures ANOVA with CBM-I Condition (Benign vs. Control) as the between subjects factor and Test Sentence Type (Target vs. Foil Sentence) and Test Sentence Valence (Benign vs. Negative) as the within subjects factors. A tendency to rate Negative Test Sentences as more similar to the original passage than Benign Test Sentences will be revealed by a main effect of Test Sentence Valence. If this tendency is significantly smaller for participants in the Benign CBM-I Condition than for participants in the Control CBM-I Condition then there will be a two way interaction. This two way interaction should reflect the fact that the degree to which similarity ratings are higher for Benign Test Sentences relative to Negative Test Sentences will be disproportionately great for the Benign CBM-I Condition compared to the Control CBM-I Condition. If the CBM-I manipulation serves to induce a genuine change in interpretation bias, rather than eliciting a response bias, then this two way interaction will be disproportionately great in the Target Test Sentences as compared to Foil Test
Sentences. This will be seen as a three way interaction in which the two way interaction described above will be significantly greater on Target Test Sentences relative to the Foil Test Sentences.

Results revealed a significant main effect of Test Sentence Type, $F(1, 40)=53.42$, $p<.01$, partial-$\eta^2=.57$, reflecting higher similarity ratings for Target ($M=21.96$, $SD=2.82$) than for Foil Test Sentences ($M=14.71$, $SD=3.93$). This shows that participants retained memory of the original passages. There was also a significant main effect of Test Sentence Valence, $F(1, 40)=67.12$, $p<.01$, partial-$\eta^2=.63$, indicating participants gave higher similarity ratings to Benign Test Sentences ($M=21.28$, $SD=2.55$) than Negative Test Sentences ($M=15.39$, $SD=3.48$). More importantly, there was a significant Test Sentence Type x CBM-I Condition interaction, $F(1, 40)=12.23$, $p<.01$, partial-$\eta^2=.23$, indicating that the degree to which participants gave higher similarity ratings to Target Test Sentences than to Foil Test Sentences was disproportionately greater in the Benign CBM-I Condition as compared to the Control CBM-I Condition. No other significant effects were found, specifically, there was no significant Test Sentence Valence x CBM-I Condition interaction, $F(1, 40)=1.28$, $p=.26$, partial-$\eta^2=.03$, no significant Test Sentence Type x Test Sentence Valence interaction, $F(1, 40)=.20$, $p=.66$, partial-$\eta^2=.01$, and no main effect of Condition, $F(1, 40)=.00$, $p=.97$, partial-$\eta^2=.00$.

Of most importance, there was a significant three way interaction effect between CBM-I Condition, Test Sentence Valence and Test Sentence Type, $F(1, 40)=5.10$, $p<.05$, partial-$\eta^2=.11$. This interaction effect indicates that the degree to which Benign Test Sentences were rated significantly more similar to the original passage than Negative Test Sentences, was disproportionately great in the Benign CBM-I Condition as compared to the Control CBM-I Condition. Further, this effect was significantly
greater in the Target Test Sentences than the Foil Test Sentences. The nature of this three way interaction is consistent with the induction of an interpretation bias and is presented in Figure 1.

Figure 1. Similarity Ratings for Target and Foil Sentences

**Did the Stressor Evoke Heightened State Anxiety?**

The state anxiety VAMS ratings for both conditions pre and post the exam stressor were found to be normally distributed and assumptions of sphericity and homogeneity of variance were met. The third requirement of this study was that the exam stressor must evoke heightened state anxiety, and do so to an equivalent degree for participants assigned to each of the two CBM-I Conditions. The state anxiety VAMS ratings obtained before and after the exam stressor are presented in Table 3.
Table 3. Pre and Post Stressor Mean VAMS ratings (SDs in brackets)

<table>
<thead>
<tr>
<th></th>
<th>Benign CBM-I Condition</th>
<th>Control CBM-I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Condition Mean (SD)</td>
</tr>
<tr>
<td>Pre Stressor</td>
<td>21.18 (13.81)</td>
<td>19.95 (16.30)</td>
</tr>
<tr>
<td>Post Stressor</td>
<td>41.05 (14.63)</td>
<td>41.85 (11.01)</td>
</tr>
</tbody>
</table>

These state anxiety VAMS ratings were subjected to a 2x2 repeated measures ANOVA with Assessment Point (Pre vs. Post Stressor) as the within subject factor and CBM-I Condition (Benign vs. Control) as the between subject factor. This revealed a significant main effect of Assessment Point, F(1, 40)=89.70, p<.01, partial-η²=.69, which indicates that state anxiety was significantly elevated post stressor (M=41.45, SD=13.05), as compared to pre stressor (M=20.57, SD=14.47). No other significant effects emerged from this analysis. Of particular relevance, there was no significant interaction between Assessment Point and CBM-I Condition, F(1, 40)=0.21, p=.65, partial-η²=.01, indicating that participants in each of the CBM-I Conditions did not experience differential elevation of state anxiety in response to the stressor. These results provide evidence that participants in both groups were experiencing heightened state anxiety to an equivalent degree prior to beginning the CBM-I manipulation, as was required for the study.

**Did the CBM-I Manipulation Affect the Rate of Anxiety Dissipation?**

The seven state anxiety VAMS ratings subsequent to the exam stressor for each of the two CBM-I Conditions were found to be normally distributed and the assumption of homogeneity of variance was met. However, the assumption of sphericity was violated therefore Greenhouse-Geisser corrected tests are reported. The main aim of the current study was to determine whether a CBM-I procedure, that successfully creates a
group difference in interpretation bias for negative interpretations of emotionally ambiguous test situations, also serves to produce a corresponding group difference in the rate of Anxiety Dissipation following evocation of state anxiety. Average state anxiety VAMS ratings on each state anxiety assessment point across the Anxiety Dissipation Phase are presented in Figure 2.

![Figure 2](image_url)

*Figure 2.* Average state anxiety VAMS ratings across the seven assessment points.

These state anxiety VAMS were subjected to a 2 x 7 Repeated Measures ANOVA with Assessment Point (seven Post Stressor time points) as the within subjects factor, and CBM-I Condition (Benign vs. Control) as the between subjects factor. The fourth requirement of this study stipulates that state anxiety must decline across time, to
an equivalent degree in each of the experimental groups. This will be seen as a progressive decline in state anxiety across time, as indicated by a main effect of Assessment Point. Here, the main effect of Assessment Point was significant, $F(3.32, 132.62) = 21.103, p<.01$, partial-$\eta^2 = .35$. A trend analysis demonstrated a significant cubic trend, $F(1, 40) = 6.31, p<.05$, partial-$\eta^2 = .14$, as can be seen in Figure 2. This trend shows state anxiety to change direction twice by dissipating initially followed by a slight increase in state anxiety then returning to dissipation, to demonstrate an overall decrease in state anxiety over time. This fulfils the fourth requirement of the study.

The interaction of Assessment Point and Condition demonstrated a trend towards significance, $F(3.32, 132.62) = 2.40, p=.07$, partial-$\eta^2 = .06$. While using a two-tailed test the significance of this effect fell just outside conventional significance, the directional prediction generated by the central hypothesis justifies increasing the power to detect this effect by conducting a one-tailed test. When using a one tailed test the results would indicate a significant effect. Given the one-tailed test is accurate in finding a significant result then this may suggest that state anxiety dissipated to a greater degree in the Benign CBM-I Condition than the Control Condition, as is shown in Figure 3.
Figure 3. Average state anxiety VAMS ratings across the seven assessment points for each CBM-I condition

Discussion

This final study examined the theoretical hypothesis that negative interpretation bias causally contributes to diminished Anxiety Dissipation. In contrast to the previous experiment, in this study an exam stressor was introduced to evoke heightened state anxiety. The study aimed to determine whether a CBM-I procedure that is successful in producing a group difference in selective interpretations of ambiguous test situations, creates a group difference in the rate of Anxiety Dissipation following evocation of state anxiety using an exam stressor. As with all studies in this research program, in order to test the hypothesis four requirements had to be met. The first requirement, that there could be no group difference in dispositional anxiety prior to beginning the experiment,
was met. No group difference was observed in general Dispositional Anxiety or in the specific disposition to experience test anxiety, at the beginning of the experiment. Thus, Dispositional Anxiety was not confounded with CBM-I Condition. The second requirement was met as the CBM-I procedure induced a group difference in negative interpretations of ambiguous test relevant information. The third requirement of the study was also met, as the introduction of the stressor significantly heightened state anxiety to an equivalent degree across all participants. Finally, the fourth requirement of the study was met, as this heightened state anxiety significantly declined across the duration of the study.

With all the requirements having been met the hypothesis was able to be tested by examining the differential rate of Anxiety Dissipation in the two CBM-I Conditions. The results revealed that, using one-tailed testing, there was a significant group difference in Anxiety Dissipation. The pattern of results indicated that the rate of Anxiety Dissipation was significantly greater for participants in the Benign CBM-I Condition than participants in the Control CBM-I Condition. Caution is necessary when interpreting the one-tailed test and future studies may need to increase the power to allow detection of a group difference in Anxiety Dissipation with a two-tailed test. However, the current findings provide support for the theoretical hypothesis that negative interpretation bias causally contributes to diminished Anxiety Dissipation when an exam stressor is introduced. These findings suggest that Benign CBM-I procedures can not only reduce Anxiety Reactivity, but may also increase the rate of Anxiety Dissipation following evocation of heightened state anxiety using an exam stressor.

These findings stand in contrast to the results obtained in Experiment 4 which employed the speech stressor. An important change from the previous study to the
current study was the move to an exam stressor for evoking heightened state anxiety. This stressor was considered to be more ambiguous than the speech stressor and so it was assumed that the differential effects of the CBM-I procedure would be strengthened if the stressor was more ambiguous in nature. The results in the current study may reflect this use of a more ambiguous stressor. This may mean that that CBM-I does causally contribute to diminished Anxiety Dissipation in situations that are intrinsically ambiguous as the emotional ambiguity is what has been trained. Future studies may seek to confirm this hypothesis by replicating the contrasting findings of Experiment 4 and the current study.

The discrepancy between the results of the previous study and the current study may also be attributable to the degree of noise in the methodology and so further testing with other stressor types would be required to determine whether this is the case. However, there are two distinct factors that may be contributing to this difference between the studies and they are the role of self-focused attention and the timing of the future stressful event. Self-focused attention is a characteristic of social anxiety that consumes cognitive capacity. Thus, this may be interfering with the effects of the CBM-I procedure. Alternatively, it may be the case that when individuals are worrying about an exam that is far away in the future, then the degree of Anxiety Dissipation is greater which means there is more opportunity for a difference to occur. The differences between stressor types and the implications of these differences will be discussed in more detail in the next chapter, the General Discussion.

The results of the present study suggest that negative interpretation bias causally contributes to diminished Anxiety Dissipation when an exam stressor is employed to increase state anxiety, and this has both theoretical and applied implications. Firstly, these findings could contribute to the refinement of cognitive theories of information
processing in anxiety. Current models suggest that negative interpretation bias causally contributes to Dispositional Anxiety but only in reference to the impact on Anxiety Reactivity. These models may now be able to include Anxiety Dissipation as a separate construct of Dispositional Anxiety that is causally influenced by negative interpretation bias. Secondly, this finding could contribute to the development of future therapeutic interventions targeting maladaptive cognitive processes contributing to heightened anxiety vulnerability. Clinical therapeutic interventions currently employ a technique called cognitive challenging (Beck, 2011). Cognitive challenging is an effortful task that helps people identify the negative thoughts they are having about certain experiences or situations in their lives, and aims to change these thoughts by providing specific examples from their everyday life events as evidence against these negative thoughts. For example, a person who is anxious may have thoughts that others find the things they say to be stupid and so do not want to talk to them. Challenging this kind of thought would mean finding evidence in their lives contrary to this which would include such experiences as moments others have actively engaged in a conversation with you and positive comments that have been made by others about what you have said. Typically, cognitive challenging is learnt in a clinical setting and clients are required to practice challenging their negative thoughts in everyday life outside of the therapy room. This means that in most circumstances where clients are being asked to practice challenging their negative thoughts is when they are also currently experiencing heightened state anxiety. This may make it very difficult for these clients to carry out the cognitive challenging technique without their heightened state anxiety interfering and without the support of their clinician. This is where the CBM-I manipulation employed in the current study may be useful. As CBM-I can give clients a structured environment to make appraisals when they are experiencing heightened state anxiety,
which is usually quite difficult for clients, this should allow them to practice their clinical skills outside of the therapist office. This may, in turn, enhance the effect of the therapeutic intervention. In addition, as this may mean utilising CBM-I outside of the home and sometimes away from the computer, future research should seek to explore methods of delivering this CBM-I manipulation outside of the home and lab, the most practical method of which will be through apps using smart phone technology. Within the attentional bias literature studies have already begun to explore the use of smart phone technology in order to disseminate CBM-A procedures outside the home, as would be required for the future research recommended here (Enock et al., 2014). However, this method of delivery has not yet been examined within the interpretation bias literature.

The current study was has provided some promising results that may have important implications for the future direction of interpretation bias research. Of course, this study will need to be replicated to assess the robustness of the current findings. These replications should consider some limitations of the current study that may have created variability in the rate of Anxiety Dissipation. First, the current study did not control for the number of exams students were to complete. It was ensured that each participant was to complete at least one exam, but no data was collected as to the number of exams each participant was going to sit. In addition, no data collected regarding the timeline of each participant’s exams. Even though all participants completed the study in the two weeks prior to the exam period, students likely had exams at different times. Given that the exam period lasts also lasts for two weeks, this creates potentially substantial variability in the time between the study and the date of participants’ exam. Participants whose exam was scheduled sooner than others may have had a stronger anxious reaction to the worry induction in the current study, and
may have found it more difficult to cease worrying about their upcoming exam. These factors may have contributed to differences in both the initial increase in state anxiety in response to the stressor and in Anxiety Dissipation. It is important to note that although there were no group differences between these factors, variability may have added substantial noise in the data which may have acted to reduce the ability to detect a differential impact of the CBM-I procedure on Anxiety Dissipation. Future studies replicating the methodology of the current study should control for these factors if possible, to reduce additional noise in the rate of anxiety dissipation. Further, the test anxiety specific stimuli employed for this CBM-I manipulation were created especially for this experiment, therefore to encourage replication and to continue future research these stimuli are included in Appendix 1 and will be made freely available. The more general implications of this study and suggestions for future research in the context of the entire research project will now be discussed in the General Discussion.
Chapter 7: General Discussion
CHAPTER 7

This final chapter of the thesis will provide a review of the experimental findings, discuss the implications of these findings, and consider avenues for future research. The main aim of this research program was to test the two theoretical hypotheses that attentional bias to negative information causally contributes to diminished Anxiety Dissipation and that negative interpretation bias causally contributes to diminished Anxiety Dissipation. Support for these hypotheses would be observed if successful induction of a group difference in cognitive bias serves to produce a subsequent group difference in Anxiety Dissipation. Critically, in order to test these hypotheses, results in each study needed to meet four requirements. In each of the studies two requirements were consistently fulfilled. It was always the case that there was no group difference in Dispositional Anxiety prior to beginning the experiment, and the stressor always evoked heightened state anxiety and did so to an equivalent degree in both groups of participants. Each of the other two requirements were fulfilled in some but not all of the studies, and in only one study were all the requirements fulfilled. The greatest challenges observed in this research program were, i. the inconsistent capacity of CBM procedures to effectively induce a group difference in cognitive bias, and ii. The inconsistent occurrence of the decline in state anxiety which was necessary in order to measure the rate of Anxiety Dissipation. The findings of the current research program will be evaluated in this chapter, first through a discussion of the effectiveness of the CBM-A and CBM-I procedures in inducing a group difference in attentional bias to negative information and negative interpretation bias, respectively. Following this, the discussion will engage with the differences across the studies in inducing a decline in
state anxiety. Finally, the third section of this chapter will discuss the experimental findings in relation to the theoretical hypotheses.

**The Inconsistent Capacity of CBM Procedures to Induce a Group Difference in Cognitive Biases**

To summarise, the first half of this research program examined the causal contribution of attentional bias to negative information to diminished Anxiety Dissipation. Experiment 1 and Experiment 2 implemented the commonly used Dot Probe Task as the CBM-A procedure with the intention of inducing a group difference in attentional bias. However, in both of these studies, no such group difference in attentional bias to negative information was induced. Since the completion of these studies, there has been emerging evidence suggesting that the Dot Probe CBM-A manipulation may not be consistently successful in modifying attentional bias (e.g. Everaert, Mogoâ¸e, David, & Koster, 2014). Therefore, the third study of the research program employed a novel CBM-A procedure, the Emotion-in-Motion CBM-A manipulation, in the hope that this would prove to be more effective in inducing a group difference in attentional bias to negative information (Notebaert et al., under review). In line with results from previous studies that have employed this procedure, the results from Experiment 3 revealed that the Emotion-in-Motion CBM-A manipulation induced a significant group difference in attentional bias to negative information.

In the second half of the research program examining the causal contribution of negative interpretation bias to diminished Anxiety Dissipation, the scenario-based CBM-I manipulation developed by Mathews & Mackintosh’s (2000) was used to induce a group difference in interpretation bias. This task proved to be successful in inducing a group difference in negative interpretation bias both in Experiment 4 and 5. Below, the implications of the current findings for researchers seeking to modify patterns of
attentional bias will be considered, after which the implications of the current findings for researchers seeking to modify patterns of interpretation bias will be discussed.

The Effectiveness of CBM-A Procedures in Producing a Group Difference in Attentional Bias to Negative Information

Recent reviews and meta-analyses have shown that current CBM-A procedures are frequently ineffective in producing the intended change in attentional bias (Deacon & Abramowitz, 2004; Hallion & Ruscio, 2011; Pergamin-Hight, Naim, Bakermans-Kranenburg, van Ijzendoorn, & Bar-Haim, 2015). A recent manuscript from MacLeod, Grafton & Notebaert (2019) highlighted the inconsistent nature of CBM-A to induce a change in attentional bias. The authors pointed out that there is a high degree of variability within an individual’s bias score across time which can be linked to the psychometric limitations of current methods for assessing attentional bias. Examining the psychometric properties of the tasks used to both manipulate and assess attentional bias will be useful in determining the contributing factors to the lack of CBM-A manipulation findings. Other factors this manuscript offers as necessary directions for future research are such things as taking multiple measures of attentional bias or by taking the same measure on multiple occasions. The limitations around the psychometric properties of CBM-A tasks are addressed in more detail below. It is also important to understand the distinction between CBM as the intended procedure for facilitating modification of attentional bias, and CBM as the process of the bias modification taking place. CBM-A procedures are tasks that are designed as an experimental manipulation that can create group differences in attentional bias. Whereas CBM as a process refers to the cognitive changes that take place in the tendency to attend towards negative information as a result of the CBM-A procedure, which will be referred to as the bias change. In studies that have failed to induce a bias change using a CBM procedure, the impact of the bias change on elevated Dispositional Anxiety cannot be ascertained (Clarke, Notebaert, & MacLeod, 2014). Therefore, meta-analyses that do not differentiate between those studies in which a bias change was and was not achieved provide information about the
effectiveness of the CBM procedure in reducing Dispositional Anxiety. However, these studies cannot inform about the effectiveness of the process of bias change in reducing Dispositional Anxiety. An important avenue for future research is to examine the moderating factors that can potentially explain why the Dot Probe CBM-A manipulation does not robustly modify attentional bias. Some of these moderating factors may concern particular task parameters and individual differences.

It is possible that the CBM-A manipulation was not successful due to particular features of the task. As such task parameters will now be compared to previous studies to explore this as a consideration for future studies. The specific task parameters of concern are the length of the session in which CBM-A is delivered as well as the number of sessions delivered. Early studies delivered attentional training in a single session to examine the causal contribution of this attentional bias to Dispositional Anxiety. Researchers subsequently began to implement attentional training into clinical settings which consisted of multiple sessions of a shorter duration with the aim of inducing a more enduring change in attention bias (e.g. Amir, Beard, Burns, & Bomyea, 2009). While it may seem reasonable to assume that more training trials (achieved through either longer or more sessions) will exert a more robust effect of attentional bias, no single study has systematically examined whether this is the case. Some meta-analyses have attempted to look at the issue and the results have been inconsistent (Cristea, Kok, & Cuijpers, 2015; Mogoașe, David, & Koster, 2014). One study found a non-significant trend suggesting that the delivery of multiple sessions of the Dot Probe CBM procedure is more effective than a single session in producing a group difference in attentional bias (Hallion & Ruscio, 2011). Given the amount of variation between studies, it is difficult to draw conclusions concerning whether more training trials do or do not lead to a greater change in bias. Future meta-analyses may seek to resolve this
issue by determining what factors are contributing to the inconsistency in results. For example, earlier studies were more successful in evoking a bias change and as such the first meta-analysis of this kind (Hakamata et al., 2010) found an association between the number of sessions and the magnitude of the bias change. Subsequent meta-analyses have not always found this association, but they have always included studies that have not been successful in evoking a bias change. Future research could restrict analyses to those studies that did evoke a bias change in order to reveal whether these studies show an association between the number of sessions and the magnitude of the bias change. Also, the present study consists only of a single session and so if there had been multiple sessions of delivering the Dot Probe CBM procedure the bias change may have been induced. So, future research should run these attentional bias studies with multiple sessions to explore the hypothesis.

One candidate individual difference that may be moderating the degree to which the Dot-Probe CBM procedure modifies patterns of attentional bias is an individual’s pre-existing attentional bias. There exists some evidence that a larger attentional bias to negative information at baseline predicted a greater reduction in attentional bias to negative information in response to CBM-A. Mogoașe et al. (2014) examined the impact of pre-existing attentional bias on the magnitude of change in attentional bias to negative information after completing a CBM-A procedure. The results revealed that a greater attentional bias to negative information at baseline was associated with a greater reduction in this attentional bias. There is also some evidence that the stability of attentional bias moderates the magnitude of a change in attentional bias. For example, Heeren, Philippot, & Koster (2014) recruited individuals high in Dispositional Anxiety, and assessed attentional bias to negative information two weeks before completing CBM-A, just prior to completing CBM-A and after CBM-A. The CBM-A task
consisted of a modified Dot Probe CBM procedure configured with the intention of training participants to attend away from negative information. The results revealed that the Dot Probe CBM procedure was successful in modifying attentional bias, and that a more stable attentional bias, in other words less variance in attentional bias between the two baseline time points, predicted a greater change in attentional bias following CBM-A. A limitation of the studies in the current research project is that attentional bias was not assessed prior to administering the CBM-A procedure and so there was no baseline measure of attentional bias. This means that it was not possible to determine whether baseline attentional bias was a moderating factor on the effectiveness of the CBM-A procedure in inducing a group difference in attentional bias. Future studies examining the hypothesis that negative cognitive bias causally contribute to diminished Anxiety Vulnerability may need to consider specifically selecting participants who have a greater attentional bias to negative information and who have a stable attentional bias. This may mean that the CBM-A procedure is more likely to induce a bias change which will meet this requirement and allow for the hypothesis to be examined. To do this, a baseline measure of attentional bias will need to be incorporated into the methodology. This will be particularly important for studies employing the Emotion-in-Motion task as it is in its infancy and including baseline measures will provide further information about how attentional bias causally contributes to anxiety reactivity and dissipation.

Attentional control is another individual difference factor that refers to the ability to focus and shift attention. Previous studies using transcranial direct current stimulation (tDCS) have found that by stimulating the dorsolateral prefrontal cortex (DLPFC) the effects of CBM-A in inducing a bias change can be enhanced (Clarke, Browning, Hammond, Notebaert, & MacLeod, 2014; Clarke, Notebaert, & MacLeod, 2014). It has been suggested that as the DLPFC is the cortical region involved in
attentional control, stimulating this region will improve attentional control, and consequently improve the effect of CBM-A procedures in inducing a bias change. This theory was tested in a study from Basanovic, Notebaert, Grafton, Hirsch, & Clarke (2017). These researchers investigated the association between attentional control and the magnitude of change in attentional bias evoked by a CBM-A procedure. To do this, participants were allocated to either a benign condition, in which they completed a Dot Probe CBM-A manipulation designed to encourage attention away from negative information, or a negative condition in which they completed a Dot Probe CBM-A manipulation designed to encourage attentional toward negative information. Several assessments of attentional control (specifically measuring attentional inhibition and attentional selectivity) were completed prior to the CBM-A procedure. The results demonstrated a positive correlation between attentional control and the degree of change in attentional bias evoked by the CBM-A procedure. This provides evidence that attentional control may moderate the induced change in attentional bias. It also suggests that by improving attentional control the effects of the CBM-A procedure in inducing a bias change may be improved. The current studies have not measured attentional control and how it has moderated the impact of a bias change occurring. Given that this may enhance the effect of the Dot Probe CBM procedure in inducing a bias change, future studies that extend the current research program may seek strengthen attentional control prior to delivery of the Dot Probe CBM procedure.

Future research may also usefully employ a methodology that both enhances attentional control and attenuates cognitive biases simultaneously. This has already begun to be explored with the Combined Cognitive Bias Hypothesis which suggests that because attentional bias, interpretation bias, memory, and attentional control interact to maintain the symptoms of psychological disorders, such as depression and anxiety,
interventions that target these processes all together may be more successful in reducing Dispositional Anxiety (Hirsch, Clark, & Mathews, 2006). Everaert, Koster and Derakshan (2012) postulated that when different CBM procedures, including those to enhance attentional control, are combined they could potentially generate increased therapeutic benefits for sufferers of depression. Substantial support for the Combined Cognitive Bias Hypothesis has now emerged (Beard, Weisberg, & Amir, 2011; Everaert, Duyck, & Koster, 2014; Everaert, Tierens, Uzieblo, & Koster, 2013; Butler et al., 2015). One such study to test the effectiveness of combined CBM in reducing the symptoms of Dispositional Anxiety was conducted by Brosan, Hoppitt, Shelfer, Sillence, & Mackintosh (2011). In this pilot study the combined CBM procedure consisted of administering the Dot Probe CBM-A manipulation then immediately following this administering a Word Association Paradigm as a CBM-I procedure. Patients were delivered the combined CBM procedure on three separate occasions with attentional bias, interpretation bias and anxiety measured before the first session and following the third session. Results revealed that the combined CBM procedure successfully produced a change in attentional bias from pre- to post completion of the three sessions. This was evident as there was an attentional bias to negative information present prior to completing the initial combined CBM procedure that was no longer present post completion. There was also a significant increase in positive interpretations from pre- to post completion. The impact of this combined CBM procedure on Dispositional Anxiety was very promising with all participants showing a significant reduction in symptomatology. These results provide support for the effectiveness of combined CBM to successfully induce a change in cognitive biases as well as producing subsequent therapeutic benefits. However, this study did not compare the effectiveness of the combined approach in inducing a change in bias and its subsequent effect on
Dispositional Anxiety to such effects when employing CBM procedures that target a single cognitive process, i.e. attentional bias and interpretation bias. Future research will need to compare these CBM procedures to determine whether the combined approach is superior. If this is found then the Combined Cognitive Bias Hypothesis presents a new direction of research to address the aims of the current research program and can be adopted to determine whether a combined CBM procedure will serve to produce a group difference in negative cognitive biases resulting in a subsequent group difference in Anxiety Dissipation.

**Future Directions in Developing Effective CBM-A Tasks.** While it is important to examine the moderating factors that may influence the effectiveness of the Dot Probe CBM-A manipulation to induce a bias change in the pursuit of developing CBM-A techniques, it is equally important to continue to develop and validate novel CBM-A procedures. Recently, several novel CBM-A paradigms have been developed, as reviewed in Chapter 4. Relatively few studies have sought to examine the effectiveness of the novel CBM-A procedures to induce a change in bias. One of these novel paradigms is the Emotion-in-Motion CBM-A manipulation and its ability to modify patterns of attentional bias and subsequently impact on anxiety vulnerability has also been replicated (Notebaert et al., under review). Therefore, the Emotion-in-Motion CBM-A manipulation was employed in Experiment 3 of this research program to increase the chance of creating a group difference in attentional bias. The results of this study did indeed demonstrate that the Emotion-in-Motion CBM-A manipulation successfully induced a group difference in attentional bias to negative information. This provides evidence that the Emotion-in-Motion CBM-A manipulation may be a more effective procedure to modify attentional bias than the Dot Probe CBM procedure. The complex and dynamic Emotion-in-Motion CBM-A manipulation differs in many
aspects from the Dot Probe CBM-A manipulation, and several of these differences could contribute to its demonstrated capacity to modify patterns of attentional bias. These include the use of dynamic stimuli, performance feedback, consistent engagement with the task and explicit instructions. These features will be discussed in more detail below, as they could guide future research into the development of more effective novel CBM-A procedures.

The Emotion-in-Motion CBM-A manipulation has stimuli moving around the screen and requires participants to track the target stimulus. This was designed to incorporate both movement and complexity, as is characteristic of real life environments, which was thought to increase the likelihood of inducing a group difference in attentional bias. This is in contrast to the static display of stimuli in the Dot Probe CBM-A manipulation. The dynamic nature of the Emotion-in-Motion CBM-A manipulation was suggested to potentially enhance engagement with the task as well as concentration. The Emotion-in-Motion CBM-A manipulation also incorporated block by block feedback on participants’ performance, a feature which is not present in traditional probe-based training paradigms. Specifically, in the Emotion-in-Motion CBM-A manipulation, each block of trials is presented as a game as at the end of each block and the participant is provided with a score that they are encouraged to beat in each of the subsequent blocks. This is in contrast to the Dot Probe CBM-A manipulation which involves either no feedback at all or trial by trial error feedback, but critically there is no feedback per block. The introduction of this feedback method was intended to increase motivation. So, it was suggested that this feedback method is likely to have contributed to enhanced participant engagement (Notebaert et al, in press). Also, performance feedback following each block has been shown to enhance learning in simple repetitive tasks which may have increased the likelihood of inducing a group
difference in attentional bias. The current findings suggest that the Emotion-in-Motion CBM-A manipulation was effective in inducing a group difference in attentional bias and this may be attributable to the features of the task.

The Emotion-in-Motion CBM-A manipulation requires continuous tracking of the target stimulus as the measure of attentional bias which also serves to sustain consistent engagement with the task. In contrast, the Dot Probe CBM-A manipulation only requires brief intermittent button press responses. It is possible that this continuous task engagement contributed to the effectiveness of the task in modifying attentional bias. While requiring participants to track stimuli using the mouse ensured continuous task engagement it may not be the best way to measure attentional bias. Future research may consider better ways of measuring attentional bias that also serves to secure continuous task engagement, for example using eye tracking technology. Eye tracking is fast becoming a well-recognised measure of attentional bias in many different types of psychopathology including bipolar disorder (García-blanco, Salmerón, Perea, & Livianos, 2014), schizophrenia (Jang, Kim, Kim, Lee, & Choi, 2016), depression (Sanchez & Vazquez, 2014) and, anxiety (Armstrong & Olatunji, 2012 for review; Chen, Basanovic, Notebaert, Macleod, & Clarke, 2017). Providing real time feedback about allocation of attention using eye tracking has also been shown to reduce errors, improve confidence in completing the task, and assist with maintenance of eye gaze on the target (Henneman et al., 2014; Majaranta & Bulling, 2014). Future studies can look towards this approach of employing eye tracking that requires participants to consistently track the target stimulus with their eye gaze while simultaneously providing a better measure of attentional bias than using the mouse to track the target stimulus.

There is one other feature of the Emotion-in-Motion CBM-A manipulation that may contribute to its effectiveness in modifying patterns of attentional bias, and that is
the use of explicit instructions. In the Emotion-in-Motion CBM-A manipulation participants are instructed to track the face with the unique emotional expression, making it explicit that they are required to pay attention to stimuli of one valence. These instructions are unlike those in the conventional Dot Probe CBM-A manipulation where participants are asked to identify a probe without any mention of the valence of the preceding stimuli. It has now been shown that explicit instructions can enhance the degree to which a CBM-A procedure modifies attentional bias (Krebs et al., 2010; Lee et al., 2015). For example, Grafton, Mackintosh, Vujic, & MacLeod (2013) tested whether explicit instructions affect the capacity of the Dot Probe CBM-A manipulation to modify attentional bias to negative information. In this experiment, one subset of participants completed the Dot Probe CBM-A manipulation and were allocated to either a Benign CBM-A Condition or a Negative CBM-A Condition. These participants were only instructed on how to complete the computer task. Another subset of participants completed the same Dot Probe CBM-A manipulation and were instructed on how to complete the task but were also given information about the contingency of the CBM-A condition to which they were allocated prior to completing the Dot Probe CBM-A manipulation. Specifically, in this latter subset of participants, those assigned to the Benign CBM-A Condition were instructed that the probe would generally appear in the locus of the neutral word in each word pair and they must quickly shift their attention to this neutral word. Whereas participants assigned to the Negative CBM-A Condition were instructed that the probe would generally appear in the locus of the negative word in each word pair and that they must quickly shift their attention to this negative word. The results revealed that the Dot Probe CBM-A manipulation successfully induced a group difference in attentional bias to negative information in both subsets of participants but that this effect was doubled in size for the subset of participants who
received explicit instructions. This emphasises that explicit instructions regarding participant’s allocation of attention may enhance the effect of the CBM-A procedure in inducing a bias change. To summarise, it is to be hoped that future CBM-A procedures will extend the conventional Dot Probe CBM procedure to create novel procedures, such as the Emotion-in-Motion CBM-A manipulation, that are more effective in inducing a group difference in attentional bias than the Dot Probe CBM-A manipulation. Regardless of the task itself, it is possible that encouraging consistent engagement and motivation through gamification, feedback and explicit instructions may further improve the effectiveness of a CBM-A procedure.

**The Effectiveness of CBM-I Procedures in Producing a Group Difference in Negative Interpretation Bias.** In both Experiment 4, which examined the effect of CBM-I on Anxiety Dissipation in participants high in disposition to experience social anxiety and Experiment 5 which, in contrast, employed participants high in disposition to experience test anxiety, the CBM-I procedure successfully induced a group difference in negative interpretation bias. This differs from the CBM-A experiments in which the intended bias modification was not consistently successful in inducing a group difference in attentional bias to negative information. One reason for this difference might be that the CBM-I procedures were better able to match the content of the task stimuli to the type of concerns associated with the specific type of anxiety in question. It was considered important to match the content of the CBM-I manipulation stimuli (in this case scenarios) to the concerns of the specific type of anxiety. Matching the content in this way is known as content specificity, and applying this has been shown to result in stronger effects of the CBM-I procedure in modifying interpretation bias (Mackintosh et al., 2013). To accomplish this in Experiment 4, the ambiguous scenarios employed were matched for content between social situations and the concerns associated with
social anxiety. These scenarios already existed and were taken directly from Mathews & Mackintosh (2000). However, for Experiment 5, which recruited participants high in disposition to experience test anxiety, the negative interpretations of ambiguous scenarios were to be matched for content between test and exam settings and the concerns associated with test anxiety. However, no such stimuli had yet existed. Therefore, a novel set of stimuli was created for the purpose of this study to administer Mathews & Mackintosh’s CBM-I procedure using test anxiety stimuli to produce a group difference in interpretation bias. It is a pivotal finding for future research wishing to engage with test anxiety that this CBM-I procedure is still effective in creating a group difference in interpretation bias when these novel stimuli are employed. As such, these ambiguous scenario stimuli have been made publicly available to share in Appendix 1. To conclude, the findings from Experiment 4 and 5 demonstrate the effectiveness of CBM-I procedures in inducing a group difference in negative interpretation bias.

**The Decline in State Anxiety Following its Evocation in Response to a Stressor**

To examine whether the impact of CBM procedures on negative cognitive bias affects the rate of Anxiety Dissipation it was necessary that in each of the studies the induced heightened state anxiety significantly declined across the experimental window. This would allow for a potential differential decline between participants in the Benign CBM Condition who were encouraged to adopt a more benign bias and participants in the Control CBM Condition who completed a task designed to not encourage a directional bias. The results from all but one study demonstrated a significant decline in induced heightened state anxiety across the experimental window. Specifically, in the two CBM-A studies that employed the Dot Probe CBM-A manipulation and both the CBM-I studies, this dissipation of induced heightened state anxiety occurred. The
results of these studies suggest the methodology employed can be used in future research to assess Anxiety Dissipation. This methodology consists of employing a stressor that has been shown to reliably evoke state anxiety, and measuring state anxiety using Visual Analogue Mood Scales (VAMS) at five minute intervals over a 30-35 minute time frame following the stressor. Also of note is that the current studies measured Anxiety Dissipation across the period when the CBM procedure was being delivered.

It is important to recognise that in one study, a significant decline in state anxiety was not observed across the experiment window. Experiment 3 examined the impact of the Emotion-in-Motion CBM-A manipulation on Anxiety Dissipation following evocation of state anxiety using the speech stressor. In this study, heightened state anxiety did not significantly decline across the experimental window. It is worth considering the unique features of this study that may have compromised Anxiety Dissipation within the experimental session. In the Discussion of Experiment 3 it was recognised that the task parameters associated with the gamification of this CBM-A procedure could have contributed to absence of Anxiety Dissipation. These parameters included movement of stimuli around the screen to make the task better reflect real life environments as a means of inducing a greater group difference in attentional bias. Another task parameter included providing game scores as feedback to motivate the participant to improve their score and thus perform better in each game. Including these features in the Emotion-in-Motion CBM-A manipulation was considered advantageous in making the task more engaging than the original Dot Probe CBM-A manipulation. However, there may be some disadvantages of this procedure that were possibly contributing to the absence of Anxiety Dissipation. These consist of the movement of
stimuli, the use of feedback and the use of the STAI-SF as a measure of state anxiety, which were all discussed in detail in Chapter 4.

The current thesis is the first to introduce Anxiety Dissipation as a distinct pattern of heightened state anxiety that could lead to elevated Dispositional Anxiety. As such, Anxiety Dissipation has never before been tracked and no studies in the CBM field have measured state anxiety in such a way as has been employed in the methodology of this thesis. This means that there is much to learn about the process of Anxiety Dissipation and thus places this thesis as a starting point to answer many questions about the process of Anxiety Dissipation in both anxious and non-anxious individuals. Given that there is one study that failed to reduce heightened state anxiety this suggests that there may be evidence for a longer baseline level of dissipation in different circumstances. Future studies examining the process of Anxiety Dissipation could seek to determine whether there is a linear decline or if heightened state anxiety remains at baseline then suddenly drops off. The process of Anxiety Dissipation could also be observed by adding physiological measures of state anxiety, such as heart rate variability. Future studies could also benefit from the addition of specific features that allow measurement of what is happening for the participant during the anxiety dissipation process. For example, participants could be interviewed during the process and asked questions such as “Did you do anything to help the anxious feeling go away?” However, this will only measure the process that they are consciously aware of. To observe change in the cognitive process during the anxiety dissipation phase assessments of other cognitive processes could be included, for example a measure of attentional control. This methodology will allow researchers to determine which cognitive processes moderate change across the anxiety dissipation phase.
Does Variability in Attentional Bias to Negative Information and Negative Interpretation Bias Causally Contribute to Variation in Anxiety Dissipation?

In order to test the theoretical hypothesis, all four of the proposed requirements needed to be met in a single study. The two requirements regarding group equivalence were met in every study. Specifically, each study had no group difference in Dispositional Anxiety prior to beginning the experiment and the stressors evoked heightened state anxiety to an equivalent degree in both groups of participants. However, in the studies concerning the contribution of attentional bias to negative information to Anxiety Dissipation, the remaining two requirements were never met in the same study. In these studies when anxiety dissipated significantly across the experimental window, the CBM-A task did not successfully induce a group difference in attentional bias to negative information. In contrast, in the study where the CBM-A procedure did induce a significant group difference in attentional bias to negative information, there was no significant decline in state anxiety across the experimental window. Therefore, it was not possible to test whether attentional bias to negative information causally contributes to diminished Anxiety Dissipation, the reasons for which were explored earlier in this discussion.

Each of the four requirements was met in both interpretation bias experiments, meaning that it was possible to test the hypothesis in these studies. The results from these experiments revealed mixed evidence to support the experimental hypothesis. Experiment 4, which employed the social stressor, did not demonstrate a significant differential dissipation in state anxiety between the Benign CBM-I Condition and the Control CBM-I Condition. Therefore, there is no evidence to support the hypothesis that negative interpretation bias causally contributes to diminished Anxiety Dissipation when a social stressor has evoked heightened state anxiety. However, in the final
experiment which employed the exam stressor there was a group difference in Anxiety Dissipation whereby heightened state anxiety declined at a greater rate for participants in the Benign CBM-I Condition as compared to participants in the Control CBM-I Condition. This supports the hypothesis that variability in negative interpretation bias does causally contribute to variation in diminished Anxiety Dissipation when an exam stressor has evoked heightened state anxiety. This section will now address these results in more detail.

The Causal Contribution of Negative Interpretation Bias to Diminished Anxiety Dissipation. The results of the current research program suggest that the impact of variability interpretation bias on variation Anxiety Dissipation may be restricted to specific stressful situations as only the study that employed the exam stressor showed evidence to support the hypothesis. To determine why this effect on Anxiety Dissipation was restricted to the test anxiety study it will be useful to examine the key difference between the stressors used in the two studies. There are two notable differences between the social stressor and exam stressor: the role of self-focused attention and the magnitude of state anxiety evoked by the stressor. Another factor that may be contributing to these conflicting results could be the type of state anxiety that is being measured.

Although in these studies there was a significant group difference in attentional bias evoked by the CBM-I procedure, it may have been the case that the magnitude of the bias change in the social anxiety study was insufficient to exert an impact on Anxiety Dissipation. Current research suggests that a smaller effect of CBM-I manipulations will result in a smaller subsequent effect on mood (Cristea et al., 2015; Hallion & Ruscio, 2011; Menne-Lothmann et al., 2014). This hypothesis can be examined by looking at the effect sizes of the group difference in interpretation bias.
following the CBM-I manipulation in the two CBM-I studies. The magnitude of the
effect in the exam stressor study (partial-$\eta^2=.11$) is noticeably larger than the effect
found in the social anxiety study (partial-$\eta^2=.06$), which suggests that there may have
been interference in the process of modifying interpretation bias in the social anxiety
stressor. It is possible that the magnitude of the bias change may have been
compromised by self-focused attention and so could have been placing a higher
cognitive load on the individual. Self-focused attention has been identified as being a
core characteristic of social anxiety, whereas this is not present in test anxiety (Clark &
Wells, 1995). There are two prominent models of social anxiety that inform about the
characteristics of heightened state anxiety in this population and each identify self-
focused attention as a core characteristic. One model proposed by Rapee & Heimberg
(1997) is represented as a cycle and states that anxious persons’ mental representation
of themselves impacts how they judge the probability and consequences of negative
evaluation from others. This then influences their behavioural, cognitive and physical
symptoms which enhances their perceived internal cues and then strengthens their
mental representation of themselves, thus starting the cycle again. The updated version
of this model goes further to include imagery as an additional feature that may act to
maintain symptoms of social anxiety (Heimberg, Brozovich, & Rapee, 2010). Research
has found that socially anxious individuals are more likely to have spontaneous
intrusive mental images related to the feared event than non-anxious individuals
(Hackmann, Clark, & Mcmanus, 2000; Hackmann, Surawy, & Clark, 1998). This
mental representation of self means that these individuals are undergoing a constant
monitoring of themselves and have a constant thought process associated with one’s
appearance, behaviour and overall self-image. This ultimately consumes a significant
amount of cognitive capacity that could otherwise have been focused on the task at hand, in this case the CBM-I procedure.

Another model of social anxiety that identified self-focused attention as a core characteristic was proposed by Hofmann (2007). This model states that high perceived social standards, poorly defined social goals, and heightened self-focused attention lead to negative self-perception, high estimated negative consequences of socialising, low perceived emotional control and poor perceived social skills. With regards to self-focused attention, Hofmann proposed that when socially anxious individuals are presented with a threatening situation, their attention will shift inwards and they will monitor and observe their own thoughts and behaviours. In particular they will experience negative self-imagery and imagine themselves from the observer’s perspective. There is now evidence that self-focused attention causally contributes to heightened state anxiety and that this influences subsequent information processing biases, including interpretation bias (Woody, 1996, Heinrichs & Hofmann, 2001; Hofmann & Scepkowski, 2006). This self-focused attention is a cognitive process that is using a significant portion of the cognitive capacity available. As such, introducing a stressor that evokes self-focused attention, such as the speech stressor, could contribute to placing a high cognitive load on participants when completing the CBM-I manipulation. This in turn will make it more difficult to complete the task at hand, and so the effect of the CBM-I procedure on Anxiety Dissipation will not be as strong at inducing a group difference in Anxiety Dissipation as when the stressor employed evokes less self-focused attention, such as the exam stressor. Future studies can explore whether this interference is due to self-focused attention by including measures of cognitive preoccupations that identify the types of thought intrusions and their frequency (Hayes et al., 2010; Hirsch et al., 2009; Krebs et al., 2010), and
determining whether this mediates the subsequent rate of Anxiety Dissipation. Future research should also work towards boosting the effect of the CBM-I manipulation for the types of anxiety identified as having high cognitive interference. This can be done by including imagery within the CBM-I procedure as the use of imagery during CBM-I has been shown to improve the effects of CBM-I (see review: Menne-Lothmann et al., 2014). Such studies will be able to determine if CBM-I with imagery provides conditions in which heightened state anxiety can decline. If this is the case then that will allow for the current research aim to be tested.

A second difference between the stressors is that the exam stressor manipulation elicited greater heightened state anxiety than did the social stressor manipulation. It is reasonable to assume that a higher level of state anxiety increases the prospect of Anxiety Dissipation occurring across the experimental window. Indeed, in the test anxiety study, state anxiety increased by a magnitude of 20.88 points. In contrast, the magnitude of the evoked state anxiety in the social anxiety study was significantly less at 12.79 points, and a differential decline was not induced in this study but was induced in the test anxiety study. This suggests that a greater magnitude of state anxiety evoked by the stressor improves the ability to observe a possible decline in state anxiety. Testing this hypothesis would be an interesting future line of research that would provide important information into the optimal conditions under which to measure Anxiety Dissipation. Alternatively, future studies could seek to match the severity of the stressors used. Follow up analyses revealed that the magnitude of induced state anxiety was significantly greater for the exam stressor than the social stressor F(1, 100)=23.29, p<.05, as the magnitude of change reported above would indicate. It was also revealed that the magnitude of anxiety dissipation was enhanced for the exam stressor as compared to the social stressor, F(6, 606)=26.42, p<.05. It is plausible that the
difference in anxiety dissipation is due to severity of the stressor. As such, a repeated measured ANOVA was run with Time as the within-subjects factor and Stressor Type as the between-subjects factor while also adding Anxiety Reactivity as the covariate (this was calculated subtracting the post stressor state anxiety score from the pre stressor state anxiety score). The results revealed that there was no longer a significant difference in the rate of Anxiety Dissipation between stressors when the covariate is introduced, \( F(6, 594)=1.79, p=.10 \). This implies that severity of the stressor has a direct impact on the rate of anxiety dissipation. Future research could aim to test whether CBM-I causally contributes to the rate of Anxiety Dissipation following state anxiety evocation with a social stressor, using a method designed to evoke a greater increase in state anxiety. This could, for example, include using a heart rate monitor to inform the experimenter when the participant has reached the targeted level of heightened state anxiety, and continue to add anxiety provoking details to their required speech task until they reach the targeted level.

Finally, it may be the case that these studies are not measuring the appropriate type of anxiety. Research has established there is variation in the extent to which people experience somatic symptoms such as trembling, sweating, and hyperventilation, versus cognitive symptoms of anxiety, such as worry and poor concentration (e.g. Endler & Kocovski, 2001). Ree, French, Macleod, & Locke (2015) emphasised the importance of distinguishing between these two variants of state anxiety for predicting responses to stress. They developed the State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA) that provided pooled items which formed two subscales, one for cognitive symptoms and one for somatic symptoms of state anxiety. The validation of this inventory provided evidence that cognitive and somatic symptoms are separate constructs and that this is a valid assessment tool for distinguishing the two constructs.
It may be the case that negative cognitive bias may be contributing to cognitive anxiety, more so than somatic anxiety. But these two constructs have not been distinguished in the current research program’s measurement of Anxiety Dissipation. Therefore, participants who do not show a decline in heightened state anxiety may be experiencing more somatic anxiety. Future research should seek to identify whether individual differences in the way in which state anxiety is experienced impacts the effectiveness of the Dot Probe CBM-A manipulation in modifying attentional bias to negative information.

In summary, the CBM-I study which involved the exam stressor provided evidence for the causal contribution of negative interpretation bias to diminished Anxiety Dissipation. As noted in the discussion section of Chapter 6, this means that theories of Dispositional Anxiety may need to include diminished Anxiety Dissipation as it may causally contribute to elevated Dispositional Anxiety. These findings also have implications for the future clinical application of CBM-I in that it could be used in conjunction with traditional Cognitive Behavioural Therapy to enhance the therapeutic benefits of cognitive challenging. Alternatively, CBM-I has the potential to be employed as a standalone intervention for reducing heightened anxious symptoms when they are being experienced in the moment through internet and smart phone delivery. However, this will require further investigation.

**Summary**

The current research program was not able to draw conclusions as to whether negative attentional bias causally contributes to diminished Anxiety Dissipation. Further research using the Dot Probe CBM procedure could be more effective in inducing a change in bias by delivering multiple sessions, restricting the selection of participants to those with a greater pre-existing attentional bias to negative information, and
strengthening attentional control prior delivering the CBM-A procedure. There is also substantial evidence for the move to using novel CBM-A tasks, such as the Emotion-in-Motion CBM-A manipulation, which have been shown to be more effective than the Dot Probe CBM procedure. However, future researchers could also improve the Emotion-in-Motion CBM-A manipulation by using eye tracking to measure attentional bias and use explicit instructions to enhance the effect of the task on inducing a change in bias.

The current research program did find that negative interpretation may causally contribute to diminished Anxiety Dissipation but that this may be dependent on the type of stressor introduced. The study that introduced an exam stressor found a differential decline in Anxiety Dissipation that was not evident in the study that introduced a social stressor. This may be due to the magnitude of the bias change being smaller in the social anxiety study as a result of self-focused attention. Another reason could be that the stressor in the test anxiety study evoked a greater level of state anxiety which increased the prospect of Anxiety Dissipation occurring. Finally, there is also the possibility that this CBM-I manipulation is targeting cognitive anxiety and so anxiety will not dissipate so well in participants who are more inclined to experience somatic anxiety. The current research program has made a generous contribution to the understanding of whether or not negative cognitive biases causally contribute to variation in diminished Anxiety Dissipation. However, there is much more that still needs to be explored as has been described in this current section and further research is necessary. But these studies have provided the groundwork to guide potential future studies.
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Appendix 1

Materials for Experiment 6

You take a mock driving test and your instructor takes you on a difficult route. You think that you might have made a number of mistakes and at the end your instructor tells you that had it been for real you would have
p--s-d
passed
f--l-d
failed
Did you drive well?

You take a test and find it very difficult. When the results come out you find out that you scored under 50%. You ask your fellow students how they did and find out that everyone else's mark was
l-w--
lower
h--h-r
higher
Was your mark higher than the other students?

You overhear a radio programme about performance on a test you completed recently, but t very successfully. An eminent academic explains that a student of average ability should expect to get most of the questions wr--g
wrong
c-rr--t
correct
Did you do as well as you would have expected to do?

You play a game with your friend's children where you have to remember lots of things at once. You take part but quickly realise that you are finding the game quite hard. For you, t being able to remember the items is inco-s-q--nt-al
inconsequential
wo--y-ng
worrying
Does it bother you that you cannot remember the items?

You are taking part in paintballing as part of a team building exercise at work. Every time you start a new game you get shot straight away. Thinking you could well be the worst on your team makes you feel like l--gh--g
laughing
cr--ng
crying
Does being the worse on your team upset you?
You take an exam determining your ability to join the civil service.
The questions are very abstract and challenging. You find out you had a low score.
They kw how this will make you feel given that your own career interests lie
el-ew-ere
elsewhere
t-ere
there
Does it matter that you didn't do well on the test?

Your brother says that his children are doing better at sport than yours.
You realise that one reason is that your children do t attend
extra evening coaching which means that they are less
pr-ss-r-d
pressured
ad--nc-d
advanced
Do you think that more coaching would improve things for your children?

You are at a show for abstract paintings, and hear someone explain why they are
important. You don't really understand the paintings and decide the person talking
is trying to show how clever they are. You think compared to them you are quite
kn--ledg--b-e
knowledgeable
inf-ri-r
inferior
Do you know quite a lot about art?

You have a series of reasoning tasks to do and are given a challenging one.
You concentrate hard but it is very difficult and when you finish you know
you didn't get many correct. Later it is explained that the test assessed your
re-o-ve
resolve
int-ll-g--c-
intelligence
Was your score an important part of the test?

At your evening class, you are given a task to complete for the next week.
You finish it early and ask the tutor for his opinion. He says the work is good,
apart from missing a section. You feel that he will think you are
le-a--i-g
learning
c-rel--s
careless
Was your tutor pleased with the quality of work on your paper?

You struggle to solve even a few of the items in a test you just completed.
Afterwards you compare notes with others and find that
compared with you, the others were considerably more
cha--e-g-d
challenged
cl-v-r
clever
Did you do better than the others on the previous occasion?

You join an evening class on creative writing. At the early stages the teacher has lots of points to suggest improvement and you are asked to discuss these points in class. You are beginners together but you think the others will find your mistakes re-ssur--g
reassuring
s-u--d
stupid
Did you think other people would be superior?

You receive an essay back from your tutor and you got a much lower grade than you expected. She tells you that on this occasion she deliberately set a task that you would find ha--
hard
unde--nd--g
undemanding
Did your tutor expect you to find it difficult?

You are goal keeper for your local football team.
You save some of the goals but let a number in.
At the end of the game the score is 6-5 to y--
you
t-em
them
Did you win the game despite your mistakes?

You are at a party at a neighbour's house who insists that you take part in a general knowledge game he likes. You can answer only a few of the questions and feel a bit embarrassed. Then you think back to the ones you answered and feel quite pro--
proud
i-r-nt
igrant
Did you end up feeling pleased about being able to answer a few the questions?

You visit your bank to check on your account. You added up all the transactions in your recent statement and think that there has been an error.
When the clerk goes over the items with you it is clear that the mistake is t-éir-
theirs
y--rs
yours
Did you make a mistake adding up the transactions?

You take night school classes to learn German. Before the final exam you went to
Germany for a couple of weeks to brush up on your skills. When you get the exam results you find out you just passed even though you spent all that time in Germany ---

Did you expect to do better in the exams?

You apply for a job and are asked to take part in some tests as part of the recruitment process. You find the different tasks very difficult and at the end their feedback makes you think that this exercise revealed your willpower flaws

Was the exercise making an assessment of your intellectual ability?

You are playing a solo as part of a concert. As you are playing you know you are making some mistakes. At the end you think back to the bits that you played well and feel pleased ashamed

Do you feel happy when you think about the bits you played well?

With some colleagues you are given a new job to do at work. You think you have some idea how to do it, but when you try it on your own thing works out right. Feeling stupid you ask your colleagues and discover that compared to you they are clueless knowledgeable

Were the others just as confused as you?

You know that you have answered very few questions correctly in the test you have just taken. As you think about other people doing the same test you guess they will think that compared to them you are better awful

Will the others doing the test approve of your results?

At school, you met with a career advisor who gave series of tests to assess your aptitude for different jobs. Thinking back to how you did on these tests, and your subsequent career choice, you realise your scores on each one were clearly irrelevant

significant
Were your scores on the tests important?

You are at a party where your friend makes everyone join in with a game, and you get an extremely low score. From the expression on the others' faces you see that getting a higher score for this game might make them think you were rather a g--k
geek
st--
star
Did you want to get a high score on the game?

A group of colleagues invite you to a quiz night. You are part of a team but cannot answer all but one or two questions. Afterwards they comment on the specialist questions that were asked. You can see that your correct answers were v-t-l
vital
ins-ff-c-e-t
insufficient
Were your friends pleased with your performance?

You are playing pool after work with someone you have t met before and thinking that you are rather good you start to play. You manage to pot a couple of balls before you lose and then find out the person you were playing against was a pr-f-ss--n-l
professional
b-g-n-er
beginner
Would you have expected to win the game?

You are reading a book about how to impress at work. You try to implement a strategy suggesting you should imagine making errors in an important task. As you think about this situation you find your mind is filled with a feeling of ca--
calm
ina-equ--y
inadequacy
Do you feel relaxed?

A colleague asks you to organise a rota for coffee making duties. As you pin it up several people complain about the way in which you have designed it. You reflect on their comments and conclude that your organisational skills are probably fi--
fine
sl--py
sloppy
Are you satisfied with your organisational skills?

Your orchestra asks you to play a solo at the next concert. You practice a few times until you feel ready to play it with the orchestra. At the first
rehearsal you make a mistake. The conductor will think that your work is
promising
rushed
Did you feel disappointed with your performance?

You signed up for a study in which you are asked to complete some tests of ability.
As you read the instructions and begin the task you realise it is difficult. It is
clearly designed so someone of average ability should find most of the examples
tricky
straightforward
Is the task designed so that the examples are easy?

You are trying out a memory puzzle in a magazine. At the end you did not get
many answers correct. You read to the end of the article, and it explains that the
difficulty is set so that on most items someone of your general ability would be
right
Did you make more mistakes than would be expected?

You are assessed for a promotion at work and have a tough interview to go through.
After each answer you get the impression you are failing. At the end you are told
the questions were deliberately challenging and that your promotion has been
accepted
declined
Was your impression about failing wrong?

You are at a party and one of the games is a trivia quiz. You feel obliged to join
but do not know the answers to any of the questions you were asked. You think the
questions were mostly about things interesting to people who are relatively
intelligent
smart
Did you care about not knowing the quiz answers?

You consider joining the society for people who score highly on intelligence tests.
You take the test and are told that your score was not high enough to be accepted.
Thinking about it you realise that people who eventually join must be very
inspirational
Are you unhappy about not being accepted?

You join a tennis club and before long, you are asked to play in a doubles match even though you are very nervous. You lose and afterwards you discuss your performance with your partner. They focus on the shots that you played
well
shoddily
Did they focus on your good performance?

You have gone on a skiing holiday with friends. You take part in a downhill race with the other 10 students in your class. You finished sixth even though you had spent more time than anyone else
practicing
practicing
Did you enjoy your position?

You completed a really difficult test designed to encourage you to think about the emotional responses to such tests in the future. When you explain how the test was designed as a teaching tool you emphasise its capacity to estimate ability is negligible
accurate
Is it a good test of ability?

Your bathroom looks rather dingy and so you decide to put new tiles up. You are not experienced and when you look closely they are not all straight. In the end, you look at your work and decide that your efforts were worthwhile
futile
Did your efforts improve the look of the room?

As you work at each new example in a test you find you are not able to solve them in the time given. You assume that you should be able to do the tasks and the time allowed has therefore been carefully chosen so as to be impossible
enough
Do you think you should finish in the time?

You are given a modern test of intelligence. You work through trying your hardest but find the tasks very difficult. At the end of the session the assessor suggests someone from your background should expect to get only about 10% of these items
Were you expected to get most of the items wrong?

You are set to work on a test with two components. Each one is fairly easy by itself but you have to do both together. It is surprisingly difficult to solve and you make many mistakes. You think that this number of mistakes is not surprising.

Do you think you were worse than others at this test?

You have a go at an online game that your friend says is really fun. You start playing but don't seem to get a very high score. You think that this is because you find the game too trivial.

Was the game too difficult for you?

On holiday, one evening your family is persuaded to take part in a team quiz. With your low score you earn the loser's prize; a mug for each team member. Compared with the ornate winner's trophy you think being given mugs will be embarrassing.

Are you glad that you were given the mug?

Generally when you take part in ability tests you feel you do reasonably well. This time you can hardly solve any items. You hear another group have done much better. Their success is due to them having much more specific and extensive tuition.

Are the other group more intelligent than you?

You are feeling rather tired and decide to have a go at crossword in the paper. You try for a bit but can't make sense of any of the clues. In the end you give up thinking that in order to do well at something like this you would need to be more alert.

Did you think you weren't clever enough to solve the clues?
You take part in a research task and are surprised at your score at the end. The task was designed so that the score measures an aspect of 'performance'. Your responses assess whether you have good ability to deal with task failure switching Was this testing your ability to deal with disappointment?

After trying the first few questions in a test you realise that most of these items stretch your ability. As you tackle the ones that follow you feel determined demoralised Are you looking forward to tackling the next items?

The morning of your first appraisal with your new boss has arrived. She points out some of your mistakes and weaknesses and you think she will follow this up with other comments that are more critical Does your new boss have anything nice to say about your work?

As you work through examples in a test, you find it hard to keep all the details in mind to answer the questions. Then you think about your performance in this type of test and realise your achievements compared with other people will be very reasonable feeble Do you think you are performing worse than most others on this test?

You have taken an exam as part of an evening course and don't feel you did well. At the next class the grades are on the board and everyone is looking at them. As you compare your grades you realise everyone else did worse be--e better Did you do better than everyone else?

As part of an intelligence test you have to solve word encryption codes. Although you expected to do more, at the end of the time you have solved only one. You conclude that a higher score is more
unusual
usual
Do you think your score is lower than expected on this test?

You decide to attend an exam preparation class for the course you are studying. The presenter explains that the test has been arranged to provide questions to suit a range of ability, so in order to pass, students would need to correctly answer a few lot
Do you need to answer most questions correctly to pass?

Your boss asks you to do a job at work. You finish it before the deadline, although he finds some mistakes in it. You are new to the job and feel that your boss will think you are progressing negligent
Is your boss satisfied with you?

You attend an interview procedure at a recruitment centre with many others. You complete several written tests and receive feedback. You got very few questions correct and you answered the most important items correctly improperly
Do you think your performance was good enough on the important questions?

You are playing a game of cricket with friends and it is your turn to bat. You manage to hit a few balls before you are out. You think that the shots you missed were a result of overall poor bowling performance
Did you blame yourself for doing well at cricket?

You are taking a music exam and have to do a sight-reading test. As you play you realise it is easy and make some mistakes. When finished the examiner tells you the level of difficulty of the piece was deliberately chosen to be difficult easy
Were you expected to play well?
You are short-listed for a job and after an interview you are asked to take some aptitude tests. After you are told your answers are nearly all wrong. You guess they were testing your reactions to stress when you are later told you have been successful unsuccessful
Did you handle the stressful interview acceptably?

You are meeting an old friend that you haven't seen for years. As you think of how your life has progressed since you last saw them you wonder if they will think that compared with them your ups and downs add up to a life that has been quite fulfilling uninteresting
Do you think your friend will think you have had a good life?

As a member of the fundraising team at school, you organise a dance. You do your best although there is little time and you don't think that you have done a very good job. When you get feedback you hear that compared to last year it was superior worse
Did people prefer last years' dance?

You join a quiz team in a tournament. Most questions are asked to individuals in specialist rounds. The first game is hard and you don't get many questions right. Afterwards you hear the others saying that compared to them they think you did okay badly
Are the other members of the team pleased with how you performed?

You are learning to administer intelligence tests. Working through some items in an example test you find that after the first few you can not solve any more questions. Later you see that your final score is listed as showing an ability level that is high low
Does the task indicate that your intelligence is low?

You have a go at doing the mental puzzles in your newspaper and find them surprisingly difficult. You are surprised because you think that you have very many good qualities and think being good at solving this sort of puzzle is relatively unimportant
Does it bother you that you are finding the puzzles difficult?

You sign up for a 'learning for fun' course in woodworking. Everyone is given a test to reveal their existing expertise, and you end up joining a less abled group. You tice how the other groups progress and conclude your group is finding it more --

fun

tou--
tough

Is your group enjoying the week?

You try to help your friend's son with ATAR maths. You can't answer any of the questions and think back to how you did when you took the exams. Quickly you realise that you cannot help because the skills you had were quite
dif-er--t
different
w--k
weak

Are the skills you have too feeble?

You decide to have a go at some online crosswords. Quickly you realise that you are t very good and cannot work out any of the clues, just as you decide to stop playing you see that the ability level was set to
ex--rt
expert
--ce
vice

Are you concerned that you cannot solve any of the clues?

In a long task you are required to attempt a number of items but many of them seem impossible. When finished you’re told the session was designed to test a particular attribute. To achieve well on this attribute, you need to show evidence of mental
r-sil-e-ce
resilience
im-rov-ment
improvement

Was this a test of your determination?

Your friend is keen on skating and persuades you to try it out. At the rink you put on skates and step on the ice. You glide forward, slowly at first, then faster, your feet don't seem to obey your instructions. As you continue you start to feel
e-cit-d
excited
d-zz-
dizzy

Do you feel well?

You are on a long journey and suddenly traffic comes to a halt and you have to make
a detour. You realize you must have made a wrong turn and find yourself winding through a maze of small roads concluding that this route has turned out to be very beautiful stressful
Did you enjoy driving through country roads?

You overhear a teacher saying that he gives new groups an almost impossible test, and reads their scores aloud to allow them to compare the results. He then leads a discussion and uses this feedback to encourage them to treat the results as a joke jolt
Are the results of the test important?

Reflecting one day, you look back at achievements and disappointments that you have experienced during your life. Overall, your main feeling about life so far is one of satisfaction regret
Are you generally happy about the events experienced in your life?

You are taking an introductory course in Spanish language. Teaching is interactive, and everybody is asked to participate actively. The first sentence you say has a few mistakes. In this context, you feel this means that you are learning failing
Do you think your mistakes are bad?

You need to phone a work colleague. As you did not have your mobile with you when he gave you his phone number, you memorised it. When you need it, you have a moment of hesitation, which makes you feel as though your memory is terrible
Are you worried about the hesitation?

You have received a new credit card and memorised the pin number at home. You are using it for the first time with lots people waiting at the cashier's. You start with the wrong number and think this might be due to you being rushed str---d
stupid
Does your mistake indicate that you will remember the number?

You are shortlisted for a job and asked to attend a two day interview procedure. On day one you complete several written tests that may or may not be important. You receive feedback on them and you got very few questions correct. You feel relaxed
d-smay--
dismayed
Do you think that performance on the task is important for the job?

Your swimming club asks you to swim in a competition, as they are short of speed swimmers. You lose your first race and as you get out of the pool, your team mates are ready to talk with you. They say that you swam well
b-dl-
badly
Were your team mates angry because of your swimming performance?

The final part of your interview involves taking a written intelligence test. Ten minutes before the end, you glance around the room to see how the others are doing. Compared with them, you think that your answers will make you seem superior
inf----r
inferior
Did you do poorly on the intelligence test?

Your supervisor asks you to write a report. The finished document is quite brief but took a lot of time and effort. As she reads through it the next afternoon, you think that she will find that the amount you have written is
en--gh
enough
sc-nt
scant
Did your supervisor think your report was comprehensive?

You meet an old school friend at a pub. You discuss the old teachers and recall the examinations you took together when you were at school. Memories come into your mind of answering exam questions and feeling completely
c--pet--t
competent
st--id
stupid
Was it a good experience for you answering exam questions?

You are thinking back of a question a teacher asked you when you were in primary school. You remember this question very well, as you responded correctly first,
but just at the end you came to the wrong conclusion. This made you feel like a
cmp---
champion
d-ce
dunce
Was it important that you made the wrong conclusion?

You are memorising some new information for a test. The facts are very hard to
remember so you try to develop a strategy to make them easier to recall later.
When you receive the test later on you conclude that your strategy has
w--k-d
worked
fai--d
failed
Did you easily recall the new information?

During your exam you have to select 3 questions to answer as extended essays as
well as 4 short answer questions. You start on the short answers and remember
a lot to say. As you start on the essays you glance at the clock and start to
rel--
relax
w--ry
worry
Did you have plenty of time for the essay section of the exam?

You've finished writing the answer to the second question in your exam. You take a
small break, seeing what's left. You realize the questions left are more difficult
than you had anticipated. Checking the clock, you decide you've planned your time
w--l
well
b--ly
badly
Will you finish your exam in time?

It's an important day for you today, because you are sitting
an important exam. Before that, you meet a friend and
eat a good meal. During the exam, you feel
s--tai--d
sustained
s--k
sick
Did the meal help you concentrate throughout the exam?

You open the first page of your exam and look at the selection
of questions. After reading them all your heart starts to race as you
realise that of all of the questions available, you can answer
m--t
most
n-ne
ne
Will you be able to solve all questions?

You are revising with your friends in your back garden. One of your friends starts to test you on how well you know the subject. You find that you know the subject really w-ll well p--r-y poorly Do you feel confident about your knowledge?

You sit down at your desk in the exam hall. Before you are allowed to start, you are given 10 minutes to read through the exam paper. You open the booklet and start reading. The topics in the exam paper are all ones that you have r-v--ed revised f--g-tt-n forgotten Can you answer most of the questions?

You are half way through an exam question. You have already written several pages in answer to it. Re-reading the question, you realise that you have understood the question w-ll well in-or--c-ly incorrectly Did you understand the question?

You decide to work on your coming exam with a group of friends. You collect some old exam questions and start brainstorming possible answers. Some of you answers are different from theirs and you realise that you are very likely to have revised s--fi---nt-y sufficiently in--ffic---t-y insufficiently Did you find the revision session encouraging?

As you turn over the page on your exam paper and read through all the questions, you realise that all the practice answers you prepared have been w--th---le worthwhile f-r-ot--n forgotten Did you find your preparation useful?

You have been advised to make essay plans and notes to help you structure your essays in exams. As you start on the first question you think your knowledge of the topic and your essay plans are
Did your essay plans help you in your exam?

Your tutor springs a surprise revision test on you. You have yet started revising for this subject. As you listen to the questions, you realise that they are easy. Did you answer the questions well?

Your first exam is just over and you were relieved to have remembered a great deal to write in your essays. You talk to your fellow students as you walk away from the exam room. When everyone talks about answers they had given you feel a sense of satisfaction. Were you pleased with your answers after the exam?

As you sit down and start an important exam you become very aware of your thought processes. Reading through the first question, which is compulsory, your mind is completely blank. Do you feel confident to answer the first question?

You assumed that you would be well prepared for this assessment. You start writing the first question and you find the answers are coming to you with ease. Are you easily able to answer the first question?

You are sitting in a written math exam and make a break after half of the time. You’ve answered a quarter of the questions and are finding it difficult, you think you have answered the questions correctly. Do you expect to have a low grade?
As you work through examples in a test you find it hard to keep all the details in mind to answer the questions. Then you think about your performance in this type of test and realise your achievements compared with others will be very reasonable poor
Do you think you are performing worse than most others on this test?

You are sitting in a small room and have just started doing a test that seems very difficult. The room temperature was not noticeable when you went in but now as you make a start you feel aware that you are cool hot
Did you feel hot and bothered in the room?