Are Attention Bias and Interpretation Bias Reflections of a Single Common Mechanism or Multiple Independent Mechanisms?

Marilyn Fitzgerald

BA (Hons.)

This thesis is submitted as a partial requirement for the degree of

Doctor of Philosophy / Master of Psychology (Clinical)

of the University of Western Australia

School of Psychology

2008

Abstract

There is abundant evidence of anxiety-linked threat-biased attention and anxiety-linked threat-biased interpretation (cf. Mathews & MacLeod, 1994, 2005). The present research aimed to determine whether these cognitive biases reflect a single common underlying mechanism (the Common Mechanism Account) or multiple independent underlying mechanisms (the Independent Mechanisms Account). To address this question, a battery of eight experimental tasks was developed; four tasks measured attention bias and four measured interpretation bias. Participants with different levels of trait anxiety, completed pairs of these tasks. The pattern of associations amongst all eight tasks was compared with the pattern of associations between the four tasks that measured attention bias and the pattern of associations between the four tasks that measured interpretation bias. Both Accounts predicted strong associations between the four tasks that measured attention bias, and between the four tasks that measured interpretation bias. However, the Common Mechanism Account predicted generally strong associations between all of the eight tasks, that were equivalent in strength to the associations between tasks measuring attention bias and to the associations between tasks measuring interpretation bias. In contrast, the Independent Mechanisms Account predicted weaker associations between all of the eight tasks than the associations either between the tasks measuring attention bias or between the tasks measuring interpretation bias. The obtained pattern of associations between internally reliable measures of anxiety-linked attention bias and anxiety-linked interpretation bias failed to support the Common Mechanism Account, but rather was consistent with the predictions of the Independent Mechanisms Account. Theoretical and applied implications of the results are discussed.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

Acknowledgments

I owe a special debt of gratitude to Professor Colin MacLeod, the supervisor of this research, whose advice, assistance and patience have been unfailing from the conception of this project to its conclusion.

The timely, constructive and most helpful advice of Associate Professor Murray Maybery, Dr. Davina French, Associate Professor David Morrison and Professor Andrew Mathews is also very much appreciated.

Special thanks also to Associate Professor Andrew Page for his guidance throughout this research project and for his meticulous review and invaluable comments regarding a draft of this thesis.

Matt Huitson's many hours of invaluable assistance with the computer programming using *Metacard* software are gratefully acknowledged.

Thanks are also due to Dr. Craig Clark for the use of his *MC-Psych dll* software for the auditory stimuli, and Herb Jurkiewicz and Annie Morgan for their assistance with the development of the auditory stimuli using *Sound Forge* software.

Not least, I would like to thank my husband Andrew Purser, my parents Robert and Lyn Fitzgerald, my family, friends, and colleagues for their unconditional encouragement and support in the course of my journey.

Are Attention Bias and Interpretation Bias Reflections of a Single Common Mechanism or Multiple Independent Mechanisms?

Inspired largely by Beck's schema theory (Beck, 1976; Beck & Clark, 1988, 1997; Beck, Emery, & Greenberg, 1985), research conducted over the last twenty years has shown that individual differences in information processing biases can distinguish individuals with clinical and sub-clinical symptoms of a range of psychological disorders from individuals who do not have these symptoms (Dalgleish & Watts, 1990; MacLeod, 1990; Mathews & MacLeod, 1994, 2005; Williams, Watts, MacLeod, & Mathews, 1988, 1997). These studies have employed a diversity of research methodologies and demonstrated the occurrence of information processing biases across a range of psychopathology, including depression (MacLeod, 1990; Mathews & MacLeod, 1994, 2005), eating disorders (Faunce, 2002), chronic pain (Roelofs, Peters, Zeegers, & Vlaeyen, 2002), substance abuse (Cox, Fadardi, & Pothos, 2006), and insomnia (Ree & Harvey, 2006). Arguably the most widely researched emotional condition that has been associated with individual differences in information processing biases is anxiety, which is the focus of the present research project (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007; MacLeod, 1990; Mathews & MacLeod, 1994, 2005).

A central tenet of cognitive models of emotion is the assumption that individuals who experience particular emotional conditions do so due to their biased information processing (Eysenck, 2004). Two forms of information processing bias that have been implicated as playing causal roles in the development of emotional conditions are attention bias and interpretation bias (Mathews & MacLeod, 2002). The attention bias associated with emotional dysfunction involves the preferential allocation of attentional focus to stimuli whose meaning is representative of a person's concerns relative to neutral stimuli (MacLeod, 1990; Williams et al., 1988, 1997). The type of interpretation bias associated with such dysfunction involves the preferential interpretation of an ambiguous stimulus as possessing a meaning that is consistent with a person's concerns (MacLeod, 1990). In the case of anxiety, it is assumed that concerns are related to danger and threat (Beck et al., 1985). As such, anxiety conditions have been shown to be associated with: the tendency to selectively attend to threat, herein referred to as *threat-biased attention*; and the tendency to selectively interpret ambiguous stimuli as threatening, herein referred to as *threat-biased interpretation* (MacLeod, 1990, 1999; Mathews & MacLeod, 1994, 2005; Mogg, Bradley, & Williams, 1995; Williams et al., 1988, 1997). Recent research suggests that each bias can cause individuals to preferentially direct cognitive processing resources towards information that is compatible with various emotional conditions, thereby promoting the development of these emotional conditions (Mathews & MacLeod, 2002).

Despite the abundance of evidence that the two information processing biases exist (MacLeod, 1990, 1999; Mathews & MacLeod, 1994, 2005; Williams et al., 1988, 1997), it is not known whether they both result from the same underlying cognitive mechanism, or whether each bias is caused by a different cognitive mechanism. Understanding the relationship between attention bias and interpretation bias may not only advance our theoretical knowledge of biases in information processing, but may also facilitate the development of improved clinical assessment instruments and treatment interventions. The present research investigates the association between attention bias and interpretation bias. As the conception of these information processing biases has been most clearly articulated in terms of their association with anxiety (MacLeod, 1990, 1999; Mathews & MacLeod, 1994, 2005), the primary focus of the research is to establish the relationship between anxiety-associated individual differences in the two information processing biases. The particular type of anxiety chosen for examination is trait anxiety since variability in these information processing biases has been most frequently and robustly associated with individual differences in trait anxiety (MacLeod, 1990, 1999; Mathews & MacLeod, 1994, 2005).

By way of setting the context, before elaborating on the particulars of the experimental question, the present chapter reviews evidence of the two information processing biases. In light of previous comprehensive reviews (e.g., MacLeod, 1990, 1999; Mathews & MacLeod, 1994, 2005; Williams et al., 1988, 1997), this review is not intended to be exhaustive. Rather, its purpose is to demonstrate trait anxiety-associated individual differences in interpretation bias and attention bias as measured under a variety of experimental conditions. Research into individual differences in attention bias is first reviewed, followed by a consideration of investigations into individual differences in interpretation bias. Evidence of each information processing bias is reviewed in the context of measures designed to reveal the initial focus of information processing and measures designed to reveal the subsequent revision of the focus of information processing. Consideration is also given to the different stimulus modalities employed by the various measures of each information processing bias. After reviewing the evidence of each information processing bias, the present experimental question is expanded. Then the different theoretical accounts of the association between individual differences in attention bias and individual differences in interpretation bias are discussed. Finally, the chapter will conclude with a brief overview of the method to be adopted.

The following literature review focuses on the association between variability in trait anxiety and individual differences in attention bias and interpretation bias. However, since clinically anxious individuals are also typically characterised by elevated levels of trait anxiety (e.g., Mogg, Mathews, & Weinman, 1989), evidence of information processing biases associated with clinical anxiety disorders is also examined.

Individual Differences in Attention Bias

A range of approaches has been developed to measure the individual differences in emotional conditions associated with biased attention towards threatening information. Tasks measuring attention bias may be classified in two categories. Firstly, there are measures of the tendency to initially orient attentional focus towards threatening information, herein referred to as measures of *Initial Attention Bias* (e.g., MacLeod, Mathews, & Tata, 1986; MacLeod & Rutherford, 1992; Mathews & MacLeod, 1986). Secondly, there are measures of the ability to revise the initial orientation of attention away from threatening information, herein referred to as measures of *Revised Attention Bias* (e.g., Fox, Russo, Bowles, & Dutton, 2001, Yiend & Mathews, 2001). The present section will consider these classes of measures, highlighting the use of auditory and visual stimuli.

Measures of Initial Attention Bias

The Emotional Stroop Task

One of the most widely used measures of biased attention towards threatening information is the emotional Stroop task (Mathews & MacLeod, 1994, 2005; Williams, Mathews & MacLeod, 1996). The original emotional Stroop task required participants to name the ink colours of words, while ignoring the words' threatening or neutral meanings (Mathews & MacLeod, 1985). Numerous studies have shown that relative to the speed of naming the colour of neutral words, individuals exhibit longer response latencies when naming the colour of threatening words (Mathews &

MacLeod, 1994, 2005; Williams et al., 1996). Typically, the effect is considered representative of the extent to which threatening relative to neutral information can capture the focus of an individual's attention.

In a representative emotional Stroop study, Mogg et al. (1989) presented a series of coloured neutral, physical threat and social threat words to participants diagnosed with generalised anxiety disorder and control participants. The authors found that compared with the control participants, participants with generalised anxiety disorder displayed longer colour-naming latencies for the threat-related relative to the neutral words. Further, it was revealed that participants with generalised anxiety disorder were particularly slow to colour-name threat-related words that were congruent with their reported predominant worries. This finding suggests that high anxious individuals experience difficulty in directing their attention away from threat-related words pertinent to their concerns.

Other researchers have examined the emotional Stroop effect under conditions in which participants were unable to report the content of the emotional word stimuli (MacLeod & Rutherford, 1992; Mogg, Bradley, Williams & Mathews, 1993). For example, Mogg, Kentish and Bradley (1993) asked participants with a range of trait anxiety levels to name the background colours of threat-related, and neutral words that were presented too briefly to permit their content to be reported. Mogg et al. (1993) found a significant correlation between trait anxiety and an index of the relative colour-naming latency for threat-related relative to neutral words, such that the greater a participants' trait anxiety, the longer their colour-naming latency was for threat-related relative to neutral words. The authors interpreted this finding as evidence that trait anxiety is associated with a subconscious attention bias towards threat.

The emotional Stroop task has also revealed biased attention towards threat-related information using a variety of stimuli other than visual word stimuli. For instance, some researchers have employed a variant of the emotional Stroop task that presented pictorial stimuli to measure biased attention towards threat-related information (e.g., Hester, Dixon and Garavan, 2006; Putman, Hermans, & van Honk, 2004; van Honk, Tuiten, de Haan, van den Hout, & Stam, 2001). Martin and Jones (1995) asked participants reporting spider phobia and control participants to name the colour of pictures that were threatening in nature (e.g., a picture of a spider) and pictures that were neutral in nature. In comparison with the control participants, individuals reporting spider phobia exhibited slowed colour-naming latencies for the threat-related relative to the neutral pictures. Martins and Jones (1995) interpreted this result as suggesting that individuals reporting spider phobia experience difficulty avoiding attending to the threatening picture content.

Other research suggests that auditory stimuli could be employed in a variant of the emotional Stroop task to assess individual differences in attention bias associated psychopathology (e.g., Jerger, Stout, Kent, Albritton, Loiselle, Blondeau, & Jorgenson, 1993; Morgan & Brandt, 1989). In auditory versions of the Stroop task, participants are typically required to indicate whether a word is spoken by a male or a female, while ignoring the word's semantic content (e.g., Jerger et al., 1993; Morgan & Brandt, 1989). Although at present attention bias in psychopathology has not been assessed using an auditory emotional Stroop task, Wurm, Labouvie-Vief, Aycock, Rebucal and Koch (2004) showed that an auditory emotional Stroop task can distinguish adults on the basis of their age. Therefore, it is possible that an auditory emotional Stroop task could be employed to measure individual differences in attention bias associated with psychological disorders such as anxiety.

Despite its wide use, the use of the emotional Stroop task as a measure of initial attention bias has been questioned (e.g., Fox, 1993a, 1993b, 1994; Fox, Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002; Lavy & van den Hout, 1994). These researchers argue that since the to-be-responded-to information (colour) and the to-be-ignored information (word meaning) occur within the same stimulus it is unclear whether the emotional Stroop task measures the ease of initial orientation of attentional focus, or the ease of subsequent shifting or revision of initial attentional focus (Fox, 1994). Alternatively, other researchers propose that the increased colour-naming latencies for emotional words in the emotional Stroop task may reflect attempts to avoid processing stimuli due to their emotional content (de Ruiter & Brosschot, 1994). Yet other authors suggest that the emotional Stroop task measures the processing of a stimulus' attributes and the preparation of a response to the stimulus rather than the initial orientation of attention towards a stimulus (Pratto & John, 1991, Williams et al., 1996).

The Dot Probe Task

Another experimental method that has been widely used to measure differences in attention bias associated with individual differences in emotional conditions is the dot probe task (MacLeod et al., 1986). In the original form of the dot probe task, a neutral word stimulus and a threat-related word stimulus are simultaneously briefly displayed on a computer screen. Following the offset of this pair of stimuli, a probe appears in the location vacated by one of the stimuli. Participants are asked to press a button in response to this probe and their reaction time is recorded. The assumption is that when the probe appears in the person's initial focus of attention, then the person will be faster to detect the occurrence of a probe in that locus. Faster identification of probes appearing in the vacated location of threat-related stimuli relative to neutral stimuli is interpreted as evidence of an attention bias towards threatening information.

A large body of research has shown that relative to low trait anxious participants, the probe responses of high trait anxious participants are more rapid when probes appear in the location vacated by threat-related relative to neutral words (Mathews & MacLeod, 1994, 2005; Williams et al., 1996). For instance, MacLeod and Mathews (1988) found that relative to participants who reported low trait anxiety levels, participants who reported high trait anxiety levels displayed speeded detection times for probes located in the position vacated by threat-related stimuli relative to those located in the position vacated by neutral stimuli. The authors concluded that individuals with high trait anxiety direct their attention towards threat related information.

The dot probe task has also been employed to examine the association between differences in trait anxiety and variability in attention bias towards threat-related pictorial stimuli (e.g., Bradley, Mogg, & Millar, 2000; Fox, 2002). By way of example, Bradley, Mogg, Falla and Hamilton (1998) presented participants with faces that displayed happy, threatening or neutral expressions. Relative to low trait anxious participants, the authors found that high trait anxious participants responded significantly more quickly to probes located in the position vacated by a face with a threatening expression rather than either a happy or neutral expression. To Bradley et al. (1998) this finding suggested that individuals with high trait anxiety initially focus their attention towards threatening information.

The dot probe task has also evidenced biased attention towards threat-related information using auditory rather than visual stimuli (Eysenck, MacLeod, & Mathews, 1987). Halkiopoulos (reported in Eysenck et al., 1987) presented participants reporting high and low trait anxiety pairs of auditory words, one word appearing in each channel. The pairs of words contained one threat-related and one neutral member. Randomly following some of the pairs of words was an auditory probe. The participants' task was to respond as quickly as possible to this probe. Relative to the low trait anxious participants, high trait anxious participants responded to probes that appeared in the channel of a preceding threat-related word significantly more quickly than to probes that appeared in the channel of a preceding neutral word. This effect was interpreted as evidence that individuals with high trait anxiety tend to selectively attend towards threat (Eysenck et al., 1987).

Like the emotional Stroop task, it has been proposed that performance on the dot probe task may not reflect an individual's tendency to initially orient attention towards threat-related information, but rather may represent an individual's difficulty revising their initial attentional focus away from threat-related information (Fox, 1994; Fox et al., 2001). Fox et al. (2001) argue that to perform the dot probe task it is necessary to attend to both the location of the threat-related stimulus and the location of the neutral stimulus. Therefore, since both locations must be attended to, it is not certain whether performance of the dot probe task reflects a tendency to orient initial attention towards threat or difficulty revising one's attentional focus away from threat (Fox et al., 2001).

The Dichotic Listening Task

Unlike the emotional Stroop and the dot probe tasks, the dichotic listening task was developed with the specific aim of measuring the attentional processing of auditory stimuli (Bonanno, Davies, Singer, & Schwartz, 1991; Burgess, Jones, Robertson, Radcliffe, & Emerson, 1981; McCabe & Gotlib, 1993). In the dichotic listening task, participants are asked to repeat aloud neutral words that are presented in the *attended* ear, while neutral or threat-related words are simultaneously presented in the *unattended* ear. At the same time, participants also perform an unrelated reaction time task. It is assumed that slower reaction times on the reaction time task when threat-related words are presented in the unattended earphone (relative to the reaction times when neutral words are presented), reflects the capture of the initial focus of attention by threatening information.

Using a dichotic listening task, Mathews and MacLeod (1986) compared the performance of participants diagnosed with generalised anxiety disorder and non-anxious control participants. Unlike the control participants, the participants with generalised anxiety disorder displayed significantly slower reaction times when threat-related rather than neutral words were presented in the unattended ear. This finding suggests that threatening information captures the initial focus of attention of individuals with generalised anxiety disorder.

In a different study, Foa and McNally (1986) found that before, but not after treatment, participants with OCD evidenced significantly longer reaction times on a primary task when endeavouring to ignore threat-related rather than neutral words presented to the unattended auditory channel. From these findings the authors concluded that while obsessive compulsive disorder is associated with biased attention towards threat, this bias is decreased with effective treatment.

Measures of Revised Attention Bias

The Cuing Task

In an effort to dissociate the occurrence of initial attention bias from revised attention bias, recent research has employed emotional variants of Posner's (1980) cuing paradigm to measure the association between individual differences in emotional conditions and revised attention bias (Fox et al., 2001; Koster, De Raedt, Goeleven, Franck & Crombez, 2005; Leyman, de Raedt, Schacht, & Koster, 2007). In the cuing task, participants are instructed to locate a probe that appears in one of two screen locations. Preceding the probe, either a neutral or a threat-related cue is shown in one of these two screen positions. On the majority of trials (approximately 80%), the cue is presented in the same position as the probe, thereby predicting the position in which the probe will appear. On the remaining trials (approximately 20%), the cue is presented in the opposite location to the probe. Slower identification of probes appearing in the opposite location to that of the preceding cue, when that cue is threat-related rather than neutral, suggests difficulty revising the initial focus of attention away from negative information.

The cuing task has been found to be sensitive to an association between individual differences in attention bias and variability in trait anxiety (e.g., Koster, Crombez, Verschuere & de Houwer, 2006). For instance, Broomfield and Turpin (2005) analysed the effect of differences in levels of trait anxiety on revised attention bias. These researchers found that, relative to that of low trait anxious participants, the response time of high trait anxious participants was disproportionately slowed when a probe appeared in the opposite location to that vacated by a threat-related relative to a neutral cue word. This was interpreted as evidence that high trait anxious individuals experience difficulty revising their initial focus of attention away from threat-related information.

The cuing task has also revealed individual differences in revised attention bias to threatening information associated with variability in psychopathology using pictorial stimuli (Yiend & Mathews, 2001). Koster, Crombez, Verschuere, van Damme and Wiersema (2006) employed a cuing task in which high and low trait anxious participants were asked to locate probes that followed picture cues that were either neutral or threat-related. At stimulus presentation durations of 200 and 500 ms, relative to their low trait anxious counterparts, the high trait anxious participants responded more slowly to probes that appeared in the opposite location to the location vacated by the preceding threat-related, rather than neutral cue. These results suggest that relative to individuals with low trait anxiety, individuals with high trait anxiety tend to have difficulty revising their initial focus of attention away from threat.

At present, stimuli in the cuing task have only been presented in the visual modality. However, using a methodology similar to that of the auditory dot probe task (Halkiopoulos, reported in Eysenck et al., 1987) described earlier, it would be possible to modify the cuing task to measure the revised attentional processing of threat-related auditory information.

The Eye Movement Task

Further evidence supporting the association between individual differences in emotional vulnerability and the ease of revising the initial focus of attention from threatening information comes from eye movement tasks (Mogg, Millar, & Bradley, 2000; Putman, Hermans, & van Honk, 2006). Specifically, researchers track participants' eye movements to determine the speed with which the participants shift attentional resources away from threatening information towards neutral information (Calvo & Avero, 2005). It is assumed that an increased fixation duration on threat-related, as opposed to neutral stimuli, reflects impaired ability to revise ones attentional focus away from threat-related and towards neutral information.

Calvo and Avero (2005) measured the initial fixation duration of high and low trait anxious participants when viewing pairs of pictures each of which included a threat-related scene and a neutral scene. During the first 500 ms following onset of the picture pairs, compared to the low trait anxious participants, the high trait anxious participants exhibited longer viewing times for the pictures of threat-related scenes relative to the pictures of neutral scenes. The authors interpreted this result as evidence that at early stages of processing, trait anxiety is associated with difficulty revising attentional focus away from threat.

In summary, there is considerable research evidence that individual differences in anxiety are associated with differences in threat-biased attention (Dalgleish & Watts, 1990; Eysenck, 1992; MacLeod, 1990, 1999; Mathews & MacLeod, 1994; 2005; Williams et al., 1988; 1997). The selective orientation of attention towards threat-related information has been demonstrated using a wide array of measures, and using a variety of stimulus types (e.g., MacLeod et al., 1986; Mathews & MacLeod, 1988; Mogg et al., 2000). More recently, the ease with which attention is revised away from threat-related information has been examined. Although, this research is in its infancy, revised attention has also been demonstrated using a variety of measures and different stimulus types (e.g., Fox et al., 2001; Koster et al., 2006).

Individual Differences in Interpretation Bias

Relative to attention bias, an even greater variety of approaches has been developed to test individual differences in the biased interpretation of ambiguous stimulus. Likewise, tasks measuring interpretation bias can be classified as either measures of the tendency to initially interpret an ambiguous stimulus in terms of its threat-related meaning, herein referred to as measures of *Initial Interpretation Bias* (e.g., Mathews Richards and Eysenck, 1989; Richards, 2004; Richards, Reynolds, & French, 1993); or measures of the ease with which the initial interpretation of an ambiguous stimulus as threat-related can subsequently be revised, herein referred to as measures of *Revised Interpretation Bias* (e.g., Amir, Beard, & Przeworski, 2005; Grafton, 2006). Each of these classes of measures will be considered in this section, highlighting the range of stimulus modalities employed.

A number of measures of interpretation bias utilise stimuli that are *homographs*, *homophones* or *homonyms* (e.g., Mathews et al., 1987; Richards, 2004; Richards & French, 1992). Before describing the interpretation bias measures these three stimulus types will be defined. A homophone is a word that is pronounced in one way but has two different meanings and sometimes two different spellings (e.g., *DIE*, *DYE*; Barnhart, 1962). A homograph is a word that is spelt in one way but has two different meanings and sometimes two different pronunciations (e.g., *PRODUCE* as in *create*, and *PRODUCE* as in *crop*; Barnhart, 1962). It is important to note, that by definition a homograph can be, but is not necessarily also a homophone. Likewise, a homophone can be, but is not necessarily also a homograph. Finally, homonym is a term that encompasses both homographs and homophones. As such, a homonym is a word that is spelt in one way, and/or pronounced in one way, but has two different meanings (e.g., *TRAIN* as in *locomotive*, and *TRAIN* as in *teach*; Barnhart, 1962). For the purpose of the present research project, herein the term *homonym* refers to *only* those words that are *both* spelt in one way *and* pronounced in one way, but have two different meanings.

Measures of Initial Interpretation Bias

The Self Report Task

Self report tasks are a collection of tasks which are designed to determine an individual's tendency to initially interpret an ambiguous stimulus as threat-related or neutral in emotional valence on the basis of his/her tendency to select either the threat-related or the neutral meaning of an ambiguous stimulus in the absence of any contextual or additional information (Blanchette & Richards, 2003; Huppert, Pasupuleti, Foa, & Mathews, 2007; Lawson, MacLeod, & Hammond, 2002; Richards, 2004). Self report tasks employ a variety of stimuli including visual and auditory stimuli.

A range of self report tasks employ auditory stimuli. Three are: the homophone definition task, in which participants define aurally presented homophones on the basis of the first definition that comes to mind (e.g., Earleywine, 1994); the homophone associations task, in which participants spontaneously identify associates of aurally presented homophones (e.g., Pincus, Pearce, McClelland, Farley, & Vogel, 1994); and the homophone sentence construction task, in which participants construct sentences using homophones (e.g., Richards et al., 1993). It is assumed that participants' responses reflect their favoured interpretation of the homophone. Biased interpretation of ambiguity in a threatening manner is reflected by selecting a greater proportion of the ambiguous stimuli's threat-related than neutral meanings.

Eysenck, Mogg, May, Richards and Mathews (1991) asked participants diagnosed with generalised anxiety disorder and control participants to listen to a series of unambiguous and ambiguous sentences presented on a cassette player. The ambiguous sentences were designed so that they could be interpreted as being either threat-related or neutral (e.g., *the doctor examined little Emily's growth*). Eysenck et al. (1991) found that on a subsequent recognition test, relative to control participants, participants with generalised anxiety disorder were more likely to interpret the ambiguous sentences in a threatening manner. This suggests that anxious individuals tend to favour the threatening interpretation of ambiguous visual information.

Other self report tasks have involved the visual presentation of face stimuli (e.g., Mohlman, Carmin, & Price, 2007). For example, Mohlman et al. (2007) asked participants with social anxiety to sort photographs of faces in terms of whether they depicted happy, sad or angry expressions. Relative to the control participants, the participants with high levels of social anxiety classified a greater proportion of ambiguous expressions as angry. The researchers interpreted this finding as providing evidence that individual differences in social anxiety are associated with differences in the biased interpretation of ambiguous stimuli.

When considering the self report task it is not certain whether it really reflects an individual's initial interpretation or rather reflects an individual's favoured interpretation (Richards & French, 1992). That is, when performing a self report measure such as the homophone definition task, an individual could access the neutral meaning of the homophone before the threat-related meaning of the homophone, but choose to respond to the threat-related meaning. As a consequence, some researchers have questioned whether such self report tasks are subject to the influence of experimenter demand or other response bias effects (Mathews & MacLeod, 1994, Richards & French, 1992).

Similarly, other researchers have questioned whether self report tasks measure an individual's interpretation of ambiguous information at the time that it was encountered (Hirsch & Mathews, 1997, 2000). Hirsch and Mathews suggest that rather than measuring individuals' initial interpretation of ambiguous stimuli, these tasks may actually reflect interpretative judgements made retrospectively. As such, it is possible that individuals recall the ambiguous stimulus and its two meanings and then retrospectively select one meaning over another.

The Homophone Spelling Task

The homophone spelling task was developed to decrease the influence of experimenter demand (Mathews & MacLeod, 1994). It provides a good example of a measure of initial interpretation bias that uses auditory stimuli (Richards, 2004). In the homophone spelling task, participants are directed to transcribe aurally presented homophones using the first spelling that comes to mind (Mathews et al., 1989; Mogg, Bradley, Miller, Potts, Glenwright, & Kentish, 1994). The homophones included in the task have either a threat-related or a neutral meaning. Each has a single pronunciation, but two different spellings. It is assumed that individuals will spell each homophone in terms of their initial interpretation of it. A tendency to interpret ambiguous information negatively will be reflected by spelling a greater proportion of homophones in terms of their negative meanings.

The homophone spelling task has most frequently been employed to demonstrate the association between individual differences in anxiety and differences in interpretation bias (Richards, 2004). For example, Eysenck et al. (1987) asked participants with varying levels of trait anxiety to spell aurally presented homophones that permitted both threat-related and neutral interpretations (e.g., *PAIN* as in *hurt*, and *PANE* as in *window*). A significant positive correlation between trait anxiety level and the number of spellings consistent with the homophones' threat-related meanings, suggested that trait anxiety is associated with the tendency to interpret ambiguous information in a disproportionately threatening manner.

The Reading Time Task

The reading time task utilizes visual stimuli to measure individual differences in interpretation bias (Mathews & Mackintosh, 2000, Wingrove & Bond, 2005). Reading time tasks are typically considered measures of the tendency to initially interpret a ambiguous visual word stimuli as threatening. Participants are required to read an ambiguous sentence that could be interpreted as threat-related or neutral and then to read a continuing sentence that is consistent with either the threat-related or the neutral meaning of the ambiguous sentence (e.g., Calvo & Castillo, 1997, 2001). The speed of reading the continuing sentence is assumed to reflect interpretation bias. Faster reading times for continuing sentences consistent with the threat-related as opposed to the neutral meaning of the ambiguous sentences are considered to indicate that the participant tends to initially interpret an ambiguous sentence as threatening.

The reading time task has revealed an association between differences in interpretation bias and individual differences in anxiety (Calvo, Eysenck, & Castillo, 1997). For example Calvo and Castillo (1997) presented high and low trait anxious participants with ambiguous sentences followed by continuing sentences consistent with either the threat-related or neutral meaning of the ambiguous sentence. Compared with the low trait anxious participants, high trait anxious participants were faster to read the continuing sentences that were consistent with the threat-related meaning of the preceding ambiguous sentence rather than the continuing sentences that were consistent with the neutral meaning of the ambiguous sentences. This result may be taken to imply that for the high trait anxious group, the threat-related continuing sentences were more often consistent with the group members' initial interpretation of the ambiguous sentences.

As was the case for some of the measures of initial attention bias (e.g., the emotional Stroop task, Mathews & MacLeod, 1985; and the dot probe task, MacLeod et al., 1986), while the effects yielded by the reading time task are most commonly explained as reflecting initial interpretation bias (e.g., Calvo et al., 1997), they could equally reflect the difficulty a person has in revising his initial interpretation of an ambiguous stimulus.

The Lexical Priming Task

The lexical priming task is another example of a task that employs visual stimuli to study biased interpretation and individual differences in emotional conditions (Richards & French, 1992). The lexical priming task seeks to measure whether an ambiguous word stimulus is initially interpreted in terms of its threat-related meaning. In the lexical priming task participants are asked to identify whether a letter string is a word or not and the speed of their response is recorded. On half the trials, the letter string is preceded by a prime word. On the critical trials, the prime word is a homograph with a single spelling, and with both a threat-related and a neutral meaning (e.g., *ARMS* as in *weapons* and *ARMS* as in *limbs*), and the following letter string is a word related to the homograph's threat-related or neutral meaning. It is assumed that the initial interpretation of the homograph as threatening is reflected in disproportionately speeded lexical decisions when letter strings are words related to the threat-related meaning, rather than the neutral meaning of the preceding homograph when compared with the unprimed condition.

Anxiety-associated interpretation bias has been demonstrated in studies employing lexical priming tasks (Calvo, Eysenck, & Estevez, 1994, Richards & French, 1992). For example, Calvo et al. (1994) asked high and low test anxious participants to make lexical decisions about threat-related words, neutral words, and non-words, that either were primed by a preceding threat/neutral ambiguous sentence, or were unprimed. All participants exhibited speeded lexical decisions in the primed relative to the unprimed condition. However, relative to their unprimed performance, on the primed trials high but not low test anxious participants exhibited faster lexical decisions for words related to the threat-related meaning of the preceding ambiguous sentence than for words related to the neutral meaning of the preceding ambiguous sentence. This finding suggests that high test anxiety is associated with a tendency to interpret ambiguous stimuli in a threatening manner.

A variant of the lexical priming paradigm employed face stimuli rather than letter strings. It has also demonstrated an association between variability in emotional conditions and individual differences in interpretation bias (Yoon & Zinbarg, 2007). Yoon & Zinbarg (2007) presented socially anxious and control participants with prime pictures showing faces with ambiguous expressions, followed by target pictures showing faces with unambiguous expressions. Participants were asked to classify the target pictures as representing the expressions of happiness, anger or disgust. Relative to their unprimed performance, on the primed trials, the participants with social anxiety, but not the control participants, displayed speeded classification of unambiguous angry faces relative to unambiguous happy or disgust faces. The authors interpreted this finding as evidence that individuals with social anxiety tend to initially interpret ambiguous stimuli as threatening.

To date, only visual stimuli have been employed in lexical decision tasks that assess individual differences in interpretation bias. However, it would not be difficult to modify these lexical decision tasks so that the biased interpretation of auditory stimuli could be examined. Indeed, past research has employed auditory stimuli in versions of the lexical decision task that were not intended measure variability in interpretation bias (e.g., Boothroyd, Mulhearn, Gong, & Ostroff, 1996; Holcomb & Neville, 1990; Milberg, Blumstein, & Dworetzky, 1988). Typically, auditory versions of lexical decision tasks are identical to visual versions of lexical decision tasks, except that the stimuli are presented aurally (e.g., Boothroyd et al., 1996; Holcomb & Neville, 1990; Milberg et al., 1988). Non-word stimuli are created by modifying single consonants of words (Milberg et al., 1988). Since visual lexical decision tasks have been found sensitive to individual differences in interpretation bias, it is reasonable to expect that auditory lexical decision tasks would yield similar findings.

The Relatedness Judgement Task

A relatively new measure of interpretation bias is the relatedness judgement task (Grey & Mathews, 2000; Wilson, MacLeod, Mathews, & Rutherford, 2006). Developed by Grey and Mathews (2000), the relatedness judgement task is designed to measure the initial interpretation of an ambiguous stimulus. In this task, participants are presented with a homograph (e.g., *SHOT*), followed by a pair of unambiguous words, one of which is semantically related to the preceding homograph (e.g., *GUN*, *FISH*). The participants' task is to identify the related word. On half of the trials the related word is associated with the homograph's threat-related meaning and on half of the trials the related word is associated with the homograph's neutral meaning. Initial interpretation of an ambiguous stimulus as threatening is reflected by disproportionately speeded identification of words related to the homograph's threat-related rather than neutral meaning. At this stage, the relatedness judgement task has not been used to assess individual differences in interpretation bias associated with trait anxiety or other enduring anxiety conditions. However, Wilson et al. (2006) found an association between elevated state anxiety and the speeded identification of words related to the homographs' threat-related rather than neutral meanings. This association suggests that the relatedness judgement task may provide a novel way to the measure interpretation bias, that is also amenable to the use of a variety of different stimulus types.

Measures of Revised Interpretation Bias

The Modified Lexical Priming Task

Despite the growing interest in the revision of initial attention from threat, at present only one published study has directly examined the ease with which individuals revise their interpretation of an ambiguous stimulus following the initial interpretation of that stimulus as threatening (Amir et al., 2005). This study employed a variant of the lexical priming task. Amir et al. measured the impact of initially priming one meaning of a homograph on the subsequent ability to re-interpret that homograph to yield the alternative meaning. In a trial, participants were presented with two prime-target pairs (e.g., *BANK-SAVE*; and *BANK-RIVER*); one pair after the other. The same prime word was presented in each of the two pairs, and on the critical trials this prime was a homograph. Participants were instructed to read aloud the target words and their response latency for reading the target in the second pair was recorded. On the critical trials, the first prime-target pair was intended to activate one particular meaning of the homograph. The second prime-target pair was intended to assess the participant's ability to access the homograph's alternative meaning relative to the homograph's activated meaning. Amir et al. did not find a significant difference between the relative response latencies of the socially anxious and control participants when the homograph's threat-related meaning was activated but the second target was related to the homograph's neutral meaning. This could suggest that social anxiety is not associated with a difficulty revising the initial threatening interpretation of an ambiguous stimulus. However, when the homograph's neutral meaning was activated and the second target was related to the homograph's neutral meaning, Amir et al. unexpectedly discovered that unlike the control participants, the socially anxious participants' relative response latencies were slowed. Amir et al. interpreted this result as showing that in socially anxious individuals, threat meanings of ambiguous stimuli are activated and persist even when neutral meanings are implied.

The Modified Homophone Spelling Task

Although they did not directly measure the ease with which individuals revise their interpretation of an ambiguous stimulus when it was initially interpreted as threatening, Blanchette and Richards (2003) modified a homophone spelling task to investigate the effect of emotional context on the interpretation of ambiguous information. In this study, participants simultaneously heard a homophone with both an emotional and neutral meaning and viewed a contextual cue (an unambiguous word that was semantically related to one of the homophone's meanings). Participants were then asked to spell the homophone that they heard. Blanchette and Richards found that relative to participants with low state anxiety, participants with elevated state anxiety tended to interpret homophones in a manner that was consistent with the contextual cue, regardless of whether this cue was related to the homophone's emotional or neutral meaning. Blanchette and Richards interpreted this finding as evidence that anxiety affects the process by which ambiguity is resolved.

In summary, research has shown an association between variability in the symptoms of emotional conditions and individual differences in the tendency to preferentially interpret ambiguous stimuli as threatening rather than neutral (Mathews & MacLeod, 1994, 2005). Like attention bias, differences in interpretation bias have been found to be most robustly associated with differences in levels of anxiety (Mathews & MacLeod, 1994, 2005). Most measures of interpretation bias were originally considered sensitive to the initial interpretation of an ambiguous stimulus as threatening. However, this has been questioned (Richards & French, 1992). Some researchers have argued that measures of initial interpretation bias could instead reflect the subsequent revision of interpretation following initial interpretation of an ambiguous stimulus as threatening (Richards & French, 1992). Recently efforts have been made to specifically investigate revised interpretation from threat (e.g., Amir et al., 2005). As in the case of attention bias, interpretation bias has been demonstrated using verbal stimuli presented visually, verbal stimuli presented aurally and pictorial stimuli.

The Association between Attention Bias and Interpretation Bias

The research reviewed thus far demonstrates that there are individual differences in attention bias and interpretation bias. These biases are associated with individual variations in anxiety. Individuals with psychological conditions tend to evidence biased attention towards threatening information, and likewise tend to evidence biased interpretation of ambiguous information as being threatening in emotional valence (Dalgleish & Watts, 1990; MacLeod, 1990; Mathews & MacLeod, 1994, 2005; Williams et al., 1988, 1997). Adding to the robustness of these findings, comparable effects have been found consistently over a range of research methodologies.

However, at present it is unclear how biases between attention and interpretation relate to each other. The present research aims to investigate this relationship, to test the alternative accounts of the cognitive mechanisms underpinning attention bias and interpretation bias.

Several theoretical models have been advanced to explain the association between anxiety and attention bias and interpretation bias (see Mathews & Mackintosh, 1998 and Mogg & Bradley, 1998, 2004 for reviews). These models include: Beck's Schema Model of Anxiety (Beck, 1976; Beck & Clark, 1988, 1997; Beck et al., 1985); Bower's Network Model (Bower, 1992; Bower & Forgas, 2000); Williams et al.'s (1988, 1997) Integrative Model; Eysenck, Derakshan, Santos and Calvo's (2007) Attentional Control Theory; Mogg and Bradley's (1998) Cognitive Motivational Model; and Mathews and Mackintosh's (1998) Cognitive Model of Selective Processing in Anxiety, to name but a few.

These models may be distinguished on the basis of their explanation of the relationship between individual differences in attention bias and interpretation bias. As such, some models are consistent with a Common Mechanism Account, while others are consistent with an Independent Mechanisms Account. A Common Mechanism Account proposes that attention bias and interpretation bias are concurrent manifestations of a single underlying selective processing mechanism. This account implies that attention bias and interpretation bias should covary. An Independent Mechanisms Account proposes that attention bias and interpretation bias each are manifestations of quite different underlying selective processing mechanisms. If the Independent Mechanisms Account is correct, then attention bias and interpretation bias need not covary. The following sub-sections consider theoretical models that are consistent with the Common Mechanism Account (herein referred to as *Common*

Mechanism Models), and theoretical models that are consistent with the Independent Mechanisms Account, (herein referred to as *Independent Mechanisms Models*).

Common Mechanism Models

Three examples of theoretical models of cognition and emotion that are consistent with the hypothesis that a single common mechanism underlies anxiety-associated attention bias and interpretation bias are: Beck's Schema Model of Anxiety (Beck, 1976; Beck & Clark, 1988, 1997), Bower's Network Model (Bower, 1992; Bower & Forgas, 2000), and Williams et al.'s Integrative Model (Williams et al., 1988, 1997)[1].

According to Beck (1976; Beck & Clark, 1988, 1997), each psychological disorder is characterised by a particular cognitive schema that influences the content of an individual's perceptions and interpretations. Beck proposes that anxiety is characterised by a *Danger Schema* which causes the anxious individual to selectively attend to threatening information, and to preferentially interpret ambiguous information as being threatening. Beck's Schema Model of Anxiety represents a Common Mechanism Account since a single cognitive mechanism (the Danger Schema) brings about both threat-biased attention and threat-biased interpretation in individuals with anxiety.

Bower's Network Model proposes that emotions, concepts and memories of past events may be conceptualised as nodes within a network (Bower, 1992; Bower & Forgas, 2000). Activation of one node may spread to adjoining nodes depending on the strength and recency of the initial activation and the proximity of the nodes to one another (Power & Dalgleish, 2008). According to Bower, when an emotion node, such as the anxiety emotion node, is activated an associated concept node is also activated

[1] It is acknowledged that there are a number of other theoretical models of cognition and emotion that may be considered Common Mechanism Accounts (e.g., Mathews & Mackintosh, 1998; Mogg & Bradley, 1998). However, it is beyond the scope of this review to consider all such examples. Rather, the purpose of this review is to explicate the key features of theoretical models that represent Common Mechanism Accounts.

via spreading activation. This concept node contains thematic information and rules of inference related to the emotion, and causes individuals to selectively attend to information that is consistent with their emotional condition and to selectively interpret ambiguous information in a manner that is congruent with their emotional condition. As such, this concept node represents a single mechanism that equally brings about both attention bias and interpretation bias.

Drawing on the work of Graf and Mandler (1984), Williams et al. (1988, 1997) propose that attention bias and interpretation bias associated with emotional conditions such as anxiety arise due to the increased *Integration* of information congruent with an individual's particular enduring emotional condition. Integration refers to the mutual activation of perceptual and semantic variables which represent a concept in the cognitive system (Williams et al., 1988). According to Williams et al. anxiety is associated with the integration of the representation of threat. A consequence of the integration of threat is the prioritised allocation of processing resources towards possible sources of threat. As a result, anxious individuals tend to attend towards threatening information and to interpret ambiguous information in terms of its threatening meaning. Williams et al.'s Integrative Model represents a Common Mechanism Model since both anxiety-linked attention bias and interpretation bias arise from a shared cognitive mechanism which is the integration of threat.

Clearly, Beck's Schema Model (Beck, 1976; Beck & Clark, 1988, 1997), Bower's Network Model (Bower, 1992; Bower & Forgas, 2000), and Williams et al.'s Integrative Model (Williams et al., 1988, 1997) differ substantially from one another in terms of the nature of the common mechanism implicated within each as underlying attention bias and interpretation bias. However, the three models share the feature that biased attention and biased interpretation favouring emotionally congruent information, reflect the actions of a single common mechanism.

Independent Mechanisms Models

Unlike Common Mechanism Models, which specify that a single shared mechanism underlies both attention bias and interpretation bias (e.g., Beck, 1976; Beck & Clark, 1988, 1997; Bower, 1992; Bower & Forgas, 2000; Williams et al., 1988, 1997), the criteria that define Independent Mechanisms Models is debatable. There are a number of models that have sought to explain only a single cognitive bias (e.g., Öhman, 1993; Whalen, 1998). For example, Öhman (1993) explained the occurrence of anxiety-linked attention bias, as being due to the activation of an expectancy system that causes the selective detection of anxiety-congruent information in the environment. Alternatively, Whalen (1998) specifically explained anxiety-linked interpretation bias as being caused by the excessive activation of the amygdala, whose primary role (according to Whalen) is to disambiguate ambiguous information. These two models could be considered to be Independent Mechanism Models, however while these models are only intended to explain one bias this does not mean that the theorist rejects the possibility that the model could explain the other bias. Better examples of Independent Mechanism Models may be those intended to explain particular emotional conditions as reliant on one bias more heavily than the other (e.g., Panic Disorder: Clark, 1986; Clark et al., 1997; Social Anxiety: Clark & Wells, 1995).

According to Clark, individuals who experience recurrent panic attacks, do so because they tend to misinterpret bodily sensations involved in normal anxiety responses (e.g., heart palpitations, breathlessness, etc.) in a catastrophic fashion (Clark, 1986, 2004; Clark et al., 1997). For example, panic disorder sufferers may interpret increasingly rapid heart palpitations as evidence that they are about to have a heart attack. Since Clark's (1986, 2007) model suggests that panic disorder primarily occurs due to the threat-biased interpretation and not due to threat-biased attention, this suggests that attention bias and interpretation bias each rely upon separate dissociable mechanisms.

Clark and Wells' (1995) Model of Social Anxiety Disorder, implicates attention bias, rather than interpretation bias, as the key cognitive mechanism that underlies social anxiety disorder. Clark and Wells posit that when individuals with social anxiety disorder enter feared social situations they tend to focus their attention towards themselves and are vigilant for evidence of their poor social performance. Therefore, since Clark and Wells' model proposes that attention bias rather than interpretation bias underlies the development and maintenance of the disorder, this implies that each bias relies upon a separate underlying mechanism.

As demonstrated by the preceding review, theoretical models of cognition and emotion may be divided in terms of whether they implicate a single common cognitive mechanism, or multiple independent mechanisms as underlying emotion-associated differences in attention bias and interpretation bias. However, at the inception of this research project no empirical research had been conducted to clarify the association between attention bias and interpretation bias. Therefore, elucidating this association is the focus of the present research.

The Present Research Approach

An obvious approach to determining whether emotion-associated differences in attention bias and interpretation bias rely on a common mechanism or independent mechanisms, would be to conduct a meta-analysis of those studies that have examined the association between measures of attention bias and measures of interpretation bias. However, when this research project commenced few studies had examined emotion-associated differences in attention bias and interpretation bias amongst the same participants, and of these studies none had directly analysed the association between the measures of attention bias and interpretation bias. Consequently, a meta-analysis was not possible.

Nevertheless, even if there were enough studies to conduct a meta-analysis, it was not considered an ideal method by which to assess the association between attention bias and interpretation bias. Two limitations of meta-analysis were considered particularly problematic for the present experimental question. First, given that some measures of the information processing biases share similar methodologies, while others possess quite distinct methodologies, it would be unclear whether associations yielded by a meta-analysis reflect genuine relationships rather than superficial task similarities. For the same reason, it would also be uncertain whether the absence of associations yielded by a meta-analysis reflect genuine dissociations rather than superficial task differences. Second, meta-analysis requires the combination of studies that each employ different measures, however these measures may not readily be compared (Rosenthal, 1991). If the measures were transformed to enable comparison, this could affect their integrity and therefore compromise the meaningfulness of any associations yielded by a meta-analysis. Therefore, the present research project was designed to avoid the problems inherent in traditional meta-analysis, whilst at the same time creating a conceptual space that would permit the simulation of a meta-analysis of the associations between tasks measuring attention bias and tasks measuring interpretation bias.

To create conditions ideal for the assessment of the association between emotion related individual differences in attention bias and emotion related individual differences in interpretation bias, a battery of eight novel tasks was created. Half of the tasks were designed to measure attention bias and half of the tasks were designed to measure interpretation bias. Since practice effects could confound comparisons, it was methodologically inadvisable to have all of the participants complete all of the tasks. However, to facilitate comparisons, each participant completed two such tasks, and the correlation between indexes of their performance on each task pair was determined. The strength of association between pairs of tasks that included one measure of attention bias and one measure of interpretation bias, was then compared with the strength of association between pairs of tasks that both assessed interpretation bias, or both assessed attention bias.

The Common Mechanism Account and the Independent Mechanisms Account generate alternative predictions regarding the strength of the associations between task pairs that include either two measures of attention bias or two measures of interpretation bias, relative to the strength of associations between task pairs that include one measure of attention bias and one measure of interpretation bias. Both accounts lead us to expect strong associations between tasks that both assess attention bias or both assess interpretation bias. However, according to the Common Mechanism Account, the associations between tasks that assess attention bias and tasks that assess interpretation bias should be generally strong, and indeed should be equivalent in strength to the association between tasks that both assess attention bias or both assess interpretation bias. However, if the Independent Mechanisms Account is true, then the associations between tasks that measure of attention bias and those that measure interpretation bias should be generally weak, and indeed substantially weaker than the strength of association between tasks that both assess attention bias or both assess interpretation bias.

In brief, the present research project aimed to investigate the relationship between attention bias and interpretation bias by examining the patterns of association between a range of measures of attention bias and a range of measures of interpretation bias. The development of the battery of tasks to enable the assessment of associations is described in detail in the Methodological Overview in the next chapter. In the following eight chapters, the sensitivity of each of the measures of attention bias and interpretation bias is determined. After which, the patterns of associations between the measures of attention bias and interpretation bias are examined.

CHAPTER 2

METHODOLOGICAL OVERVIEW

Research Framework

The overarching aim of the present thesis was to determine whether individual differences in attention bias to threat and individual differences in interpretation bias favouring threat resolutions of ambiguity result from a shared underlying selective processing mechanism (the Common Mechanism Account) or whether these biases each result from independent mechanisms (the Independent Mechanisms Account). The approach taken to this question was to examine the patterns of correlation across a range of measures of attention bias and a range of measures of interpretation bias. If variations in attention bias and in interpretation bias each correspond to a separate dimension of individual difference, and therefore are best explained by the Independent Mechanisms Account, then the bias measures would inter-relate in a manner that distinguished attention bias from interpretation bias tasks. Conversely, if variation in attention bias and in interpretation bias reflect the same individual difference dimension, then bias measures would correlate equally across all tasks, regardless of whether they assess attention bias or interpretation bias.

As described in chapter 1, numerous experimental tasks have been developed to measure anxiety-linked attention bias and interpretation bias (e.g., Calvo et al., 1994; Eysenck et al., 1987; MacLeod et al., 1986; Mathews & MacLeod, 1985). Initially, consideration was given to employing these pre-existing experimental tasks in the present research. The benefit of using pre-existing experimental tasks is that past research has demonstrated the tasks' sensitivity to anxiety-linked threat-biased information processing. Likewise the findings of the present research would directly relate to the body of research into threat-biased information processing. However, using these pre-existing tasks for the present purpose was considered problematic for a number of reasons. First, despite their wide use, the internal reliability of the pre-existing measures of biased information processing is largely unknown (Mauer & Borkenau, 2007). This may be because often their designs were not amenable to the assessment of internal reliability. However, a task's internal reliability can affect its capacity to correlate with another task (Humphreys & Drasgow, 1989; John & Benet-Martinez, 2000; Schmitt, 1996). Put simply, the strength of the correlation between two tasks is limited by the strength of the correlation between the items within each task. Therefore, it is crucial that the internal reliabilities of the present tasks are determined. Second, it was not possible to ensure that the methodological diversity of tasks chosen to measure attention bias would be equivalent to the diversity of the tasks chosen to measure interpretation bias. If the methodological diversity of tasks chosen to measure each bias was not equivalent, correlation between measures could be inappropriately influenced by superficial methodological similarities. Thus, for example, if attention bias was assessed using various methodologies that were all very similar to one another, while interpretation bias was assessed using methodologies that were each very different from one another, and not at all similar to those used to assess attention, then all the attention bias scores may correlate positively with each other, but share less variance with the interpretation bias scores. This might be taken as support for the Common Mechanism Account, though in reality could instead reflect the similarities of superficial assessment task attributes. Therefore, it was considered essential that regardless of the particular information processing bias measured, all tasks were equivalent across a range of key parameters. Consequently, to create a battery of tasks that was ideal for the examination of patterns of correlation between measures of attention bias and measures of interpretation bias, task construction was rigorously constrained by a series of clearly specified requirements. So that patterns of correlation across the experimental tasks would reflect more than superficial task similarities, the tasks had to permit comparison between measures of attention bias and interpretation bias obtained under a diverse range of conditions. However, to permit comparison between measures of attention bias and interpretation bias, it was also desirable to ensure that similar experimental tasks were used to measure attention bias and interpretation bias; and that the methodological variability across the range of experimental tasks designed to measure attention bias was similar to the methodological variability across the range of tasks designed to measure interpretation bias. Finally, so that the final analysis of the associations between tasks could take into account each task's internal reliability, the tasks had to be designed in such a way that it was possible to assess their internal reliability. A description of the way in which the experimental tasks were developed to meet these requirements follows.

General Approach to Bias Assessment

To ensure that the experimental tasks shared the appropriate similarities, a general approach to bias assessment, that was equally capable of measuring either attention bias or interpretation bias was adopted. Eight novel bias assessment tasks were then created through the modification of the general approach, four designed to measure attention bias and four designed to measure interpretation bias. This section describes the general approach to bias assessment. For illustrative purposes, examples from one of the eight variant tasks are included[2].

[2] As will be seen, the examples given here come from the task that will later be referred to as the Attention/Initial/Visual Task, but the same principles apply in the other tasks, only the stimuli presented are different.

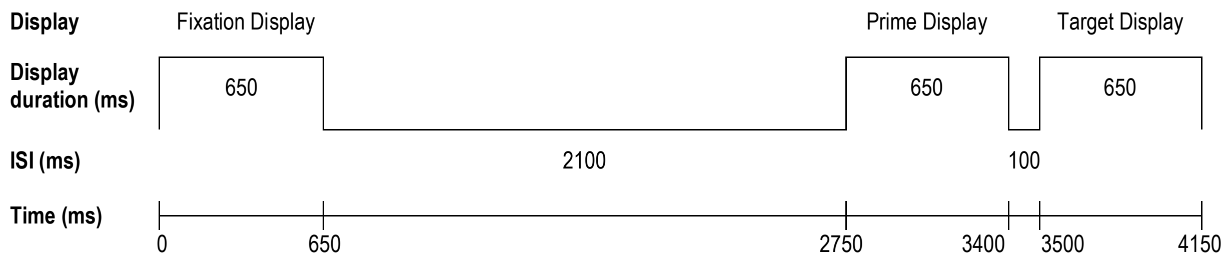
Based on Grey and Mathew's (2000) Relatedness Judgement Task, the general approach to bias assessment comprised two sequential displays. The first display, the *Prime Display*, was designed to activate two semantic representations (meanings). For example, this could be achieved by presenting two words on a computer screen which could be *BEGGAR* and *TRUDGE*. The second display, the *Target Display,* presented two unambiguous words, the *Target* and the *Foil*. The target's meaning was semantically related to one of the meanings activated by the Prime Display, while the foil's meaning was not semantically related to either of the meanings activated by the Prime Display. So, for example, another two words could be presented on a computer screen which could be *VAGRANT* and *IGNORANT*. The participants' task was to identify the location of the target, which in this example would be *VAGRANT* (as this is semantically related to one of the meanings in the Prime Display, i.e.: *BEGGAR*). Biases in information processing were assessed by presenting Prime Display stimuli that invited activation of a threatening meaning and a non-threatening meaning. Any tendency to favour the activation of one emotionally-valenced meaning over the other was revealed by the relative speed with which participants then were able to correctly identify the location of the target, within the Target Display, when this was related to either of these two possible Prime Display meanings. If a participant identified the location of targets related to the Prime Display's threatening meanings more quickly than the location of targets related to the Prime Display's non-threatening meanings, then this would reveal a tendency to selectively process threatening meanings.

Internal reliability indicates the strength of association between a tasks' items (Schmitt, 1996). Confidence that a measure is sensitive to the construct that it is designed to assess, requires knowledge of its internal reliability. Since low internal reliability can limit the extent to which measures correlate with one another, determining the internal reliability of the tasks in the present research is particularly necessary. Despite its clear importance, the internal reliability of measures of selective information processing is rarely reported (Mauer & Borkenau, 2007). Indeed, to date only two published studies have reported the internal reliability of measures of biased information processing (Mauer & Borkenau, 2007; Schmukle, 2005). Therefore, the assessment of internal reliability in the present research is a significant innovation for the literature. The general approach to bias assessment was designed to allow the assessment of internal reliability. Specifically, it was possible to compute an index of threat biased information processing, which could be submitted to a Split Half Reliability Analysis. The extent to which a task consistently measured the effect of interest was then represented by this split half correlation coefficient.

Important parameters of the general approach to bias assessment were held constant. For example, all the stimuli employed in the general approach were words. Further, the stimuli presented in the displays were designed to activate the same meanings regardless of task differences. Participants' responses were always based on the location of a stimulus. Further, the dependent measure adopted by the general approach was the speed with which the location of a target related to the Prime Display's threatening meaning was identified relative to the speed with which the location of a target related to the Prime Display's non-threatening meaning was identified. The temporal parameters also were constant across all tasks, as shown in Figure 1. Each stimulus display was exposed for a duration of 650 ms, while the inter-stimulus interval between stimulus displays was 100 ms. Thus, the stimulus onset asynchrony (SOA) between successive stimulus displays was always 750 ms. Finally, the number of trials delivered within each task was also constant.

Figure 1

Constant Trial Temporal Parameters of the General Approach to Bias Assessment.



Specific Task Variants

To measure attention bias and interpretation bias under a range of differing conditions, each experimental task was a variant of the general approach to bias assessment. Ultimately, eight experimental tasks were developed. So that the range of experimental tasks that measured each bias was diverse, the tasks were designed to differ on three dimensions. The primary distinction was designed to distinguish experimental tasks that measured attention bias from those that measured interpretation bias. The two secondary distinctions were employed to diversify the range of tasks that measured each of these two classes of bias.

Information Processing Bias Distinction: Attention Bias vs. Interpretation Bias

Half of the experimental tasks in the battery assessed interpretation bias, while half assessed attention bias. Tasks that measured interpretation bias were intended to reveal the meaning imposed on an ambiguous stimulus which permitted both a threatening and a non-threatening interpretation. Tasks that measured attention bias were intended to reveal which of two unambiguous stimuli differing in emotional valence, threat or non-threat, recruited the greatest attention.

With a slight adjustment, it was possible to use the general approach to bias assessment to measure either interpretation bias or attention bias. During the Prime Display of a task that measured attention bias, two unambiguous words, one with a threatening meaning and one with a non-threatening meaning, were simultaneously presented in different spatial locations. Conversely, during the Prime Display of a task that measured interpretation bias, a homonym that permitted a threatening and a non-threatening interpretation was presented. For example, in the interpretation equivalent of the example given earlier, the word *TRAMP* could be presented on a computer screen. Across the tasks that measured attention bias and the tasks that measured interpretation bias, during the Target Display, participants were always required to identify which of the two words in the display was related to one of the meanings activated by the preceding Prime Display. Therefore, like the Target Display in the example described earlier, the Target Display in the interpretation equivalent of that example, could be the words *VAGRANT* and *IGNORANT* presented simultaneously on a computer screen, with the target again being *VAGRANT*.

For both task types, the speed with which participants identified the target reflected their selective information processing of emotional valence. In the tasks that measured interpretation, the relative speed with which participants identified targets' locations revealed which interpretation of the homonym's meanings – the threatening or non-threatening meaning, was imposed. For example, if a participant identified the location of targets related to the homonyms' threatening meanings more quickly than the location of targets related to the homonyms' non-threatening meanings, this would indicate a tendency to interpret ambiguous information as threatening. In tasks that measured attention, the relative speed with which participants identified targets' locations revealed which word in the Prime Display – the unambiguous threat word or the unambiguous non-threat word, – received greater attention. Thus for example, if a participant identified targets related to the unambiguous threat words more quickly than targets related to the unambiguous non-threat words, this would indicate a preference to attend to the unambiguous threatening information.

So that the tasks that measured interpretation bias were comparable with the tasks that measured attention bias, it was important that the only difference between the task types was the ambiguity of the stimuli presented during the Prime Display. A set of identical word stimuli appeared in all the tasks that measured interpretation and a different set of identical word stimuli appeared in all the tasks that measured attention. The stimuli that appeared in the Target Display were exactly the same regardless of the information processing bias that the task measured or the modality in which the task was presented. As such, the Target Display always contained pairs of word-stimuli, one of which was semantically related to one of the meanings presented in the Prime Display. The stimuli shown in the Prime Display of tasks measuring interpretation differed from the stimuli shown in the Prime Display of tasks measuring attention. However, as will be seen later, the stimuli were constructed so that the differentially valenced meanings activated by the Prime Display of tasks measuring interpretation were the same as those activated by the Prime Display of tasks measuring attention. This was achieved by presenting a homonym with a threatening and a non-threatening definition in the Prime Display of a task that measured interpretation, while presenting the unambiguous synonym of this homonym’s threatening meaning and the unambiguous synonym of this homonym’s non-threatening meaning in the corresponding Prime Display of a task that measured attention.

Ensuring Equivalent Methodological Diversity across the Tasks measuring Attention Bias and the Tasks measuring Interpretation Bias

To produce a diverse range of experimental tasks that measured interpretation bias and an equally diverse range of experimental tasks that measured attention bias, the general approach to bias assessment was further modified on the basis of two secondary distinctions. To ensure that the methodological variation of the tasks that measured each bias was equivalent, the secondary distinctions between the tasks that measured attention bias were also the secondary distinctions between the tasks that measured interpretation bias. One of these secondary distinctions involved a simple manipulation of the modality of delivery of the experimental stimuli. The other secondary distinction involved a more complex manipulation that was intended to change a particular facet of the processing bias to which the task was designed to be sensitive. Each of these additional two distinctions is described below.

Modality Distinction: Visual vs. Auditory.

The Modality Distinction introduced a difference between the experimental tasks on the basis of the modality in which the stimuli appeared. The general approach to bias assessment was implemented using either visual or auditory stimuli. Visual tasks were those in which only visual stimuli were displayed. Across the visual tasks, word stimuli, coloured white and with a height of 1.10 cm, were presented against a black background on a computer screen. Auditory tasks were those in which only auditory stimuli were displayed. Thus, for example in the Auditory equivalent of the initial example, all the stimuli were heard via earphones. Across the auditory tasks, word-stimuli, spoken in a native Australian-English speaking, adult voice, at a volume of 65 dBA, were presented via earphones. Two of the tasks that measured interpretation and two of the tasks that measured attention involved the presentation of visual stimuli. Conversely, two of the tasks that measured interpretation and two of the tasks that measured attention involved the presentation of auditory stimuli.

So that the Modality Distinction did not create additional, unintended differences between the tasks that had the potential to affect task performance, steps were taken to maintain the equivalence of those tasks that involved visual stimuli and those tasks that involved auditory stimuli. Specifically, the same temporal parameters governed stimulus presentation both in the auditory tasks and in the visual tasks. As such, the visual stimuli were visible for a duration of 650 ms, and the auditory stimuli were digitally edited so that they were spoken for a duration of 650 ms. Likewise, the inter-stimulus intervals in the visual tasks corresponded with those in the auditory tasks.

Initial vs. Revised Information Processing Distinction.

The Initial vs. Revised Information Processing Distinction distinguished the experimental tasks on the basis of the presence or absence of the need to modify the selective information processing in order to complete the task. In tasks referred to as Initial Information Processing, a threat meaning and a non-threat meaning were simultaneously presented. Participants were able to process, or avoid processing either stimulus without task constraints. Like most conventional measures of selective information processing (as reviewed in Fox, 1994), tasks termed Initial Information Processing could either reflect a tendency to initially favour one meaning over another, or a tendency to have difficulty revising the focus of initial information processing away from one meaning and towards another. However, given their sensitivity to the initially selected processing option, these tasks are labelled Initial Information Processing Tasks. Tasks referred to as Revised Information Processing were designed to initially activate either the threatening meaning or the non-threatening meaning in the Prime Display. The tasks' performance then could require the subsequent revision of the focus of information processing away from the initially activated meaning and towards the alternative meaning. Tasks termed Revised Information Processing, revealed the ease with which the focus of information processing could be revised away from each meaning.

The design of tasks that measured Initial Information Processing remained identical to that prescribed by the general approach. That is, during the Prime Display, participants were simultaneously presented with a threatening and a non-threatening meaning, after which, in the Target Display, they were presented with two word stimuli, and were required to identify the location of the word that was related to one of the Prime Display meanings. Participants were free to concentrate on either meaning in the Prime Display at will. Tasks that measured Revised Information Processing included an additional display, known as the Constraining Cue Display, that *preceded* the Prime Display. In the Constraining Cue Display, a stimulus that was designed to direct the focus of participants' information processing towards either the threat meaning or the non-threat meaning in the Prime Display appeared. For instance, in a task that was equivalent to the earlier example, but measured revised interpretation, this could be achieved by presenting a Constraining Cue Display in which the word *BEGGAR* appeared on a computer screen, followed by a Prime Display in which the word *TRAMP* appeared on a computer screen. Initial interpretation was constrained by presenting in the Constraining Cue Display a stimulus that was synonymous with one of the meanings in the Prime Display. In a task that was equivalent to the earlier example but measured revised attention, initial attention was constrained by instructing participants in the Constraining Cue Display, to attend towards one of the meanings in the Prime Display on the basis of its physical form (details will be provided in the method sections of Experiments 5 and 6).

The experimental tasks were designed to ensure that the Initial vs. Revised Information Processing Distinction did not produce unintended differences between the tasks that measured Initial Information Processing and the tasks that measured Revised Information Processing. In particular, despite differences in the number of displays included in the tasks' trials, the length of all trials from the onset of the Fixation Display to the offset of the Target Display was always 4150 ms. The consistency in trial length across the tasks was effected by increasing the inter stimulus interval between the Fixation Display and the Prime Display in tasks that measured Initial Information Processing to account for the duration of the additional display included in the tasks that measured Revised Information Processing.

Experimental Stimuli

The following is an outline of the matrix of experimental stimuli used in the eight resultant experimental tasks. In order to get a full understanding of the range of stimuli employed, it is best to first recall the three different displays, that could occur within a task. Described earlier in this chapter, these were: the Constraining Cue Display, which may or may not be present; the Prime Display, which was always present; and the Target Display which was also always present. The stimuli presented in each of these displays are most easily understood when the displays are considered in their reverse temporal order. The Target Display was intended to simultaneously present two meanings, one, the target, was semantically related to one of the meanings in the preceding Prime Display, while the other, the foil, was not related to either of the meanings in the Prime Display. The Prime Display was designed to simultaneously activate a threatening meaning and a non-threatening meaning. Tasks that involved revised information processing contained an additional display, the Constraining Cue Display. Preceding the Prime Display, the Constraining Cue Display was developed to preferentially activate one of the meanings presented in the Prime Display. The stimuli were constructed so that they could be employed in each of the three displays.

To understand how the stimuli were developed so that they could be used across the eight tasks it is easiest to first think of them as sets of five word-stimuli or *quintets*. Each quintet included: a *homonym*, that possessed a threatening and a non-threatening definition; a *threat synonym*, that was synonymous with its corresponding *homonym's* threatening meaning; a *non-threat synonym*, that was synonymous with its corresponding *homonym's* non-threatening meaning; a *threat associate*, that was semantically related to both its corresponding *homonym's* threatening definition and its corresponding threat synonym; and a *non-threat associate*, that was semantically related to both its corresponding *homonym's* non-threatening definition and its corresponding non-threat synonym. Different combinations of the members of each quintet were employed in each task. For illustration purposes, an example quintet could include the following word-stimuli: *TRAMP* (*homonym*), *BEGGAR* (*threat synonym*), *TRUDGE* (*non-threat synonym*), *VAGRANT* (*threat associate*), *WALK* (*non-threat associate*).

With reference to Table 1, the way that the stimuli were distributed across the displays, as a function of the task distinctions is now described.

Table 1

Allocation of Stimuli to Trial Displays as a Function of Experimental Task Distinctions

				Constraining Cue Display Stimuli	Prime Display Stimuli	Target Display Stimuli
i.	Visual	Initial Information Processing	Interpretation	No Display	Homonym Homonym	Target Associate Foil Associate
ii.			Attention	No Display	Unambiguous Threat Synonym Unambiguous Non-threat Synonym	Target Associate Foil Associate
iii.		Revised Information Processing	Interpretation	Unambiguous Synonym	Homonym Homonym	Target Associate Foil Associate
iv.			Attention	Physical Cue	Unambiguous Threat Synonym Unambiguous Non-threat Synonym	Target Associate Foil Associate
v.	Auditory	Initial Information Processing	Interpretation	No Display	Homonym Homonym	Target Associate Foil Associate
vi.			Attention	No Display	Unambiguous Threat Synonym Unambiguous Non-threat Synonym	Target Associate Foil Associate
vii.		Revised Information Processing	Interpretation	Unambiguous Synonym	Homonym Homonym	Target Associate Foil Associate
viii.			Attention	Physical Cue	Unambiguous Threat Synonym Unambiguous Non-threat Synonym	Target Associate Foil Associate

A. Target Display Stimuli

The way that the quintets were used in the Target Display, may be understood entirely by referring to the yellow shaded section of Table 1. Across all the tasks the Target Display always comprised either a pair of *threat associates* or a pair of *non-threat associates*. One Target Display stimulus was the target, while the other was the foil (a word that was unrelated to either of the Prime Display meanings). The target was either a *threat associate* or a *non-threat associate* taken from the same quintet as the stimuli presented during the trial's prime display. If the target was a *threat associate*, then the foil was a *threat associate* taken from a different quintet to the stimuli presented in the trial's prime display. Conversely if the target was a *non-threat associate*, then the foil was a *non-threat associate* taken from a different quintet to the stimuli presented in the trial's prime display.

B. Prime Display Stimuli

The way that the quintets were used in the Prime Display, may be understood by referring to the blue shaded section of Table 1. Two alternative types of stimuli were employed in the Prime Display dependent on the information processing bias that the task measured. The prime display stimuli used in tasks that measured attention were the threat synonym and the non-threat synonym, from the same quintet. Conversely, the prime display stimuli used in tasks that measured interpretation was the homonym, presented simultaneously in duplicate in two spatially separate locations in order to match the presentation format of the prime display in tasks that measured attention bias.

C. Constraining Cue Display Stimuli

The way that the quintets were used in the Constraining Cue Display, may be understood by referring to the pink shaded section of Table 1. The Constraining Cue Display occurred only in the four tasks that measured Revised Information

Processing. Of these, the stimuli that appeared in the Constraining Cue Display differed as a function of the information processing bias that was measured. In tasks that measured interpretation bias, a synonym taken from the same quintet as the homonym in the trial's Prime Display, was presented to semantically prime either the Prime Display's threatening or non-threatening meaning. In tasks that measured attention bias, a stimulus cue designed to direct participants' attention towards either the threatening or non-threatening meaning in the Prime Display on the basis of its physical properties was shown.

D. Modality Distinction: Visual vs. Auditory Stimuli

As shown in Table 1, half of the tasks exclusively employed visual stimuli, while half exclusively employed auditory stimuli. The word-stimuli described above were designed so that they could be presented in either visual or auditory form.

Selection of Word Stimulus Quintets

64 word stimulus quintets were chosen from a pool of 80 quintets developed by Raykos (2006).[3] The selection of the quintets was intended to achieve three goals: first, each Prime Display would present two meanings that differed in emotional valence; second, within each pair of Prime Display meanings, one meaning would be semantically related to a corresponding *threat associate*, while the other meaning would be semantically related to a corresponding *non-threat associate*; third, each Prime Display of an attention task would semantically correspond with a Prime Display of an interpretation task, such that each meaning in the Prime Display of an attention task, would be synonymous with one of the meanings in the corresponding Prime Display of an interpretation task.

[3] Details of the method of selection of the word stimulus quintets are contained in Appendix A, including a summary of the critical features of the selection method.

To ensure that each Prime Display presented two meanings that differed in emotional valence, a word stimulus quintet was only retained if: the *homonym's* threatening meaning was rated as more threatening in emotional valence than the *homonym's* non-threatening meaning; and the *threat synonym* was rated as more threatening in emotional valence than the *non-threat synonym*. An ANOVA confirmed that the threatening meanings of the remaining *homonyms* were judged as significantly more threatening than their non-threatening meanings; $F(1, 124) = 249.16$, $p < .001$. Similarly, it was confirmed that the remaining *threat synonyms* were judged significantly as more threatening in meaning than the remaining *non-threat synonyms*; $F(1, 124) = 216.29$, $p < .001$. It was also considered important to ensure that the emotional valence of the meanings presented in the Prime Displays of interpretation tasks was comparable to the emotional valence of the meanings presented in the Prime Displays of the attention tasks. An ANOVA showed that as desired, the emotional valence ratings of the *homonyms'* threatening meanings did not significantly differ from the emotional valence ratings of the *threat synonyms*; $F(1, 124) = .21$, $p = .64$. Likewise, the emotional valence ratings of the *homonyms'* non-threatening meanings did not significantly differ from the emotional valence ratings of the *non-threat synonyms*; $F(1, 124) = .14$, $p = .70$.

To ensure that each Prime Display meaning was semantically associated with its corresponding *threat associate* or *non-threat associate*, the semantic association between: (i.) *homonyms* and their corresponding *threat associates*; (ii.) *homonyms* and their corresponding *non-threat associates*; (iii.) *threat synonyms* and their corresponding *threat associates*; and (iv.) *non-threat synonyms* and their corresponding *non-threat associates*; were rated on a scale from -5 (*not related*) to +5 (*highly related*). A word stimulus quintet was only retained if each of its four semantic association ratings was greater than +1. An ANOVA confirmed that the semantic relatedness of the remaining *threat synonyms* and their corresponding *threat associates* did not significantly differ from the semantic relatedness of the remaining *non-threat synonyms* and their corresponding *non-threat associates*, $F(1, 124) = 1.55$, $p = .21$. Likewise, it was confirmed that the semantic relatedness of the remaining *homonyms* and their corresponding *threat associates* did not significantly differ from the semantic relatedness of the remaining *homonyms* and their corresponding *non-threat associates*, $F(1, 124) = 1.92$, $p = .16$.

To ensure that the Prime Displays of the attention tasks were semantically equivalent to the corresponding Prime Displays of the interpretation tasks, the synonymity of the *homonyms* with the corresponding *threat synonyms* and *non-threat synonyms* was rated. Ratings were made on a scale ranging from -5 (*not synonym)* to +5 (*excellent synonym*). A word stimulus quintet was only retained if it attained synonymity ratings greater than +2. An ANOVA confirmed that the synonymity of the *homonyms* and their corresponding *threat synonyms* did not significantly differ from the synonymity of the *homonyms* with their corresponding *non-threat synonyms*, $F(1, 124) = 2.00$, $p = .15$.

The Resulting Tasks

The eight tasks consistent with the general approach to bias assessment but distinguished on the basis of the three distinctions of: Information Processing Bias, Visual vs. Auditory Modality and Initial vs. Revised Information Processing are summarised in Table 2. The tasks were programmed in parallel using Metacard 2.4.3 software. Tasks presented in the auditory modality also relied on a specially-created add-on, the MCPsych dll v2.06e to synchronise the presentation of the auditory stimuli.

Table 2

The Experimental Tasks (Task names in parentheses).

	Interpretation		Attention	
	Visual	Auditory	Visual	Auditory
Initial Information Processing	Initial interpretation of ambiguous visual stimuli [Interpretation/ Initial/ Visual]	Initial interpretation of ambiguous auditory stimuli [Interpretation/ Initial/ Auditory]	Initial focus of attention towards visual stimuli [Attention/ Initial/ Visual]	Initial focus of attention towards auditory stimuli [Attention/ Initial/ Auditory]
Revised Information Processing	Revised interpretation of ambiguous visual stimuli [Interpretation/ Revised/ Visual]	Revised interpretation of ambiguous auditory stimuli [Interpretation/ Revised/ Auditory]	Revised focus of attention from visual stimuli [Attention/ Revised/ Visual]	Revised focus of attention from auditory stimuli [Attention/ Revised/ Auditory]

Procedural Issues

One hundred and forty participants completed each experimental task in exchange for either course credit or a small monetary reimbursement. Participants were recruited from a pool of undergraduate Psychology students at the University of Western Australia and through advertisements to the wider university community. Participants were required to be fluent in English (the criteria being that they had to speak English regularly for a minimum of ten years). For each task, 70 participants completed it before performing one of the seven other tasks and 70 after performing one of the seven other tasks. Ten participants in each group of 70 completed each of the seven other experimental tasks.

To reveal the patterns of correlations between the measures of attention bias and interpretation bias, it was desirable to obtain a range of bias scores. Since past literature has shown a strong positive correlation between anxiety and information processing bias towards threat (MacLeod, 1999; Mathews & MacLeod, 1994, 2005), to maximise the likelihood of obtaining a broad range of bias scores, individuals with a range of trait anxiety were included in each experiment.

Trait anxiety was measured using the Trait Anxiety Scale of the State Trait Anxiety Inventory (STAI-T; Spielberger, Gorusch, Lushene, Vagg, & Jacobs, 1983). The STAI-T is made up of 20 items on which individuals rate the extent to which they *generally* experience a range of feelings associated with anxiety, using a scale from 1 representing *almost always*, to 4 representing *almost never*. The STAI-T was selected for use in the present research in light of: its high internal consistency (Barnes, Harp & Jung, 2002; Spielberger et al., 1983); strong test-retest reliability (Barnes et al., 2002); its extensive concurrent validity with other measures of trait anxiety (Spielberger & Sydeman; 1994); and its sizeable construct validity (Spielberger & Sydeman, 1994). An additional reason for choosing the STAI-T was that it is routinely employed in studies of anxiety-associated threat-biased processing (e.g., MacLeod & Rutherford, 1992; Mathews et al., 1986; van den Hout, Tenney, Huygens, Merkelbach, & Kindt, 1995).

To maximise the distribution of bias scores obtained by the 140 participants who completed each task, participants were selected with the intention that 28 individuals would fall into each of five trait anxiety bands, representing: *very low trait anxiety*, *low trait anxiety*, *mid trait anxiety*, *high trait anxiety* and *very high trait anxiety*. The bounds of the five trait anxiety bands were determined by inspection of a distribution of trait anxiety scores of 620 undergraduate students (screened using the STAI-T; Spielberger et al., 1983). Of these 620 students, a fifth attained STAI-T scores below 33, a fifth attained STAI-T scores between 34 – 38, a fifth attained STAI-T scores between 39 – 43, a fifth attained STAI-T scores between 44 – 50, and a fifth attained STAI-T scores above 51. Therefore, for each experiment: participants forming the *very low trait anxiety* band were to attain STAI-T scores less than 33; participants forming the *low trait anxiety* band were to attain STAI-T scores between 34 – 38; participants forming the *mid trait anxiety* band were to attain STAI-T scores between 39 – 43; participants forming the *high trait anxiety* band were to attain STAI-T scores between 44 – 50; and participants forming the *very high trait anxiety* band were to attain STAI-T scores above 51[4].

In order to examine the correlations between the bias measures, each participant was required to complete two of the eight experimental tasks. Four participants from each of the five trait anxiety bands completed each pair of tasks. Dependent on the anxiety band to which they had been allocated, participants were randomly assigned a pair of tasks. The order in which the two tasks were carried out was counterbalanced across participants so that half of the time each task was completed first. Regardless of the particular pair of tasks that a participant carried out, the same experimental procedure was employed. Participants completed the pairs of experimental tasks individually in a single test session. All task-pairs were interspersed with questions about the participant's mood taken from the STAI-T.

Thesis Structure and Preamble to Experiments

The present experimental question was whether individual differences in attention bias and interpretation bias reflect a single underlying mechanism or attributable to independent underlying mechanisms. This question was addressed was by taking parallel measures of attention bias and interpretation bias and comparing the

---

[4] Review of the percentile ranking of the STAI-T norms showed that the distribution of scores of the aforementioned 620 students was similar to that of the STAI-T normative distribution. When the STAI-T normative distribution was divided into fifths, the bounds of those five bands were comparable with the bounds of the five bands in the present research. They were: STAI-T scores less than 30; STAI-T scores between 31-36; STAI-T scores between 37-41; STAI-T scores between 42-47; and STAI-T scores above 48.

relative strength of the association between tasks in pairs that included either two measures of attention bias or two measures of interpretation bias, relative to the strength of the association between tasks in pairs that included one measure of attention bias and one measure of interpretation bias.

Chapters 3 to 10 report the internal reliability and the sensitivity of the eight experimental tasks to anxiety-associated individual differences in threat bias. Each chapter reports effects obtained from a single experimental task, and each is structured in the same way.[5] The order of the chapters is based on the nesting of the three methodological distinctions: chapters 3 to 6 report findings from tasks measuring Initial Information Processing; and chapters 7 to 10 report findings from tasks measuring Revised Information Processing. Within these chapter sets, the first two report the results of tasks measuring attention bias, and the second two of tasks measuring interpretation bias. Chapters reporting effects using visual stimuli precede those using auditory stimuli. Accordingly, the experiments are reported in the order shown in Table 3.

---

[5] Each experiment is described in full so as to demonstrate the design and methodological equivalence of the tasks.

Table 3

The Experimental Tasks by Experiment Number and Chapter Number

Chapter Number	Experiment Number	Bias Type	Experimental Task Initial/Revised	Modality
3	1	Attention	Initial	Visual
4	2	Attention	Initial	Auditory
5	3	Interpretation	Initial	Visual
6	4	Interpretation	Initial	Auditory
7	5	Attention	Revised	Visual
8	6	Attention	Revised	Auditory
9	7	Interpretation	Revised	Visual
10	8	Interpretation	Revised	Auditory

As both the capacity of the experimental tasks to tap anxiety-associated individual differences in selective processing bias and the internal reliability of the tasks have implications for the analysis of the patterns of associations, both of these factors were assessed. The task's internal reliability was determined first, after which its sensitivity to trait anxiety-associated differences was assessed.

Task internal reliability was computed using a Split-Half Method (Furr & Bacharach, 2008). Tasks which evidenced an internal reliability coefficient that was statistically significant at an α level of .05, were considered to possess an acceptable level of internal reliability for the purpose of the present research.

Task sensitivity to trait anxiety-associated differences was assessed by comparing the performance of individuals reporting extremely high and extremely low trait anxiety (with the bias measures of individuals with mid-range trait anxiety excluded), and then by examining correlations between trait anxiety scores and bias measures. A task was considered sensitive to variability in trait anxiety if it evidenced *either* a significant group difference in task performance *and/or* a significant correlation between trait anxiety and the bias measure.

Sensitivity to individual differences in trait anxiety and strong internal reliability could co-occur or they could each occur in isolation. It has long been noted that internal reliability places an upper limit on validity, such that the strength of a task's internal reliability constrains the extent to which it correlates with another variable (John & Soto, 2007; Schmitt, 1996). However, there may be unusual but possible circumstances where despite low internal reliability a measure could correlate with another variable. This may occur for example, when one measure is a binary measure. Conversely, it is possible that a task with high internal reliability may be insensitive to variability in trait anxiety. In this way, the items of a task that evidences strong internal reliability may be highly inter-related but not sensitive to individual differences in threat biased information processing associated with trait anxiety.

The key empirical question of the thesis is addressed in chapter 11, by taking measures of attention bias and interpretation bias and determining the relative strength of association between tasks measuring a single bias compared to the strength of the association between tasks measuring both biases. Of greatest interest to the empirical question was the pattern of association between tasks that evidence both significant internal reliability and also significant sensitivity to trait anxiety. However, since the relationship between tasks that did not evidence both significant internal reliability and trait anxiety sensitivity could also reveal important information, the association between these tasks was considered also. All tasks were included in the first stage of the final analysis, but inclusion in the subsequent stages was based on increasingly strict criteria. A task was included in final analysis stages one and two if it *either* possessed significant internal reliability *or* demonstrated sensitivity to individual differences in information processing bias towards threat known to be associated with anxiety (e.g., MacLeod et al., 1986; Mogg et al., 1996; Mogg et al., 1994). Tasks that evidenced *both* significant internal reliability *and* sensitivity to anxiety-associated threat-biased information processing were included in all three stages of the final analysis.

Chapter 12 summarises the results of the present research project and considers their implications for the experimental question which the project sought to address. Limitations of the project are identified and responded to, alternative explanations of the findings are considered, and significant implications of the findings are discussed. With a view towards better elucidating the cognitive mechanisms that underpin attention bias and interpretation bias, the chapter concludes with a consideration of potentially fruitful directions for future research.

CHAPTER 3

EXPERIMENT 1:

The Attention/Initial/Visual Task

The purpose of Experiment 1 was to evaluate the sensitivity of the Attention/Initial/Visual Task to anxiety-associated individual differences in attention bias towards threatening visual stimuli. Consistent with most conventional measures of information processing bias (Fox, 1994), the design of the Attention/Initial/Visual Task was such that it could either reflect the initial focus of attention towards threatening information, or difficulty revising the initial focus of attention away from threatening information and towards non-threatening information. The sensitivity of the Attention/Initial/Visual Task to individual differences in threat-biased attention determined its inclusion in the final analysis of the patterns of association between all eight experimental tasks of the thesis.

As was the case across all of the eight experiments, two criteria were used to determine the sensitivity of the present experimental task to individual differences in information processing bias towards threat: one required that the task possessed statistically significant internal reliability; the other required that the task was sensitive to individual differences in information processing bias towards threat known to be associated with anxiety. In the case of the Attention/Initial/Visual Task, the latter criterion specifically required that the Attention/Initial/Visual Task was sensitive to anxiety-associated threat-biased attention.

The Attention/Initial/Visual Task was a variant of the General Approach to Bias Assessment described in chapter 2, created to specifically measure biased attention towards threatening visual stimuli. The task began with a Prime Display in which an unambiguous threatening word and an unambiguous non-threatening word were presented simultaneously on a computer screen. This was followed by a Target Display, in which a target word and a foil word were presented simultaneously on the screen. The target was related to the Prime Display's threatening meaning on half of the trials, and to its non-threatening meaning on the other half. The participants' task was to identify the screen location of the target word and the speed of their response was measured. The participants' attention was not initially directed specifically towards one or other of the prime display meanings. It was assumed that attention bias towards the more threatening primes would be reflected by a disproportionate speeding in the identification of the location of targets related to the Prime Displays' threatening meanings relative to the identification of the location of targets related to the Prime Display's non-threatening meanings.

Undergraduate student volunteers completed the Attention/Initial/Visual Task. As will be recalled from chapter 2, participant selection was designed to obtain a sample of individuals who reported a broad range of trait anxiety levels.

The internal reliability of the Attention/Initial/Visual Task was computed to establish the consistency of the task's items. As stated in chapter 2, internal reliability was measured using a split-half reliability method. As will be recalled, to be considered an acceptable level of internal reliability, an internal reliability coefficient was required to be statistically significant at an α level of .05.

To establish whether the Attention/Initial/Visual Task was sensitive to individual differences in threat-biased attention associated with anxiety, two alternative approaches were identified. The first approach was to compare the threat-biased attention of a subgroup of individuals reporting high trait anxiety levels with the threat-biased attention of another subgroup of individuals reporting low trait anxiety levels.

This method predominates in the current literature (e.g., MacLeod & Rutherford, 1992; Mogg et al., 1994; Van den Hout et al., 1995), and so this group contrast approach permits comparison of the present findings to those obtained within such previous literature. This approach has the capacity to reveal attentional effects that may not be linearly related to trait anxiety, but that nevertheless distinguish high and low trait anxiety groups. The second approach was to compute the correlation between trait anxiety and an index of threat-biased attention. If a linear association between trait anxiety and threat-biased attention exists, this effect may be more sensitively revealed through correlational analysis than by group contrasts.

Since each of these methods of analysis provides slightly different information regarding the nature of the relationship between anxiety and threat biased information processing, both were employed. If the Attention/Initial/Visual Task is sensitive to the tendency of individuals with high trait anxiety to selectively attend to threatening information, then when compared with participants in the low trait anxiety group, the responses of participants in the high trait anxiety group will be disproportionately speeded for targets related to threatening Prime Display stimuli relative to non-threatening Prime Display stimuli. If the tendency to selectively attend to threatening information is a linear function of trait anxiety, then a positive linear correlation between trait anxiety and the index of biased attention will result. However, the Attention/Initial/Visual Task could evidence only one effect, or it could evidence both effects. Therefore, if *at least one* of the effects is significant, the Attention/Initial/Visual Task will be considered sensitive to anxiety-associated biased attention towards threat.

Consistent with the approach adopted with all the experimental tasks, dependent on whether the Attention/Initial/Visual Task met the aforementioned criteria, determined its inclusion in the final analysis of the associations between the experimental tasks, presented in chapter 11. As will be recalled from chapter 2, all tasks were included in the first stage of the final analysis, tasks that either possessed statistically significant internal reliability, or demonstrated sensitivity to anxiety-associated threat-biased information processing were included in both stages one and two of the final analysis, and tasks that demonstrated both significant internal reliability and sensitivity to anxiety-associated threat-biased information processing were included in stages one, two and three of the final analysis.

Method

Participants

Participants were selected in the manner outlined in chapter 2 . This gave rise to a sample of 140 participants, who reported a wide range of trait anxiety levels ranging from 22 to 75. The mean trait anxiety score was 42.3, *SD* = 10.0 (screened using the STAI-T; Spielberger et al., 1983)[6]. Participants included 67 males and 73 females. Their mean age was 19.8, *SD* = 4.0.

Materials

Trait Anxiety Assessment Instrument

As will be recalled from chapter 2, trait anxiety was assessed using the STAI-T (Spielberger et al., 1983).

Word-stimuli

The word-stimuli used in the Attention/Initial/Visual Task are represented in row ii. of Table 1 in chapter 2. They were taken from the quintets of experimental

[6] This mean trait anxiety score was comparable with the STAI-T college student norm of 40, *SD* = 10 (Spielberger et al., 1983).

stimuli described in Appendix A, and included visual *threat synonyms*, visual *non-threat synonyms*, visual *threat associates* and visual *non-threat associates*. The characteristics and employment of the word-stimuli were as described in chapter 2. A visual *threat synonym* was employed as the threatening member of a pair of Prime Display stimuli, while its corresponding visual *non-threat synonym* was employed as the non-threatening member of a pair of Prime Display stimuli. For the purpose of the present experiment, visual *threat synonyms* will be referred to as threat Prime Display stimuli, while visual *non-threat synonyms* will be referred to as non-threat Prime Display stimuli. Either pairs of visual *threat associates* or pairs of visual *non-threat associates* were employed as Target Display stimuli. For the purpose of the present experiment, visual *threat associates* will be referred to as threat Target Display stimuli, while visual *non-threat associates* will be referred to as non-threat Target Display stimuli. The threat Prime Display stimuli were judged to possess significantly more threatening meanings than their corresponding non-threat Prime Display stimuli. The threat Prime Display stimuli and their corresponding threat Target Display stimuli were rated as semantically related, as were the non-threat Prime Display stimuli and their corresponding non-threat Target Display stimuli. No significant difference between the semantic relatedness of the threat Prime Display stimuli and their corresponding threat Target Display stimuli and the non-threat Prime Display stimuli and their corresponding non-threat Target Display stimuli was found.

Experimental task

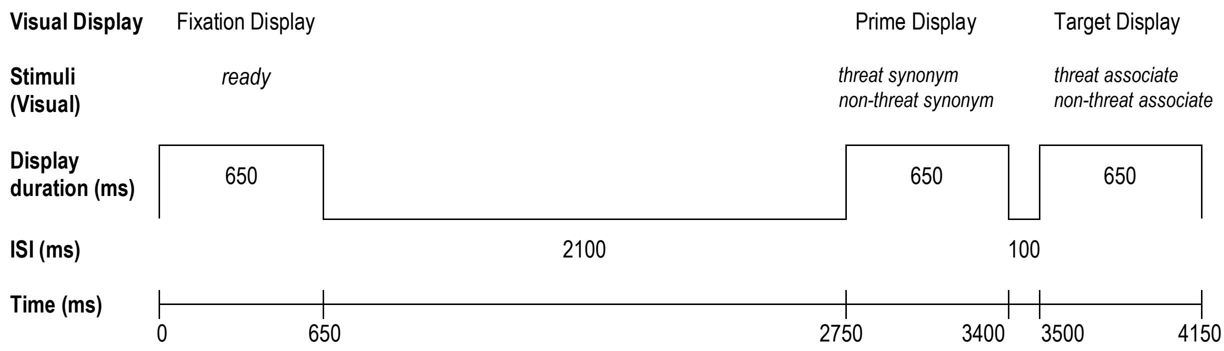
The Attention/Initial/Visual Task required participants to judge the semantic relatedness of unambiguous Prime Display and Target Display words presented visually on a computer screen.

In each trial, words set in white, uppercase, regular Arial font, 1.10 cm high, were presented against a black background on a computer screen. Each trial commenced with a Fixation Display, in which the word *READY* was presented in the centre of the screen for 650 ms. Following an inter-stimulus interval of 2100 ms, the Prime Display appeared. In the Prime Display, a pair of different words, one with an unambiguous threatening meaning and one with an unambiguous non-threatening meaning, were simultaneously presented for 650 ms. One of the Prime Display stimuli was located just above the centre of the screen while the other was located just below the centre. The vertical distance between the two Prime Display stimuli was 2.8 cm, which from the viewing distance of 75 cm subtended less than a 2 degree visual angle of separation. The unambiguous threatening words and the unambiguous non-threatening words were presented in the two Prime Display locations with equal frequency. Following an inter-stimulus interval of 100 ms, the Target Display appeared. In the Target Display, another pair of different words was simultaneously presented. Like the Prime Display stimuli, the Target Display stimuli appeared for 650 ms, one word located just above the centre of the screen, the other word located just below the centre. The vertical distance between the two Target Display stimuli was also 2.8 cm. One Target Display stimulus was the target, in that it was semantically related to one of the Prime Display word stimuli. The other Target Display stimulus was the foil. The foil was unrelated to either of the preceding Prime Display word stimuli, but was related to a Prime Display stimulus of the *same* emotional valence as the Prime Display stimulus to which the target was related. The target and the foil were presented in each of the two Target Display locations with equal frequency throughout the task. After the Target Display, participants were required to identify the location of the target word. The speed and accuracy of participants' responses were recorded by the task program. Figure 2 summarises the progression of a trial in the Attention/Initial/Visual

Task.

Figure 2

The progression of a single trial in the Attention/Initial/Visual Task.



Since the Attention/Initial/Visual Task was designed to measure biased attention towards threatening information, the critical factor governing the experimental conditions was Target Semantic Association. The Target Semantic Association Factor determined the member of the Prime Display to which the target was related. On half the trials, the target was related to the threatening member of the Prime Display, while on half the trials the target was related to the non-threatening member of the Prime Display. The task was designed to ensure that any effect of Target Semantic Association was not confounded by stimulus position. Therefore, in the Target Display the target was presented equally often in the two possible stimulus locations. Likewise, in the Prime Display the threatening stimulus was presented equally often in the two possible stimulus locations. The nested combination of these three, two-level factors gave rise to eight unique presentation conditions.

In a given trial, the Prime Display contained a *threat synonym* and its corresponding *non-threat synonym* taken from a single quintet. The target presented in the Target Display of that trial, was either the *threat associate* or the *non-threat associate* taken from the same quintet as the *threat synonym* and *non-threat* *synonym* in the Prime Display. The foil presented in the Target Display of that trial, was taken from a different quintet to that of the target, and from among *associates* that had *not* appeared within that particular block of trials. If the target was a *threat associate*, the foil was also a *threat associate*, while if the target was a *non-threat associate*, the foil was also a *non-threat associate*.

As was the case for all experimental tasks, the Attention/Initial/Visual Task contained a total of 256 trials, presented across four trial blocks. As in the other experimental tasks, in the Attention/Initial/Visual, a trial block was designed to present each of the unique presentation conditions an equal number of times. In The Attention/Initial/Visual Task, this meant that within a trial block each word stimulus was presented once. The order in which the presentation conditions appeared was random. Likewise, the allocation of the quintets of word stimuli to each presentation condition was random, under the qualification that no quintet occurred in the same presentation condition more than once.

Experimental hardware.

The stimuli were displayed on a 35 cm NEC Multi-Sync V530 monitor, controlled by a 952 MHz Intel Celeron Processor.

Procedure

As in all the experiments, participants were tested individually in visually screened, sound attenuated cubicles. Participants sat directly in front of, approximately 0.75 m from the computer screen, and read a standard set of instructions for the Attention/Initial/Visual Task presented on the screen.

The bulk of the instructions were equivalent across all four tasks involving *Initial Information Processing*, with only a couple of particular details specific to it being an Attention/Initial/Visual Task. In this as in the three other experiments involving *Initial Information Processing*, participants were directed as follows. Participants were instructed that each trial commenced with a fixation signal, the word *READY*, followed by two displays. Participants were asked to identify the location of the word in the second display that was *semantically related* to a meaning presented in the first display. Participants were advised that words were considered related if either they had the *same meaning* as each other (e.g., *QUICK* and *FAST*), or they had an *associated meaning* (e.g., *CAT* and *DOG*). They were assured that one of the words in the second display was always related to a meaning in the first display. The need for accuracy was emphasized such that participants were instructed to work as quickly as possible without making mistakes. At no time were participants informed as to the nature of the word-stimuli.

In the Attention/Initial/Visual Task, participants were directed to indicate their responses by pressing one of the standard keyboard arrow keys: if the top word in the second display was related to one of the words in the first display, they should press the upward-pointing arrow key, while if the bottom word in the second display was related to one of the words in the first display, they should press the downward-pointing arrow key.

As was the case for all eight experimental tasks, after reading the instructions, participants were presented with an example trial in which the correct responses were demonstrated. When the participants had completed the example, the experimenter reviewed the task instructions with them and answered any questions. Participants then completed a series of 16 practice trials and any further questions were answered. When it was clear that the participants understood the task's requirements, they were directed to proceed with the test trials.

As will be recalled from chapter 2, 140 participants completed each of the eight tasks, and each participant completed two of the eight experimental tasks. The order in which the two tasks were completed was counterbalanced across participants. As such, of the participants who completed the Attention/Initial/Visual Task, 70 participants completed it before one of the seven other tasks, while 70 participants completed it after one of the seven other tasks. In each case, ten of these 70 participants completed each of the seven possible other experimental tasks.

For all tasks, there was a break after each block of 64 trials. Therefore, across the entire experimental session (2 tasks, 256 trials each), there were six within-task breaks and one between-tasks break. During the between-tasks break, participants rested for five minutes. In each of the first four within-task breaks, participants received a quarter of the items of the STAI-T (Spielberger et al., 1983), presented in their original order. In the fifth within-task break, participants completed questions about their age and gender and confirmed their familiarity with the English language. In the sixth within-task break, participants were instructed only to rest.

Altogether, the experimental session, that is, the Attention/Initial/Visual Task plus one of the other experimental tasks, took approximately 100 minutes. At the conclusion of their experimental session, participants were thanked and debriefed about the experiment.

Results

Overview

The present results section has two primary purposes: to determine the internal reliability of the Attention/Initial/Visual Task and to examine whether the Attention/Initial/Visual Task reveals individual differences in attention bias to threat specifically associated with variability in anxiety. On the basis of these two purposes, the results section is divided into two parts. The internal reliability of the

Attention/Initial/Visual Task is reported first, while the sensitivity of the Attention/Initial/Visual Task to anxiety-associated threat-biased attention is reported next.

Exclusion of Inaccurate Participants

Before considering the sensitivity of the Attention/Initial/Visual Task to individual differences in threat-biased attention, it was first necessary to ensure that the participants had complied with the task instructions. To determine whether the participants completed the task as instructed, the accuracy of their responses was computed. For each individual participant, task accuracy was expressed as the percentage of correct responses given across the entire task's 256 trials. These scores were subjected to a single sample t test which revealed that mean percentage accuracy across all participants was well above the chance level of 50%, $t(139) = 54.58$, $p < .001$. The one participant who did not demonstrate above chance accuracy was excluded from further analyses.

Internal Reliability

To determine the internal reliability of the Attention/Initial/Visual Task the Spearman-Brown split-half formula was used (Furr & Bacharach, 2008). The Spearman-Brown split-half formula was chosen because it permitted the computation of internal reliability on the basis of a Threat Bias Index, that reflected the relative effects of Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat) on response latency. The Threat Bias Index was the median correct response latency on trials in the Target Related to Non-threat condition subtracted from the median correct response latency on trials in the Target Related to Threat condition. For the purpose of the split-half reliability analysis, two Threat Bias Indexes were computed for each participant, one using only the even numbered trials of each experimental condition, the other using only the odd numbered trials of each experimental condition. These two Threat Bias Indexes were then correlated to obtain the task's split-half reliability estimate.

Using the Spearman-Brown split-half formula, the internal reliability of the Attention/Initial/Visual Task was estimated as r =.007, p = ns. This internal reliability estimate suggests that the Attention/Initial/Visual Task has extremely weak internal consistency. The non-significance of this internal reliability coefficient means that Attention/Initial/Visual Task does not possess an acceptable level of internal reliability for the present research program.

Given the extremely low internal reliability estimate of the Attention/Initial/Visual Task, it could be argued that analysis of the effect of anxiety on the performance of the Attention/Initial/Visual Task is not justified. However, past research into anxiety and information processing bias typically has not analysed the tasks' internal reliability (Mauer & Borkenau, 2007). Indeed, to date only two studies have assessed the internal reliability of measures of information processing bias (Mauer & Borkenau, 2007; Schmukle, 2005). Therefore, since previous research has not restricted the assessment of the association between anxiety and information processing biases to only tasks that have demonstrated statistically significant internal reliability, the effect of anxiety on the performance of the Attention/Initial/Visual Task will be examined regardless of its extremely low internal reliability.

The Sensitivity of the Attention/Initial/Visual Task to Anxiety-associated Individual Differences in Threat-Biased Attention

This part of the results section presents the analysis of the sensitivity of the Attention/Initial/Visual Task to anxiety-associated threat-biased attention. Analyses comparing the characteristics, accuracy, and response latencies of the high and low trait anxiety groups are reported first. Correlational analyses of trait anxiety and an index of threat-biased attention are then reported.

Comparison of Trait Anxiety Groups: Analysis of Variance

Participant Characteristics. For the purpose of comparing the performance of participants who were high in anxiety with participants who were low in anxiety, participants falling within the Mid-Trait Anxiety Band were excluded from the analysis comparing the trait anxiety groups. As will be recalled from chapter 2, across all experiments, participants forming the Mid-Trait Anxiety Band were to attain STAI-T scores between 39 – 43 at screening. Exclusion of the Mid-Trait Anxiety Band left a group of participants, herein referred to as the High Trait Anxiety Group, who reported high trait anxiety as measured by the STAI-T (Spielberger et al., 1983) at screening, and a group of participants, herein referred to as the Low Trait Anxiety Group, who reported low trait anxiety as measured by the STAI-T at screening.

Next, it was considered prudent to ensure that no individual participant reported a trait anxiety score at the experimental test session that was inconsistent with his/her classification as either high or low trait anxiety based on his/her trait anxiety score at screening. To do this, participants were classified as high or low trait anxiety according to whether they fell above or below the median trait anxiety score at the experimental test session (STAI-T median = 40). Any participant, who on the basis of this experimental test time classification was assigned a trait anxiety status different to that assigned on the basis of their prior screening scores, was excluded from further analysis. Two participants in the Low Trait Anxiety Group whose trait anxiety scores at the experimental test session fell above the median trait anxiety score were eliminated, as were eight participants in the High Trait Anxiety Group whose trait anxiety scores at the experimental test session fell below the median trait anxiety score.

The characteristics of the resulting two Trait Anxiety Groups at the experimental test session are presented in Table 4.

Table 4

Participant Characteristics at the Experimental Test Session (Standard Deviations in Parentheses)

	N	Number of Males	Number of Females	Mean Age (Years)	Mean STAI-T Trait Anxiety
Low Trait Anxiety Group	54	27	27	20.3 (3.4)	31.9 (4.1)
High Trait Anxiety Group	47	19	28	19.2 (3.2)	52.6 (7.4)

An Independent Samples *t* test was conducted to ensure that the mean trait anxiety of the resulting Trait Anxiety Groups differed significantly at the time of the experimental test session. As desired, participants in the High and Low Trait Anxiety Groups differed significantly on the STAI-T (Spielberger et al., 1984) during the experimental test session, $t(99) = 17.52$, $p < .001$.

Analyses were also conducted to make certain that the resulting Trait Anxiety Groups were comparable in age and gender distribution. An independent samples *t* test showed no significant difference between the groups in age, $t(99) = 1.57$, $p = .11$. A Chi square test for independence, using Yates' Continuity Correction, showed that there was no significant difference between the two Anxiety Groups in terms of the distribution of males and females, X^2 (1) = .58, $p = .44$.

Accuracy. Table 5 displays the two participant groups' mean percentage accuracy for the Target Related to Threat condition and the Target Related to Non-threat condition.

Table 5

Mean Percentage of Correct Relatedness Judgement Responses (Standard Deviations in Parentheses)

Target Semantic Association Factor	Low Trait Anxiety Group	High Trait Anxiety Group
Target Related to Threat	87.71 (6.80)	87.23 (8.40)
Target Related to Non-threat	91.10 (5.97)	91.22 (5.89)

Since it was intended that response latency would reveal differences in task difficulty, it was desirable to ensure that the Trait Anxiety Groups did not differ in accuracy level as a function of experimental condition. Hence the effects of Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat) and Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) on accuracy were analysed using a repeated measures ANOVA. If no effect of experimental condition on accuracy occurs, then differences in response latency may be attributed to differences in task difficulty. However, if accuracy is affected by experimental condition, then it will be necessary to ensure that differences in response latency cannot be attributed to a speed-accuracy trade-off.

No main effect of Trait Anxiety Group was found, $F(1,99) = .02$, $p = .88$, meaning that there was no significant difference between the mean accuracy of participants in the High Trait Anxiety Group relative to the mean accuracy of participants in the Low Trait Anxiety Group. A main effect of Target Semantic Association was found, $F(1,99) = 77.33$, $p < .01$, due to the mean accuracy of all participants being significantly greater in the Target Related to Non-threat condition relative to the Target Related to Threat condition. It follows that if an effect of Target Semantic Association on response latency is found, it will be important to ensure that this is not due to a speed-accuracy trade-off. Of most importance, no interaction between Trait Anxiety Group and Target Semantic Association occurred, $F(1,99) = .51$, $p = .47$, meaning that the main effect of Target Semantic Association did not differ for participants in the High Trait Anxiety Group compared to those in the Low Trait Anxiety Group. Hence there was no indication that the High and Low Trait Anxiety Groups differed in terms of their patterns of accuracy on the task.

Response Latency. The preceding analyses confirmed that the participants included in the analyses reported trait anxiety at test time that was representative of the Trait Anxiety Group to which they had been allocated at screening. Likewise, the preceding analyses showed that the participants included in the analyses completed the Attention/Initial/Visual Task as instructed, and that the accuracy of the two Trait Anxiety Groups did not differ. Therefore, the issue of key importance can now be addressed: whether or not the Attention/Initial/Visual Task revealed anxiety-associated differences in threat-biased attention measured by comparing the speed with which targets related to threatening relative to non-threatening Prime Display stimuli were correctly identified.

Threat-biased attention was measured by the differential speed with which participants correctly identified the target stimulus in the Target Related to Non-threat condition relative to the Target Related to Threat condition. For each participant, the median response latency to correctly identify the target under each experimental condition was calculated[7]. The resulting median response latencies are presented in Table 6.

[7] Medians were employed to reduce the impact of any extreme response latencies (Pagano, 1994).

Table 6

Average Median Response Latency (in ms) to Correctly Identify Targets (Standard Deviations in Parentheses)

Target Semantic Association Factor	Low Trait Anxiety Group	High Trait Anxiety Group
Target Related to Threat	1405.66 (308.05)	1428.98 (417.26)
Target Related to Non-threat	1346.98 (319.74)	1385.42 (388.68)

These reaction time data were analysed using a repeated measures ANOVA considering the effects of the between-subjects factor, Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) and the within-subjects factor, Target Semantic Association Factor (Target Related to Threat vs. Target Related to Non-threat).

A significant main effect of Target Semantic Association was found such that all participants demonstrated faster median response latencies in the Target Related to Non-threat condition, than in the Target Related to Threat Condition, $F(1,99) = 11.43$, $p < .001$. When this effect is considered in conjunction with the main effect of Target Semantic Association in the preceding accuracy analysis, this shows that participants tended to respond more quickly and more accurately in the Target Related to Non-threat condition, relative to the Target Related to Threat Condition. This suggests that on average all participants were more likely to attend to the non-threatening member of the Prime Display rather than the threatening member of the Prime Display. No main effect of Trait Anxiety Group was found $F(1,99) = .19$, $p = .65$, meaning that the median response latency of participants in the High Trait Anxiety Group was not significantly different to the median response latency of participants in the Low Trait Anxiety Group. Of most importance to the issue under investigation, there was no significant interaction between Target Semantic Association and Trait Anxiety Group, $F(1,99) =$

.25, $p = .61$. This means that there was no group difference in the effect of Target Semantic Association. Therefore, there was no evidence of differential attention bias towards threat between the groups.

Assuming that relative response latency is a measure of threat-biased attention, the results of the preceding ANOVA suggest that the Attention/Initial/Visual Task is not able to distinguish the High and Low Trait Anxiety Groups on the basis of biased attention to threat. However, it remains possible that the Attention/Initial/Visual Task might be sensitive to a correlational association between anxiety and threat-biased attention. Therefore, the following section considers the linear association between trait anxiety and an index of threat-biased attention using Pearson correlational analysis.

Linear Association between Anxiety and Threat-biased Attention: Pearson Correlational Analyses

Participant Characteristics. For the purpose of the Pearson Correlational Analysis, participants falling in the Mid-Trait Anxiety Band were reinstated to the analyses. The same requirements in terms of consistency of trait anxiety level and accuracy, as those in the preceding section Comparison of Trait Anxiety Groups, applied for inclusion in the correlational analyses. Since all participants falling within the Mid-Trait Anxiety Band met these requirements, all were included.

Accuracy. As was the case for the preceding Comparison of Trait Anxiety Groups Analysis, it was intended that response latency would reveal differences in task difficulty. For that reason it was desirable to check that there was no linear association between anxiety and the relative accuracy of responses to trials in the Target Related to Threat condition and trials in the Target Related to Non-threat condition. For this purpose, a measure of trait anxiety and a measure of the accuracy of responses to trials in the Target Related to Threat condition relative to the accuracy of responses to trials in the Target Related to Non-threat condition were subjected to Pearson correlational analyses. If no association between anxiety and the accuracy measure is found, then it follows that differences in response latency may be attributed to differences in task difficulty. Alternatively, if an association between anxiety and accuracy is found, then it will be necessary to ensure that any association between the relative response latency of trials in the Target Related to Threat condition and trials in the Target Related to Non-threat condition cannot be attributed to a speed-accuracy trade-off.

The key measures included in this correlational analysis were:

i. A Trait Anxiety Index: the STAI-T(Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. An Accuracy Threat Bias Index: the mean percentage of correct responses on trials in the Target Related to Non-threat condition, subtracted from the mean percentage of correct responses on trials in the Target Related to Threat condition.

The Trait Anxiety Indexes and the Accuracy Threat Bias Indexes were normally distributed. Therefore, a Pearson correlational analysis was conducted to analyse the relationship between trait anxiety and the Accuracy Threat Bias Index. This yielded a correlation coefficient of $r = .10$, $p = .25$, indicating a non-significant weak positive correlation between the two variables. In light of the absence of a significant correlation between anxiety and the Accuracy Threat Bias Index, we may be confident that any difference in response latency in the following analysis is not due to differences in task difficulty.

Response Latency. The preceding analyses confirmed that there is no association between trait anxiety and the relative accuracy for the Target Related to Threat condition and the Target Related to Non-threat condition. Therefore, we can now turn to the issue of key importance: whether or not the Attention/Initial/Visual Task revealed a linear association between trait anxiety and threat-biased attention as measured by the relative response latency for targets correctly identified as related to threatening relative to non-threatening Prime Display stimuli.

The key measures included in this correlational analysis were:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. A Threat Bias Index: the median correct response latency on trials in the Target Related to Non-threat condition, subtracted from the median correct response latency on trials in the Target Related to Threat condition.

Like the Trait Anxiety Indexes, the Threat Bias Indexes were distributed normally. Therefore, a Pearson correlational analysis of the relationship between trait anxiety and the Threat Bias Index was conducted. This yielded a correlation coefficient of $r = .01$, $p = .87$. The proximity of this correlation coefficient to zero suggests that there is no relationship between the two variables. Assuming that the Threat Bias Index provides a measure of threat-biased attention, this non-significant and weak correlation coefficient provides no evidence that the Attention/Initial/Visual Task is sensitive to a linear association between trait anxiety and threat-biased attention.

Discussion

Summary of Findings

The present experiment was designed to assess the sensitivity of the Attention/Initial/Visual Task to individual differences in biased attention towards threat. As described in the introduction to this chapter, this was determined on the basis of the Attention/Initial/Visual Task's internal reliability and its capacity to demonstrate threat-biased attention associated with individual differences in anxiety.

The Attention/Initial/Visual Task's split half correlation coefficient failed to reach statistical significance and therefore was not considered representative of acceptable internal reliability for the present research program. This finding highlights the importance of measuring a task's internal reliability. Typically past research on selective information processing has not reported task internal reliability (Mauer & Borkenau, 2007), therefore the consistency of the items of these tasks is largely unknown. However, particularly for the purpose of the present research, since a measure's internal reliability can affect its capacity to correlate with another measure (Humphreys & Drasgow, 1989), knowledge of a task's internal reliability is vitally important.

The results of both the group comparison and the correlational analyses did not show an association between variability in trait anxiety and individual differences in biased attention towards threatening visual stimuli. Participants in the High and Low Trait Anxiety Groups displayed similar patterns of response latency in trials where the target was related to the threatening relative to the non-threatening Prime Display stimulus. Therefore, assuming that relative response latency is a measure of attention bias towards threat, the Attention/Initial/Visual Task did not pick up any anxiety group differences in threat-biased attention. Likewise, trait anxiety was not found to be linearly correlated with an attention bias towards threat. Consequently, assuming the Threat Bias Index measures attention bias towards threat, there is no evidence of a linear relationship between anxiety and threat-biased attention as measured using the Attention/Initial Visual Task.

Explanations for Findings

Given the extensive literature demonstrating individual differences in anxiety-associated attention bias towards threat (reviewed in: MacLeod, 1999; MacLeod & Rutherford, 2004; Mathews & MacLeod, 1994, 2005), the present absence of significant results can arguably be attributed to the insensitivity of the Attention/Initial/Visual Task. The present section considers possible reasons for this insensitivity.

One possible explanation for the absence of any anxiety-associated individual differences in attention bias to threat on the Attention/Initial/Visual Task is the task's temporal parameters. Some researchers suggest that trait anxiety-associated threat-biased attention may be an automatic cognitive process that can be moderated by controlled processing (MacLeod & Rutherford, 2004). Further, there is experimental evidence that cognitive processing of written text is only automatic at prime-target stimulus onset asynchronies of less than 250 ms (Neely, 1977). However, the stimulus onset asynchrony between the Prime Display stimuli and the Target Display stimuli in the Attention/Initial/Visual Task was 750 ms. For this reason, it is possible that the Attention/Initial/Visual Task did not pick up any trait anxiety-associated individual differences in threat-biased attention because the participants used controlled cognitive processing to modify their initial responses. Indeed, the long relatedness judgement response times suggest that participants fixated on both Target Display stimuli before making their decision. As a result, any effect of biased attention may have been lost by participants making multiple fixations on the Target Display stimuli. This explanation is supported by studies that have shown evidence of trait anxiety-associated threat-biased attention under masked conditions that relied on automatic attention, but not under unmasked conditions that relied on controlled attention (e.g., MacLeod & Hagan, 1992; van Honk et al., 2001; MacLeod & Rutherford, 1992). Nevertheless, other research has shown evidence of trait anxiety-associated biased attention towards threat under conditions in which controlled attention could be used (e.g., Edwards, Burt, & Lipp, 2006; Egloff & Hock, 2001; Mogg, Bradley, Dixon, Fisher, Twelftree, & McWilliams, 2000; van den Hout et al., 1995). In light of this second set of studies, it is not certain that the temporal parameters of the Attention/Initial/Visual Task can provide a complete explanation of the absence of anxiety-linked threat-biased attention.

The absence of evidence of the Attention/Initial/Visual Task's sensitivity to anxiety-associated biased attention towards threat may also be attributable to the nature of the experimental stimuli. Past research has shown that anxiety-associated attention bias is most prominent when the nature of the threatening stimuli is directly relevant to the participant's own concerns (e.g., Mattia, Heimberg, & Hope, 1993; McNally, Riemann, & Kim, 1990). For example, Hope, Rapee, Heimberg and Dombeck (1990) reported that the performance of an Emotional Stroop task by participants with social anxiety was more greatly disrupted by socially-threatening words relative to neutral words, than by physically-threatening words relative to neutral words, while the performance of participants with panic disorder was more greatly disrupted by physically-threatening words relative to neutral words, than by socially-threatening words relative to neutral words. The stimuli included in the Attention/Initial/Visual Task were not associated with a particular type of threat, and instead encompassed a range of different threatening themes. Therefore, it is possible that these experimental stimuli were not sufficiently relevant to the participants' personal concerns to reveal any anxiety-associated biased attention towards threat. Nevertheless, there are other studies that have successfully used threatening stimuli not specific to the participants' particular concerns to demonstrate anxiety-associated attention bias to threat (e.g., Mathews et al., 1990; Mogg et al., 1997). Consequently, the nature of the experimental stimuli may not fully explain the insensitivity of the Attention/Initial/Visual Task to anxiety-associated attention bias to threat.

Consideration of the key differences between the Attention/Initial/Visual Task and measures of biased attention towards visual threatening information that have been found to be sensitive to variability in anxiety (e.g., the dot probe task, MacLeod et al., 1986; the emotional Stroop task, Mogg, et al., 1989) may point to other explanations for the insensitivity of the Attention/Initial/Visual Task to anxiety-linked threat-biased attention. The most obvious feature that distinguishes the Attention/Initial/Visual Task from both the dot probe task and the emotional Stroop task is the extent to which the semantic meanings of the threatening and non-threatening stimuli require accessing to be able to perform the task. In the emotional Stroop task, participants classify threatening and non-threatening stimuli on the basis of a perceptual feature (i.e., colour; Mogg, et al., 1989). In the dot probe task, participants detect the presence of a probe that replaces either a threatening or non-threatening stimulus (MacLeod et al., 1986). As such, neither task requires that participants directly respond to the semantic meaning of the stimuli. Conversely, to perform the Attention/Initial/Visual Task, participants make judgements about the semantic relatedness of Prime and Target Display stimuli. Therefore, a person cannot perform the Attention/Initial/Visual Task without accessing the meanings of the stimuli. If variability in threat-biased attention reflects anxiety-linked differences in the extent to which the meaning of stimuli is accessed, the requirement that participants directly respond to stimulus meanings to perform the Attention/Initial/Visual Task may obscure this variability.

Implications for Present Research Thesis

Regardless of the explanation for the insensitivity of the Attention/Initial/Visual Task to anxiety-linked differences in threat-biased attention, the ultimate purpose of this experiment was to determine the suitability of the Attention/Initial/Visual Task for inclusion in the final analysis of the patterns of associations across all the experimental tasks presented in chapter 11. As will be recalled from the introduction to this chapter, to ensure that all possible associations were considered, all experimental tasks were included the first stage of the final analysis. For an experimental task to be included in subsequent stages of the final analysis, it was required to at least evidence either significant internal reliability or trait anxiety-associated individual differences in threat-biased attention. Since the Attention/Initial/Visual Task did not evidence either significant internal reliability or trait anxiety-associated individual differences in threat-biased attention, it was only included in the first stage of the final analysis.

Conclusions

In conclusion, the Attention/Initial/Visual Task did not evidence significant internal reliability or trait anxiety-associated differences in biased attention towards threat. The low internal reliability of the Attention/Initial/Visual Task highlights the importance of designing measures of information processing bias in a manner that allows the assessment of the consistency of the task's items. Possible explanations for the observed absence of anxiety-linked effects are: the long duration of the Prime Display – Target Display stimulus onset asynchrony; the experimental stimuli being generally threatening rather than specific to the participants' particular concerns; and the requirement of the Attention/Initial/Visual Task that participants directly respond to the meaning of the stimuli. Since the Attention/Initial/Visual Task was insufficiently sensitive to individual differences in attention bias towards threat it was only included in the first stage of the final analysis of the patterns of associations between the experimental tasks, presented in chapter 11.

CHAPTER 4

EXPERIMENT 2:

The Attention/Initial/Auditory Task

Experiment 2 was intended to evaluate the sensitivity of the Attention/Initial/Auditory Task to anxiety-linked individual differences in attention bias towards threatening auditory stimuli. Like the Attention/Initial/Visual Task in Experiment 1 and most conventional measures of cognitive bias (Fox, 1994), the Attention/Initial/Auditory Task was designed to measure attention bias broadly. That is, attention bias as measured by the Attention/Initial/Auditory Task could either reflect the initial focus of attention towards threat, or difficulty in revising the initial focus of attention away from threat and towards non-threat.

The design of Experiment 2 was exactly the same as that of Experiment 1, with the exception of the experimental task that was employed, which in Experiment 2 was the Attention/Initial/Auditory Task. The Attention/Initial/Auditory Task was a variant of the General Approach to Bias Assessment described in chapter 2. It was the auditory parallel of the Attention/Initial/Visual Task (Experiment 1) and identical in design except for the modality in which the stimuli were presented. As such, in each display of the Attention/Initial/Auditory Task auditory stimuli were presented via earphones.

The same criteria in Experiment 1 determined the sensitivity of an experimental task to individual differences in information processing bias towards threat: statistically significant internal reliability; and sensitivity to individual differences in information processing bias towards threat previously shown to be associated with anxiety (e.g., MacLeod et al., 1986; Mogg et al., 1996; Mogg et al., 1994). In the case of the Attention/Initial/Auditory Task, the latter criterion specifically required that the task was sensitive to anxiety-associated threat-biased attention. If the Attention/Initial/Auditory Task is sensitive to anxiety-linked threat-biased attention, then when compared with low trait anxiety group participants, the responses of high trait anxiety group participants would be disproportionately speeded for targets related to threatening relative to the non-threatening Prime Display stimuli. Likewise, if the tendency to selectively attend to threatening information is a linear function of anxiety, then we would find a positive linear correlation between trait anxiety and the index of biased attention to threat. As in Experiment 1, if *either* a significant anxiety group difference, *or* a significant linear association between anxiety and an index of threat-biased attention is found, the Attention/Initial/Auditory Task will be considered sensitive to anxiety-associated biased attention towards threat.

Consistent with the approach adopted with all the experimental tasks, dependent on whether the Attention/Initial/Auditory Task demonstrated the aforementioned criteria, determined its inclusion in the final analysis of the associations between the experimental tasks, presented in chapter 11.

Method

Participants

Participant selection was in accordance with that outlined in chapter 2 . This gave rise to a sample of 140 participants, who reported trait anxiety scores ranging from 22 to 71. The mean trait anxiety score of 41.8, *SD* = 9.9 (screened using the STAI-T; Spielberger et al., 1983)[8]. Participants included 48 males and 92 females. Their mean age was 20.0, *SD* = 4.5.

[8] This mean trait anxiety score was comparable with the STAI-T college student norm of 40, *SD* = 10 (Spielberger et al., 1983).

Materials

Trait Anxiety Assessment Instrument

As in Experiment 1, trait anxiety was assessed using the STAI-T (Spielberger et al., 1983).

Word-stimuli

The word-stimuli used in the Attention/Initial/Auditory Task are represented in row vi. of Table 1 in chapter 2, they were taken from the quintets of experimental stimuli described in Appendix A, and included auditory *threat synonyms*, auditory *non-threat synonyms*, auditory *threat associates* and auditory *non-threat associates*. The characteristics and employment of the word-stimuli were as described in chapter 2. With exception of the modality in which they were presented, the word-stimuli were identical to those used in Experiment 1. For present purposes the auditory *threat synonyms* will be referred to as threat Prime Display stimuli, the auditory *non-threat synonyms* will be referred to as non-threat Prime Display stimuli, the auditory *threat associates* will be referred to as threat Target Display stimuli, and the auditory *non-threat associates* will be referred to as non-threat Target Display stimuli.

Experimental task

The Attention/Initial/Auditory Task was identical to the Attention/Initial/Visual Task described in Experiment 1 with the exception that the word stimuli were presented aurally via earphones. The word stimuli were spoken by a native Australian-English speaking male at an even pitch and volume, and were digitally edited so that each was exactly 650 ms in duration [9]. In parallel with the presentation format of the Attention/Initial/Visual Task, when, in the Prime and Target Displays, two of the word stimuli were presented simultaneously, one was presented via the left earphone and the

---

[9] To ensure that the perceptual quality of the auditory stimuli was not compromised by the digital editing, no word's length was modified by more than 15% of its original length.

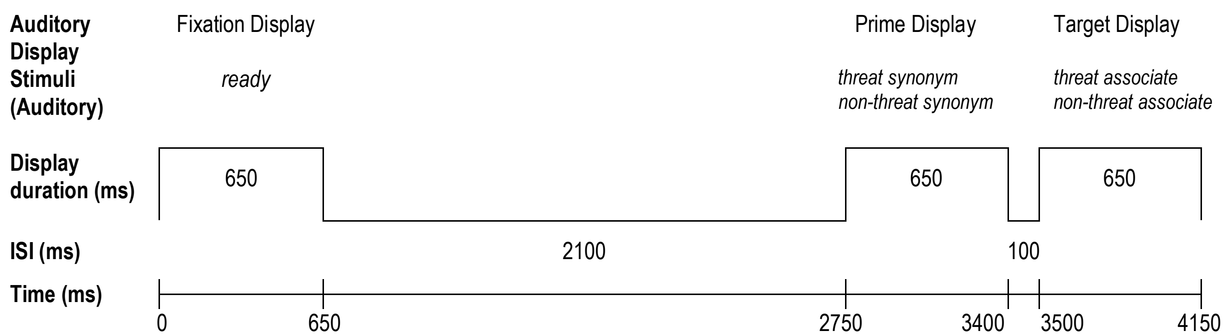
other was presented via the right earphone. Likewise, in parallel with the Experiment 1 task, the Fixation Display comprised the single word *READY* presented simultaneously via both the left and right earphones.

Aside from the presentation modality, trials in the Attention/Initial/Auditory Task were organised in the same manner and on the basis of the same critical factors and experimental conditions as those in the Attention/Initial/Visual Task in Experiment 1. Likewise, the allocation of experimental stimuli to the presentation conditions, the number of trials and trial blocks, and the balancing of presentation conditions across trial blocks in the Attention/Initial/Auditory Task were the same as for the Attention/Initial/Visual Task.

In summary, in Experiment 2 all stimulus displays were presented aurally. As shown in Figure 3, each trial included a Prime Display that contained *threat synonym* and its corresponding *non-threat synonym*, followed by a Target Display that contained either two *threat associates*, or two *non-threat associates*, one of which, the target, was semantically related to one meaning in the Prime Display. The participants' task was to identify the location of the target.

Figure 3

The progression of a single trial in the Attention/Initial/Auditory Task.



Experimental hardware.

The stimuli were presented via Pro-Luxe KT-424 stereophonic earphones and controlled by a 952 MHz Intel Celeron Processor.

Procedure

The Procedure was identical to that described in Experiment 1 with two exceptions. First, participants wore earphones for the duration of the task. Second, the keys that participants were instructed to use to indicate their responses differed from those used in Experiment 1. If the target in the second display was presented via the left earphone, participants were directed to press the left-pointing arrow key, while if the target in the second display was presented via the right earphone, participants were directed to press the right-pointing arrow key.

Results

Overview

Since the purpose of this results section and the results sections of the following experiments is identical to that of Experiment 1, their organization follows that of Experiment 1. Task internal reliability is first reported, after which the sensitivity of the task to anxiety-associated threat-biased information processing is reported.

Exclusion of Inaccurate Participants

Participants' compliance with task instructions was determined based on their accuracy (percentage of correct responses across the task's 256 trials). A single sample t test revealed that mean percentage accuracy across all participants was well above the chance level of 50%, $t(139) = 36.84$, $p < .001$. The one participant who did not demonstrate above chance accuracy was excluded from further analyses.

Internal Reliability

The internal reliability of the Attention/Initial/Auditory Task was determined using the procedure described in Experiment 1.

Using the Spearman-Brown split-half formula, the internal reliability of the Attention/Initial/Auditory Task was estimated as $r = .31$, $p < .01$. This represents weak internal consistency. However, since it is statistically significant, it is considered to be an acceptable level of internal reliability for the purpose of the present research. The following section will determine whether the Attention/Initial/Auditory Task measures individual differences in threat-biased attention associated with variability in anxiety.

The Sensitivity of the Attention/Initial/Auditory Task to Anxiety-associated Individual Differences in Threat-Biased Attention

This part of the results presents the analysis of the sensitivity of the Attention/Initial/Auditory Task to anxiety-associated threat biased attention. Analyses comparing the characteristics, accuracy and response latencies of the high and low trait anxiety groups are reported first. Correlations between trait anxiety and the Threat Bias Index are then reported.

Comparison of Trait Anxiety Groups: Analysis of Variance

Participant Characteristics. A High Trait Anxiety Group and a Low Trait Anxiety Group were obtained in the manner described in Experiment 1.

As was the case in Experiment 1, steps were taken to ensure that no individual participant's trait anxiety score at the experimental test session was inconsistent with his/her classification as either high or low trait anxiety level at screening. The steps taken to achieve this in the present experiment were identical to those outlined in Experiment 1. This resulted in the elimination of seven participants in the Low Trait Anxiety Group whose trait anxiety scores at the experimental test session fell above the median trait anxiety score (STAI-T = 40), and two participants in the High Trait Anxiety Group whose trait anxiety scores at the experimental test session fell below the median trait anxiety score.

The characteristics of the resulting two Trait Anxiety Groups at the experimental test session are presented in Table 7.

Table 7

Participant Characteristics at the Experimental Test Session (Standard Deviations in Parentheses)

	N	Number of Males	Number of Females	Mean Age (Years)	Mean STAI-T Trait Anxiety
Low Trait Anxiety Group	49	19	30	21.0	32.7 (7.5)
High Trait Anxiety Group	54	21	33	20.0	51.0 (7.7)

An independent samples *t* test revealed that participants in the High and Low Trait Anxiety Groups differed significantly in terms of trait anxiety as measured by the STAI-T (Spielberger et al., 1984) during the experimental test session, $t(101) = 16.03$, $p < .001$. However, an independent samples *t* test showed no significant difference between the groups in age, $t(101) = 1.01$, $p = .31$. In addition, a Chi square test for independence, using Yates' Continuity Correction, showed that there was no significant difference between the two Anxiety Groups in terms of the distribution of males and females, $X^2\,(1) = .00$, $p = 1.00$.

Accuracy. Table 8 displays the two participant groups' mean percentage accuracy for the Target Related to Threat condition and the Target Related to Non-threat condition.

Table 8

Mean Percentage of Correct Relatedness Judgement Responses (Standard Deviations in Parentheses)

Target Semantic Association Factor	Low Trait Anxiety Group	High Trait Anxiety Group
Target Related to Threat	78.73 (8.71)	75.91 (8.96)
Target Related to Non-threat	80.88 (7.99)	78.38 (9.37)

As in Experiment 1, to confirm that the accuracy of the Trait Anxiety Groups did not differ as a function of experimental condition, the effects of Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat) and Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) on accuracy were analysed using a repeated measures ANOVA.

No main effect of Trait Anxiety Group was found, $F(1,101) = 2.54$, $p = .11$, meaning that the mean accuracy of participants in the High Trait Anxiety Group did not significantly differ from the mean accuracy of participants in the Low Trait Anxiety Group. There was a main effect of Target Semantic Association, $F(1,101) = 23.00$, $p < .001$, evidencing that the mean accuracy of all participants was significantly greater in the Target Related to Non-threat condition, relative to the Target Related to Threat condition. Therefore, if there is an effect of Target Semantic Association on response latency, it will be important to ensure that this is not due to a speed-accuracy trade-off. Finally, there was no interaction between Trait Anxiety Group and Target Semantic Association, $F(1,101) = .11$, $p = .74$, such that this effect did not differ for participants in the High Trait Anxiety Group compared to those in the Low Trait Anxiety Group. Therefore, there was no indication that the High and Low Trait Anxiety Groups differed in terms of their patterns of accuracy on the task.

In summary, the preceding analyses confirmed that the participants included in the analyses reported trait anxiety at test time that was representative of the Trait Anxiety Group to which they had been allocated. Likewise they showed that participants completed the Attention/Initial/Auditory Task as instructed, and that the accuracy of the two Trait Anxiety Groups did not differ. Therefore, we now turn to the issue of key importance: whether or not the Attention/Initial/Auditory Task revealed anxiety-associated differences in biased attention towards threat.

Response Latency. As in Experiment 1, threat-biased attention was measured by the differential speed with which participants correctly identified the target stimulus in the Target Related to Non-threat condition relative to the Target Related to Threat condition. For each participant, the median response latency to correctly identify the target under each experimental condition was calculated. The resulting median response latencies are presented in Table 9.

Table 9

Average Median Response Latency (in ms) to Correctly Identify Targets (Standard Deviations in Parentheses)

Target Semantic Association Factor	Low Trait Anxiety Group	High Trait Anxiety Group
Target Related to Threat	1922.42 (425.55)	1933.31 (489.03)
Target Related to Non-threat	1836.17 (439.17)	1988.18 (563.06)

These reaction time data were analysed using a repeated measures ANOVA considering the effects of the between-subjects factor, Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) and the within-subjects factor, Target Semantic Association Factor (Target Related to Threat vs. Target Related to Non-threat).

No significant main effect of Target Semantic Association was found, such that there was no difference between the median response latencies in the Target Related to Non-threat Condition and the Target Related to Threat Condition, $F(1,101) = .44$, $p = .50$. Therefore, although on average all participants were more accurate in the Target Related to Non-threat Condition, on average this did not affect the speed of their responses. No main effect of Trait Anxiety Group was found $F(1,101) = .77$, $p = .38$, meaning that the median response latency of participants in the High Trait Anxiety Group was not significantly different to the median response latency of participants in the Low Trait Anxiety Group. Of most importance to the issue under investigation was that a significant interaction between Target Semantic Association and Trait Anxiety Group was found, $F(1,101) = 8.96$, $p < .01$. This interaction showed that there was a significant group difference in the effect of Target Semantic Association. The pattern of interactions was such that where as the Low Trait Anxiety Group tended to respond more quickly in the Target Related to Non-threat Condition than the Target Related to Threat Condition, suggesting a tendency to attend towards non-threatening auditory information, the High Trait Anxiety Group showed the reverse tendency such that they tended to respond more quickly in the Target Related to Threat Condition than the Target Related to Non-threat Condition, suggesting a tendency to attend towards threatening auditory information. Thus, the nature of this interaction is consistent with a relatively inflated tendency to attend towards threat in the High Trait Anxiety Group[10].

In summary, assuming that relative response latency is a measure of threat-biased attention, the results of the preceding ANOVA demonstrate that the Attention/Initial/Auditory Task is sensitive to an anxiety-associated tendency to attend

---

[10] Despite this group difference in Semantic Association, it is important to note that post hoc paired samples t tests only revealed a significant effect of Target Semantic Association on the response times of participants in the Low Trait Anxiety Group, $t(48) = 2.65$, $p < .05$, and not on the response times of participants in the High Trait Anxiety Group, $t(53) = 1.62$, $p = .11$.

to threat. In particular, these results show that the Attention/Initial/Auditory Task is capable of distinguishing the High and Low Trait Anxiety Groups on the basis of their tendency to attend to threatening relative to non-threatening auditory information. In isolation this information is valuable, however it is also useful to determine whether the Attention/Initial/Auditory Task is sensitive to a linear relationship between anxiety and threat-biased attention. Therefore, in the following section Pearson Correlational Analyses, analysing the relationship between anxiety and biased attention towards threat are reported.

Linear Association between Anxiety and Biased attention: Pearson Correlational Analyses

Participant Characteristics. In parallel with the Correlational Analyses in Experiment 1, participants falling in the Mid-Trait Anxiety Band were reinstated to the analyses. The requirements of consistency of trait anxiety level and accuracy, described in the Comparison of Trait Anxiety Groups Section above, applied for inclusion in the correlational analyses, consequently the one participant from the Mid-Trait Anxiety Band who did not demonstrate above chance accuracy was excluded from this analysis.

Accuracy. In parallel with Experiment 1, a Pearson Correlational Analysis was conducted to ensure that there was no linear association between anxiety and the relative accuracy of responses to trials in the Target Related to Threat condition compared with trials in the Target Related to Non-threat condition.

The key measures included in this correlational analysis were identical those included in the Correlational Analysis of Accuracy in Experiment 1:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. An Accuracy Threat Bias Index: Computed in the manner described in Experiment 1.

Since the Trait Anxiety Indexes and the Accuracy Threat Bias Indexes were normally distributed, they were subjected to a Pearson Correlational Analysis. The correlation coefficient representing the linear relationship between trait anxiety and the Accuracy Threat Bias Index was $r = -.03$, $p = .73$. The size of this correlation coefficient suggests that there is no relationship between the two variables. Therefore, we may be confident that any variability in response latency in the following analysis are not due to variability in task difficulty.

Response Latency. We will now address whether or not the Attention/Initial/Auditory Task revealed a linear association between anxiety and threat-biased attention as measured by the relative response latency for targets correctly identified as related to threatening relative to non-threatening Prime Display stimuli.

The key measures included in this correlational analysis were identical to those employed in the Correlational Analysis of Response Latency in Experiment 1:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. A Threat Bias Index: Computed in the manner described in Experiment 1.

Like the Trait Anxiety Indexes, the Threat Bias Indexes were also normally distributed, therefore a Pearson Correlational Analysis was conducted. As shown in Figure 11 in Appendix B, the correlation between trait anxiety and the Threat Bias Index was computed, yielding a significant weak positive correlation coefficient, $r = .29$, $p < .001$. Assuming that the Threat Bias Index provides a measure of biased attention towards threat, this correlation coefficient suggests that the Attention/Initial/Auditory Task is sensitive to a weak linear association between trait anxiety and threat-biased attention. In particular, the results of the correlational analysis show that as trait anxiety increases, so too does biased attention towards threatening auditory information.

Discussion

Summary of Findings

This experiment was designed to assess the sensitivity of the Attention/Initial/Auditory Task to individual differences in biased attention towards threat. As was the case in Experiment 1, this was determined on the basis of the task's split half correlation coefficient and on its capacity to demonstrate threat-biased attention associated with individual differences in anxiety.

The significant split-half reliability estimate of the Attention/Initial/Auditory Task shows that its items are sufficiently related to one another for the purpose of the present research program.

Both the group comparison and the correlational analyses revealed that the Attention/Initial/Auditory Task is sensitive to anxiety-associated individual differences in biased attention towards threatening auditory stimuli. The patterns of response latency for trials in which the target was related to the threat Prime Display stimulus relative to trials in which the target was related to the non-threat Prime Display stimulus were significantly different for participants in the High and Low Trait Anxiety Groups. Assuming that this relative response latency provides a measure of threat-biased attention, this provides evidence that the Attention/Initial/Auditory Task is sensitive to anxiety-associated tendency to attend towards threat. A significant weak correlation between trait anxiety and the Threat Bias Index was also found. Therefore, assuming that the Threat Bias Index measures threat-biased attention, the correlational analysis also provided evidence that the Attention/Initial/Auditory Task is sensitive to a linear association between anxiety and biased attention towards threat.

Explanations for Findings

The sensitivity of the Attention/Initial/Auditory Task to anxiety-linked differences in threat-biased attention is parallel with past studies that also revealed an association between anxiety and biased attention to threat (reviewed in: MacLeod, 1999; MacLeod & Rutherford, 2004; Mathews & MacLeod, 1994, 2005). However, the results of the present experiment contrast with those of Experiment 1. While, the Attention/Initial/Auditory Task was found to be sensitive to anxiety-linked individual differences in threat-biased attention, its parallel visual task the Attention/Initial/Visual Task, analysed in the previous experiment, was not. The difference between the results of these two experiments is surprising given the similarity of the tasks' designs. The only difference between the tasks was the modality in which the stimuli were presented.

The present results may cast doubt upon the explanations offered for the absence of effects in Experiment 1 where it was suggested that the absence of anxiety-linked threat-biased attention on the Attention/Initial/Visual Task could be attributed to the long duration of the Prime Display-Target Display stimulus onset asynchrony, lack of personal relevance of the threatening stimuli, or the requirement that participants respond to the semantic meaning of the stimuli. However, since the Prime Display-Target Display stimulus onset asynchrony, the word stimuli, and the task requirements were identical in the Attention/Initial/Visual Task and Attention/Initial/Auditory Task, it seems unlikely that these explanations can explain the absence of anxiety-linked threat-biased attention in the Attention/Initial/Visual Task. But, in respect of the stimulus onset asynchrony, it is possible that the temporal parameters differentially affect performance on the visual and auditory tasks (Anderson & Holcomb, 1995; Rodd, 2004).

In conjunction with the results of Experiment 1, the results of this experiment have potentially relevant implications for the current literature investigating anxiety-associated information processing bias towards threat. Since anxiety-associated threat-biased attention was found on the Attention/Initial/Auditory Task but not on the Attention/Initial/Visual Task, this could suggest that anxiety-associated threat-biased attention, that is not initially constrained, occurs more prominently when stimuli are presented in the auditory rather than the visual modality. Of course, the substantial body of research demonstrating anxiety-linked biased attention towards threatening visual stimuli cannot be ignored (reviewed in: MacLeod, 1999; MacLeod & Rutherford, 2004; Mathews & MacLeod, 1994, 2005). However it is possible that anxiety-linked threat-biased attention is more greatly evident when the threatening stimuli are presented in the auditory rather than the visual modality. Since no previous research has directly compared anxiety-associated biased attention towards threatening visual information relative to threatening auditory information these results are of considerable importance.

The fact that anxiety-associated threat-biased attention is absent in the Attention/Initial/Visual Task, but present in the Attention/Initial/Auditory Task, may be due to the use of more ecologically valid stimuli in the Attention/Initial/Auditory Task. Extreme, immediate danger in the real world is more likely to be communicated via spoken rather than written language (Holcomb & Neville, 1990). Likewise, from an evolutionary perspective, it is only recently that threat could be signalled by written text (Holcomb & Neville, 1990; Matlin, 1994). Furthermore, a threatening word presented in a spoken voice may provide important contextual information that is absent from written text. Therefore, for the purpose of survival it seems logical that individuals would more efficiently attend to threatening auditory stimuli than threatening visual stimuli. As a consequence, attention that is biased towards threat may be enhanced for auditory by comparison with visual stimuli.

The findings of this experiment and of Experiment 1, are also consistent with the role of language acquisition in brain development. Research suggests that in conjunction with other early experiences, early achievement of language influences the organisation of the brain (Neville, Kutas, & Schmidt, 1982, cited in Holcomb & Neville, 1990). Since children typically acquire spoken language before written language, and since spoken language develops at a time of rapid brain development, while written language develops at a time of less rapid brain development, researchers argue that spoken language has a greater influence on cerebral organisation than written language (Holcomb & Neville, 1990). Consequently, they suggest that the cognitive processing of written language may partly rely on mental systems designed to process auditory language (Holcomb & Neville, 1990). In addition, whereas spoken language has been used by most people for millions of years, written language has only been used by a small proportion of people over several thousands of years (Holcomb & Neville, 1990; Matlin, 1994). Therefore, it is reasonable to suggest that auditory information may be more efficiently processed than visual information, and consequently that threat-biased attention may be more apparent in tasks involving auditory rather than visual stimuli.

Another explanation as to why anxiety-associated threat-biased attention appears to be more prominent for auditory rather than visual stimuli may be due to differences in the accessibility of the meaning of the visual relative to the auditory stimuli. In the present research, the auditory and the visual stimuli were matched so that each occurred for 650 ms. However, while the meaning of the visual stimuli may be accessed almost immediately on presentation, the meaning of the auditory stimuli cannot be determined until most if not all of the auditory signal is presented (Holcomb & Neville, 1990). As a result, the Attention/Initial/Auditory Task may have been more sensitive to participants' initial focus of attention than the Attention/Initial/Visual Task, in which participants may have been able to make multiple attention shifts between the two stimuli in each display.

Implications for Present Research Thesis

The main aim of this experiment was to determine the suitability of the Attention/Initial/Auditory Task for inclusion in the final analysis of the patterns of associations across all the experimental tasks presented in chapter 11. In accordance with the criteria set out in chapter 2, since the Attention/Initial/Auditory Task evidenced both statistically significant internal reliability and sensitivity to significant individual differences in threat-biased information processing associated with anxiety, it was included in all three stages of the final analysis of the patterns of associations between the eight experimental tasks in chapter 11.

Conclusions

In conclusion, the Attention/Initial/Auditory Task was found to possess significant internal reliability and to reveal significant individual differences in threat-biased attention associated with anxiety. The effects of the present study in conjunction with the absence of effects in Experiment 1 may suggest that threat-biased attention, that has not previously been constrained, occurs primarily with auditory stimuli. Since the Attention/Initial/Auditory Task evidenced both significant internal reliability and significant individual differences in threat-biased information processing associated with anxiety it will be included in all three stages of the final analysis of the patterns of associations between the eight experimental tasks in chapter 11.

CHAPTER 5

EXPERIMENT 3:

The Interpretation/Initial/Visual Task

Experiment 3 evaluated the sensitivity of the Interpretation/Initial/Visual Task to anxiety-linked individual differences in the tendency to interpret ambiguous stimuli as threatening. The Interpretation/Initial/Visual Task was designed to measure interpretation bias in a broad sense, reflecting either the ease with which ambiguous visual stimuli that possess both threatening and non-threatening meanings are initially interpreted as threatening relative to non-threatening, or the difficulty with which the initial interpretation of this ambiguous stimulus is revised away from threat and towards non-threat.

Aside from the experimental task employed, the design of Experiment 3 was exactly the same as those of the previous two experiments. The Interpretation/Initial/Visual Task was a variant of the General Approach to Bias Assessment, described in chapter 2. It was the interpretation parallel of the Attention/Initial/Visual Task (Experiment 1) and identical in design with the exception of the stimuli presented during the task's Prime Display. Instead of the unambiguous threatening word and unambiguous non-threatening word that were visually presented in the Prime Display of the Attention/Initial/Visual Task, an ambiguous word that possessed both a threatening and a non-threatening meaning was visually presented in the Prime Display of the Interpretation/Initial/Visual Task.

The sensitivity of the Interpretation/Initial/Visual Task to individual differences in biased information processing towards threat was determined on the basis of the same criteria as described in Experiment 1: significant internal reliability, and sensitivity to individual differences in information processing bias towards threat previously shown to be associated with anxiety (e.g., Calvo & Castillo, 2001; Hirsch & Mathews, 1997). In the case of the Interpretation/Initial/Visual Task, the latter criterion specifically required that the task was sensitive to anxiety-associated threat-biased interpretation. If the Interpretation/Initial/Visual Task is sensitive to anxiety-linked threat-biased interpretation, then compared to the low trait anxiety group, the high trait anxiety group would evidence disproportionately speeded responses to targets related to the threatening relative to the non-threatening meaning of the Prime Display. Similarly, if the tendency to selectively interpret ambiguous stimuli as threatening is a linear function of anxiety, then a positive linear correlation will be found between trait anxiety and the index of threat-biased interpretation of ambiguous stimuli. As in the previous experiments, the Interpretation/Initial/Visual Task will be considered sensitive to anxiety-associated biased interpretation towards threat if *either* a significant trait anxiety group difference, *or* a significant linear association between anxiety and an index of threat-biased interpretation is found.

Consistent with the approach adopted with all the experimental tasks, dependent on whether the Interpretation/Initial/Visual Task demonstrated the aforementioned criteria, determined its inclusion in the final analysis of the associations between the experimental tasks, presented in chapter 11.

Method

Participants

Participants were selected in the manner outlined in chapter 2. This gave rise to a sample of 140 participants, who reported a wide range of trait anxiety scores from 22 to 75. The mean trait anxiety score was 42.2, *SD* = 9.3 (screened using the STAI-T;

Spielberger et al., 1983)[11]. Participants included 59 males and 81 females. Their mean age was 20.6, *SD* = 5.3.

Materials

Trait Anxiety Assessment Instrument

As in all of the experiments, trait anxiety was assessed using the STAI-T (Spielberger et al., 1983).

Word-stimuli

The word-stimuli used in the Interpretation/Initial/Visual Task were taken from the experimental stimuli described in Appendix A, and were those labelled visual *homonyms*, visual *threat associates* and visual *non-threat associates* in row i. of Table 1 in chapter 2. The visual *threat associates* and visual *non-threat associates* were identical to those described in the Attention/Initial/Visual Task in Experiment 1. As will be recalled from chapter 2, a visual *homonym* possessed both a threatening and a non-threatening meaning and was employed as the Prime Display stimulus. For the purpose of the present experiment, visual *homonyms* will be referred to as Prime Display stimuli. It will also be recalled from chapter 2 that either pairs of visual *threat associates* or pairs of visual *non-threat associates* were employed as Target Display stimuli. For the purpose of the present experiment, visual *threat associates* will be referred to as threat Target Display stimuli, while visual *non-threat associates* will be referred to as non-threat Target Display stimuli. As outlined in chapter 2, the threatening meanings of the Prime Display stimuli were judged significantly more negative than their corresponding non-threatening meanings, the Prime Display stimuli were rated as semantically related to both their corresponding threat Target Display

[11] This mean trait anxiety score was comparable with the STAI-T college student norm of 40, *SD* = 10 (Spielberger et al., 1983).

stimuli and Non-threat Target Display stimuli, and there was no significant difference between the means of these ratings.

Experimental task

The Interpretation/Initial/Visual Task was identical to the Attention/Initial/Visual Task described Experiment 1, with the exception that the Prime Display of the present task contained a *homonym* rather than a *threat synonym* and a *non-threat synonym*. To parallel the presentation format of the Prime Display in the Attention/Initial/Visual Task, in the Interpretation/Initial/Visual Task the single Prime Display stimulus was presented in duplicate in two spatially separate locations, one just above and one just below the centre of the screen. As in the Attention/Initial/Visual Task, the vertical distance between these locations was 2.80 cm, which subtended less than a 2 degree visual angle of separation.

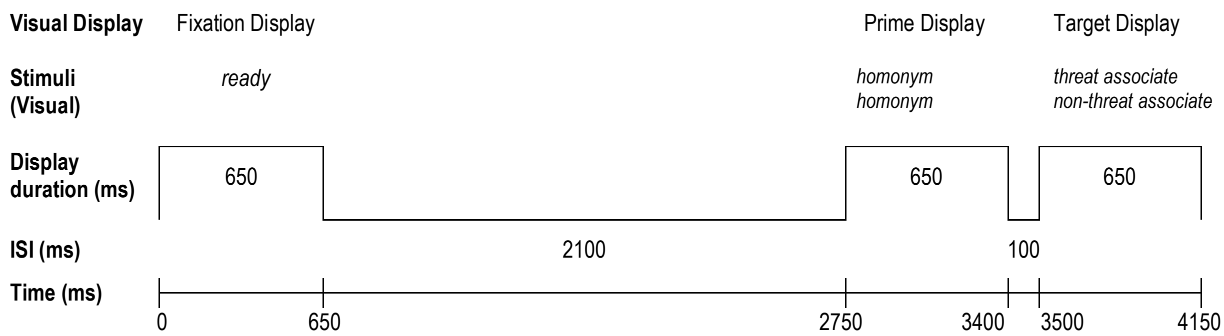
One consequence of presenting a *homonym* in the Prime Display of the Interpretation/Initial/Visual Task, rather than a *threat synonym* and a *non-threat synonym*, as in the Attention/Initial/Visual Task, was that it altered the possible presentation conditions of the trials. In parallel with the Attention/Initial/Visual Task, the critical factor governing the conditions of the Interpretation/Initial/Visual Task was Target Semantic Association. As in Experiment 1, on half of the trials, the target was related to the threatening meaning presented in the Prime Display, and on half of the trials the target was related to the non-threatening meaning presented in the Prime Display. Likewise, as in Experiment 1, the Target Display in the Interpretation/Initial/Visual Task was presented equally often in the two possible stimulus locations so as to ensure that any effect of Target Semantic Association was not confounded by stimulus position. The nested combination of these two, two-level factors gave rise to four unique presentation conditions.

Since the Interpretation/Initial/Visual Task was identical to the Attention/Initial/Visual Task in Experiment 1, aside from the stimuli presented in the Prime Display, trials in the Interpretation/Initial/Visual Task were organised in the same manner as in the Attention/Initial/Visual Task. Similarly, the experimental stimuli of the Interpretation/Initial/Visual Task were allocated to the presentation conditions in the same manner as in the Attention/Initial/Visual Task. Further, the number of trials and trial blocks, and the balancing of presentation conditions across trial blocks in the Interpretation/Initial/Visual Task were organised in the same way as in the Attention/Initial/Visual Task.

In summary, as displayed in Figure 4, trials in the Interpretation/Initial/Visual Task included a Prime Display that contained a *homonym*, followed by a Target Display that contained either two *threat associates*, or two *non-threat associates*, one of which, the target, was semantically related to one meaning in the Prime Display. The participants' task was to identify the location of the target.

Figure 4

The progression of a single trial in the Interpretation/Initial/Visual Task.



Experimental hardware.

The stimuli were displayed on a 35 cm NEC Multi-Sync V530 monitor, controlled by a 952 MHz Intel Celeron Processor.

Procedure

The Procedure was identical to that described in Experiment 1.

Results

Overview

In parallel with Experiments 1 and 2, the internal reliability of the Interpretation/Initial/Visual Task is first reported, after which the sensitivity of the Interpretation/Initial/Visual Task to anxiety-associated threat-biased interpretation is reported.

Exclusion of Inaccurate Participants

As with the results of the previous experiments, to ensure that participants complied with task instructions, their accuracy (percentage of correct responses across the task's 256 trials) was determined. A single sample t test revealed that the mean percentage accuracy across all participants was well above the chance level of 50%, $t(139) = 52.81$, $p < .001$. Since all participants demonstrated accuracy above this level they were all included in the analyses.

Internal Reliability

The internal reliability of the Interpretation/Initial/Visual Task was determined using the approach described in Experiment 1.

Using the Spearman-Brown correction, the split-half reliability of the Interpretation/Initial/Visual Task was estimated as $r = .50$, $p < .001$. This internal reliability coefficient reflects significant moderate internal consistency, suggesting that the content of the task's items tend to be consistent with one another. Given the high statistical significance of the split half reliability coefficient it is considered to represent an acceptable level of internal reliability for the present research. The following section considers the sensitivity of the Interpretation/Initial/Visual Task to anxiety-associated individual differences in interpretation bias to threat.

The Sensitivity of the Interpretation/Initial/Visual Task to Anxiety-associated Individual Differences in Threat-Biased Interpretation

This part of the results presents the analysis of the sensitivity of the Interpretation/Initial/Visual Task to anxiety-associated threat biased interpretation. Analyses comparing the characteristics, accuracy and response latencies of the high and low trait anxiety groups are reported first. The correlation between trait anxiety and an index of threat-biased interpretation is then reported.

Comparison of Trait Anxiety Groups: Analysis of Variance

Participant Characteristics. High and low trait anxiety groups were obtained in the manner described in Experiment 1.

Consistent with the previous experiments, participants whose trait anxiety scores at the experimental test session were inconsistent with their classification as either high or low trait anxiety level at screening, were excluded from further analysis. This was achieved using the same procedure as that outlined in Experiment 1. As a result, seven participants in the Low Trait Anxiety Group whose trait anxiety scores at the experimental test session fell above the median trait anxiety score (STAI-T = 40) were eliminated, as were seven participants in the High Trait Anxiety Group whose trait anxiety scores at the experimental test session fell below the median trait anxiety score.

The characteristics of the resulting two Trait Anxiety Groups at the experimental test session are presented in Table 10.

Table 10

Participant Characteristics at the Experimental Test Session (Standard Deviations in Parentheses)

	N	Number of Males	Number of Females	Mean Age (Years)	Mean STAI-T Trait Anxiety
Low Trait Anxiety Group	49	20	29	21.8 (6.5)	31.8 (4.7)
High Trait Anxiety Group	49	16	33	19.7 (3.6)	51.7 (5.9)

An independent samples *t* test showed that during the experimental test session participants in the High and Low Trait Anxiety Groups differed significantly in terms of trait anxiety as measured by the STAI-T (Spielberger et al., 1984) $t(96) = 18.26$, $p < .001$. A Chi square test for independence, using Yates' Continuity Correction, showed that there was no significant difference between the two Anxiety Groups in terms of the distribution of males and females, X^2 (1) = .39, $p = .53$. However, an independent samples *t* test showed a marginally significant difference between the groups in age, $t(96) = 1.97$, $p = .05$. Therefore when the task performance of the groups is compared an additional analysis will be conducted to assess the impact of age on task performance.

Accuracy. Table 11 displays the two participant groups' mean percentage accuracy for the Target Related to Threat condition and the Target Related to Non-threat condition.

Table 11

Mean Percentage of Correct Relatedness Judgement Responses (Standard Deviations in Parentheses)

Target Semantic Association Factor	Low Trait Anxiety Group	High Trait Anxiety Group
Target Related to Threat	87.95 (6.42)	85.30 (10.91)
Target Related to Non-threat	91.34 (4.56)	87.77 (9.38)

As in the previous experiments, to confirm that the accuracy of the Trait Anxiety Groups did not differ as a function of experimental condition, a repeated measures ANOVA, considering the effects of Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat) and Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) on accuracy was conducted. A marginally significant main effect of Trait Anxiety Group was found, $F(1,96) = 3.83$, $p = .05$, meaning that on average participants in the Low Trait Anxiety Group tended to be more accurate than participants in the High Trait Anxiety Group. Therefore, if there is an effect of Trait Anxiety Group on response latency, it will be important to ensure that this is not due to a speed-accuracy trade-off. A main effect of Target Semantic Association was found, $F(1,96) = 37.28$, $p < .001$, such that the mean accuracy of all participants was significantly greater in the Target Related to Non-threat condition, than in the Target Related to Threat condition. Therefore, in the analysis of response latency, if there is an effect of Target Semantic Association on response latency, it will also be necessary to ensure that this is not due to a speed-accuracy trade-off. Finally, there was no interaction between Trait Anxiety Group and Target Semantic Association, $F(1,96) = .92$, $p = .33$, such that this effect did not differ for participants in the High

Trait Anxiety Group compared to those in the Low Trait Anxiety Group[12]. Therefore, there was no indication that the High and Low Trait Anxiety Groups differed in terms of their patterns of accuracy on the task.

Response Latency. The preceding analyses confirmed that the participants included in the analyses reported trait anxiety at test time that was representative of the Trait Anxiety Group to which they had been allocated. Likewise, they showed that the participants completed the Interpretation/Initial/Visual Task as instructed, and that the accuracy of the two Trait Anxiety Groups did not differ. Therefore, the issue of key importance, that is, whether or not the Interpretation/Initial/Visual Task revealed anxiety-associated differences in threat-biased interpretation, is now considered.

In parallel with the measurement of threat-biased attention in Experiments 1 and 2, threat-biased interpretation was measured by the differential speed with which participants correctly identified the target stimulus in the Target Related to Non-threat condition relative to the Target Related to Threat condition. The median response latency for each participant to correctly identify the target in each experimental condition was calculated. The resulting median response latencies are presented in Table 12.

Table 12

Average Median Response Latency (in ms) to Correctly Identify Targets (Standard Deviations in Parentheses)

Target Semantic Association Factor	Low Trait Anxiety Group	High Trait Anxiety Group
Target Related to Threat	1347.25 (200.45)	1455.99 (405.29)
Target Related to Non-threat	1289.46 (182.10)	1372.86 (296.15)

[12] To account for any effect of age, a hierarchical regression was conducted. The hierarchical regression analysis included age and Trait Anxiety Group as predictors, and an Accuracy Threat Bias Index (the mean percentage of correct responses on trials in the Target Related to Non-threat condition, subtracted from the mean percentage of correct responses on trials in the Target Related to Threat condition) as the dependent variable. This analysis showed that age did not impact on the accuracy of the two groups, $R^2 = .02$, $F(1,95) = .99$, $p = .32$.

These reaction time data were analysed using a repeated measures ANOVA considering the effects of the between-subjects factor, Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) and the within-subjects factor, Target Semantic Association Factor (Target Related to Threat vs. Target Related to Non-threat).

A main effect of Target Semantic Association was found, such that the median response latency was significantly faster in the Target Related to Non-threat Condition than the Target Related to Threat Condition, $F(1,96) = 21.35$, $p < .001$. This effect matches the effect of Target Semantic Association found in the preceding accuracy analysis. That is, participants were more accurate in the Target Related to Non-threat condition, relative to the Target Related to Threat Condition. Assuming that relative response latency is a measure of threat-biased interpretation, this suggests that on average all participants were more likely to interpret the ambiguous Prime Display stimulus as non-threatening rather than threatening. No main effect of Trait Anxiety Group was found $F(1,96) = .77$, $p = .08$, meaning that the median response latency of participants in the High Trait Anxiety Group was not significantly different to the median response latency of participants in the Low Trait Anxiety Group. Finally, of greatest relevance to the issue under investigation was that no significant interaction between Target Semantic Association and Trait Anxiety Group was found, $F(1,96) = .69$, $p = .40$. This means that there was no group difference in the effect of Target Semantic Association. That is, there was no evidence of differential interpretation bias towards threat between the groups[13].

If we assume that relative response latency is a measure of threat-biased interpretation, the preceding results suggest that the Interpretation/Initial/Visual Task is

[13] A hierarchical regression, including age and Trait Anxiety Group as predictors, and a Threat Bias Index (computed in the manner described in the Internal Reliability section) as the dependent variable, showed that age did not impact on the correct response times of the two groups, $R^2 = .008$, $F(1,95) = .05$, $p = .82$.

not sensitive to anxiety-associated threat-biased interpretation of ambiguous visual stimuli. However, since analysis of variance only measures group differences, it remains possible that the Interpretation/Initial/Visual Task is sensitive to a linear relationship between anxiety and threat-biased interpretation, that was not picked up by the analysis of variance. Therefore, in the following section Pearson Correlational Analysis is used to analyse the relationship between anxiety and the biased interpretation of ambiguous stimuli as threatening.

Linear Association between Anxiety and Biased Interpretation: Pearson Correlational Analyses

Participant Characteristics. In parallel with the Correlational Analyses in the previous experiments, participants falling in the Mid-Trait Anxiety Band were reinstated to the analyses. The requirements of consistency of trait anxiety level and accuracy, described in the Comparison of Trait Anxiety Groups section above, applied for inclusion in the correlational analyses. Since all participants falling within the Mid-Trait Anxiety Band met these requirements, all were included.

Accuracy. As was the case in the previous experiments, a Pearson Correlational Analysis was conducted to ensure that there was no linear association between anxiety and the relative accuracy of responses to trials in the Target Related to Threat condition compared with trials in the Target Related to Non-threat condition.

Computation of the key measures included in this correlational analysis was identical to the computation of the key measures included in the Correlational Analyses of Accuracy in the previous experiments. As will be recalled these were:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. An Accuracy Threat Bias Index: Computed in the manner described in Experiment 1.

Since, the Trait Anxiety Indexes and the Accuracy Threat Bias Indexes were normally distributed, Pearson correlation coefficients were calculated. The correlation coefficient representing the linear relationship between trait anxiety and the Accuracy Threat Bias Index was $r = .07$, $p = .38$. The very small size of this correlation coefficient suggests that there is no relationship between the two variables. In light of this correlation coefficient, we may be confident that any differences in response latency in the following analysis are not due to differences in task difficulty.

Response Latency. Since the preceding analyses confirmed that there is no linear association between anxiety and the relative accuracy for the Target Related to Threat condition and the Target Related to Non-threat condition on the Interpretation/Initial/Visual Task, we will now address whether or not the Interpretation/Initial/Visual Task revealed a linear association between anxiety and threat-biased interpretation as measured by the relative response latency for targets correctly identified as related to threatening relative to non-threatening Prime Display stimuli.

The key measures included in this correlational analysis were identical to those employed in the Correlational Analyses of Response Latency in the two previous experiments. As will be recalled, these were:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. A Threat Bias Index: Computed in the manner described in the preceding Internal Reliability section.

Like the Trait Anxiety Indexes, the Threat Bias Indexes were normally distributed. The Pearson correlation coefficient representing the linear relationship between trait anxiety and the Threat Bias Index was $r = -.02$, $p = .73$. The very small size of this correlation coefficient indicates no relationship between the two variables. Assuming that the Threat Bias Index provides a measure of threat-biased interpretation, this correlation coefficient provides no evidence that the Interpretation/Initial/Visual Task is sensitive to a linear association between trait anxiety and threat-biased interpretation.

Discussion

Summary of Findings

Experiment 3 was designed to assess the sensitivity of the Interpretation/Initial/Visual Task to trait anxiety-associated individual differences in threat-biased interpretation. As was the case in the two previous experiments, this was determined on the basis of the Interpretation/Initial/Visual Task's internal reliability and on its capacity to demonstrate threat-biased interpretation associated with individual differences in anxiety.

The Interpretation/Initial/Visual Task's significant moderate internal reliability coefficient shows that the task possesses an acceptable level of internal reliability for the present research program.

Neither the results of the group comparison, nor the results of the correlational analysis provided evidence that the Interpretation/Initial/Visual Task is sensitive to anxiety-associated threat-biased interpretation of ambiguous visual stimuli. The response latency for trials in which the target was related to the Prime Display's threatening meaning, relative to trials in which the target was related to the Prime Display's non-threatening meaning, were similar for participants in the High and Low Trait Anxiety Groups. Therefore, assuming that relative response latency measures threat-biased interpretation, the Interpretation/Initial/Visual Task was not sensitive to anxiety group differences in threat-biased interpretation. Likewise, no correlation between trait anxiety and the Threat Bias Index was found. Thus, if the Threat Bias Index measures threat-biased interpretation, this suggests that the Interpretation/Initial/Visual Task is insensitive to a linear association between threat-biased interpretation and anxiety.

Explanations for Findings

Given the extensive literature demonstrating individual differences in anxiety-associated interpretation bias towards threat (reviewed in: MacLeod, 1999; MacLeod & Rutherford, 2004; Mathews & MacLeod, 1994, 2005), the present null results may arguably be attributed to the insensitivity of the Interpretation/Initial/Visual Task. The present section considers possible reasons for this insensitivity.

It is possible that the insensitivity of the Interpretation/Initial/Visual Task to anxiety-associated threat-biased interpretation can be explained in the same terms used to explain the insensitivity of the Attention/Initial/Visual Task in Experiment 1, to anxiety-associated threat-biased attention. As was the case in Experiment 1, the present experimental stimuli may not have been of sufficient personal relevance to the participants to produce threat-biased interpretation. Research by Calvo and colleagues (Calvo & Castillo, 1997; Calvo et al., 1994) has shown enhanced anxiety-linked threat-biased interpretation when using experimental stimuli relevant to the participant's personal concerns. These findings are consistent with research on threat-biased attention (e.g., Hope et al., 1990; Mattia et al., 1993). However, other researchers have found the opposite effect – that anxiety-associated threat-biased interpretation occurs in response to generally threatening material rather than threatening material specific to the individual's concerns (Eysenck et al., 1991; Mathews, Richards &

Eysenck, 1989). Therefore, the generally threatening nature of the experimental stimuli may not fully explain the insensitivity of the Interpretation/Initial/Visual Task to anxiety-associated threat-biased interpretation.

Other reasons for the insensitivity of the Interpretation/Initial/Visual Task to variability in anxiety may be clarified through the examination of measures of threat-biased interpretation that have been found to be sensitive to individual differences in anxiety. One measure of the initial interpretation of visual stimuli that has been shown to be sensitive to variability in trait anxiety and is similar in design to the Interpretation/Initial/Visual Task, is the lexical priming task (Richards & French, 1992). The primary difference between the lexical priming task and the Interpretation/Initial/Visual Task is the need to access the meaning of the homograph to be able to perform the task. In the lexical priming task participants classify letter strings that follow homographs with threatening and non-threatening meanings, as either words or non-words. Although studies have found that participants' lexical decisions are influenced by their interpretation of the homograph (Calvo et al., 1994), the performance of the task does not explicitly require that participants access the homograph's meanings. Conversely, in the Interpretation/Initial/Visual Task participants are specifically asked to select from among two words the target word that is semantically related to a preceding homograph. As such, it is not possible to complete the Interpretation/Initial/Visual Task without accessing the homograph's meaning. If anxiety-linked variability in threat-biased interpretation reflects individual differences in the extent to which the meaning of an ambiguous stimulus is cognitively processed, the need to access the meaning of the homograph in the Interpretation/Initial/Visual Task may obscure these anxiety-linked differences. However, the need to access the homograph's meaning may not fully explain the absence of anxiety-linked interpretation bias on the Interpretation/Initial/Visual Task. For instance, the relatedness judgement task has been found sensitive to variability in anxiety, and yet requires participants select from among two words the target that was related to a preceding homograph (Wilson et al., 2006).

Another explanation for the insensitivity of the Interpretation/Initial/Visual Task to anxiety-linked differences in threat-biased interpretation is highlighted by comparing the presentation duration of the target stimuli of the Interpretation/Initial/Visual Task with that of Richards and French’s (1992) lexical priming task. In the lexical priming task, the letter string to which participants are asked to respond remains on the screen until the participant has determined whether or not it is a word. Conversely, in the Interpretation/Initial/Visual Task, the two Target Display words only remain visible for 650 ms regardless of whether or not the participant has responded. This limited stimulus presentation duration was maintained across all experiments in the present research so that the stimuli in the auditory and visual tasks were comparable. However, it is possible that this limited presentation duration meant that the task relied on cognitive resources other than interpretative resources (e.g., memory), thereby limiting the tasks’ sensitivity to biased interpretation.

Another possible explanation for the failure of the Interpretation/Initial/Visual Task to evidence anxiety-linked threat-biased interpretation comes to light when considering the results of the present experiment in combination with the results of both Experiments 1 and 2. It is possible that anxiety-associated biased information processing, that has not been previously constrained, is more greatly evident when word stimuli are presented in the auditory modality. Therefore, the absence of anxiety-linked effects in the present experiment may be because the word stimuli in the Interpretation/Initial/Visual Task were presented visually on a computer screen. This explanation will be addressed indirectly in the following experiment in which the effect of anxiety on the performance of a task identical to the Interpretation/Initial/Visual Task, but including auditory stimuli, is assessed.

Implications for Present Research Thesis

Whatever the reason for the insensitivity of the Interpretation/Initial/Visual Task to anxiety-linked individual differences in threat-biased interpretation, the ultimate purpose of this experiment was to determine the suitability of the Interpretation/Initial/Visual Task for inclusion in the final analysis of the patterns of associations across all the experimental tasks presented in chapter 11. In line with the criteria set out in chapter 2, since the Interpretation/Initial/Visual Task evidenced significant internal reliability, but did not demonstrate anxiety-associated individual differences in threat-biased interpretation, it was included in the first and second stages of the final analysis.

Conclusions

In conclusion, the results of Experiment 3 did not provide evidence that the Interpretation/Initial/Visual Task was sensitive to individual differences in threat-biased interpretation. The Interpretation/Initial/Visual Task demonstrated significant internal reliability, but failed to reveal anxiety-associated individual differences in threat-biased interpretation. The absence of these effects may be due to the lack of personal relevance of the threatening stimuli, the need to access the homographs' meanings to perform the task, the presentation duration of the target stimuli, or the use of visual word stimuli. Since the Interpretation/Initial/Visual Task possessed significant internal reliability, but was inadequately sensitive to anxiety-linked individual differences in interpretation bias towards threat it will only be included in the first and second stages of the final analysis of the patterns of associations between the experimental tasks, presented in chapter 11.

CHAPTER 6

EXPERIMENT 4:

The Interpretation/Initial/Auditory Task

Experiment 4 evaluated the sensitivity of the Interpretation/Initial/Auditory Task to anxiety-linked variability in threat-biased interpretation of ambiguous threat/non-threat auditory word stimuli. Like the Interpretation/Initial/Visual Task in Experiment 3 and most conventional measures of information processing bias (Fox, 1994), the Interpretation/Initial/Auditory Task was designed to measure interpretation bias broadly, and therefore could reflect either the ease with which ambiguous threat/non-threat auditory stimuli are initially interpreted as threatening relative to non-threatening, or the difficulty with which the initial interpretation of this ambiguous stimulus is revised away from threat and towards non-threat.

The design of Experiment 4 was identical to that of the preceding three experiments with the exception of the experimental task, which in Experiment 4 was the Interpretation/Initial/Auditory Task. The Interpretation/Initial/Auditory Task was a variant of the General Approach to Bias Assessment described in chapter 2. It was the auditory parallel of the Interpretation/Initial/Visual Task (Experiment 3) and identical in design except that the stimuli were presented in the auditory modality. Therefore in the Interpretation/Initial/Auditory Task each display contained auditory stimuli presented via earphones.

As in the previous experiments, two criteria determined the sensitivity of an experimental task to individual differences in information processing biased towards threat. One criterion required that the task displayed significant internal reliability, while the other required that the task was sensitive to individual differences in information processing bias towards threat previously shown to be associated with anxiety (e.g., Calvo & Castillo, 2001; Hirsch & Mathews, 1997). In the case of the Interpretation/Initial/Auditory Task, the latter criterion specifically required that the task was sensitive to anxiety-associated threat-biased interpretation. If the Interpretation/Initial/Auditory Task is sensitive to the tendency of individuals with high trait anxiety to selectively interpret ambiguous stimuli as threatening, then when compared with participants in the low trait anxiety group, the responses of participants in the high trait anxiety group would be disproportionately speeded for targets related to the threatening Prime Display meaning relative to the non-threatening Prime Display meaning. Similarly, if the tendency to selectively interpret ambiguous stimuli as threatening is a linear function of anxiety, then we would find a positive linear correlation between trait anxiety and an index of biased interpretation to threat. As in the previous experiments, if *either* a significant anxiety group difference, *or* a significant linear association between anxiety and an index of threat-biased interpretation is found, the Interpretation/Initial/Auditory Task will be considered sensitive to anxiety-associated biased interpretation towards threat.

Consistent with the approach adopted with all the experimental tasks, dependent on whether the Interpretation/Initial/Auditory Task demonstrated the aforementioned criteria, determined its inclusion in the final analysis of the associations between the experimental tasks, presented in chapter 11.

Method

Participants

Participant selection was carried out in the manner outlined in chapter 2. This resulted in a sample who reported a wide range of trait anxiety scores from 24 to 65. The mean trait anxiety score was 42.1, *SD* = 9.8 (screened using the STAI-T;

Spielberger et al., 1983)[14]. Participants included 50 males and 90 females. Their mean age was 19.5, *SD* = 3.8.

Materials

Trait Anxiety Assessment Instrument

As in the previous experiments, trait anxiety was assessed using the STAI-T (Spielberger et al., 1983).

Word-stimuli

The word-stimuli used in the Interpretation/Initial/Auditory Task were taken from the quintets of experimental stimuli described in Appendix A, and included the auditory *homonyms*, auditory *threat associates* and auditory *non-threat associates* represented in row v. of Table 1 in chapter 2. These word-stimuli were identical to those described in the Interpretation/Initial/Visual Task from Experiment 3 with the exception that they were displayed in their auditory form. For the purpose of the present experiment: auditory *homonyms* will be referred to as Prime Display stimuli; auditory *threat associates* will be referred to as threat Target Display stimuli; and auditory *non-threat associates* will be referred to as non-threat Target Display stimuli.

Experimental task

The Interpretation/Initial/Auditory Task was identical to the Experiment 3 Interpretation/Initial/Visual Task with the exception that the word stimuli were auditory rather than visual in modality and therefore were presented via earphones. The perceptual characteristics of the auditory word stimuli were the same as those used in the Attention/Initial/Auditory Task in Experiment 2. The two word stimuli in the Target Display were presented simultaneously, one in each earphone, whereas the single homonym in the Prime Display was presented simultaneously via both earphones.

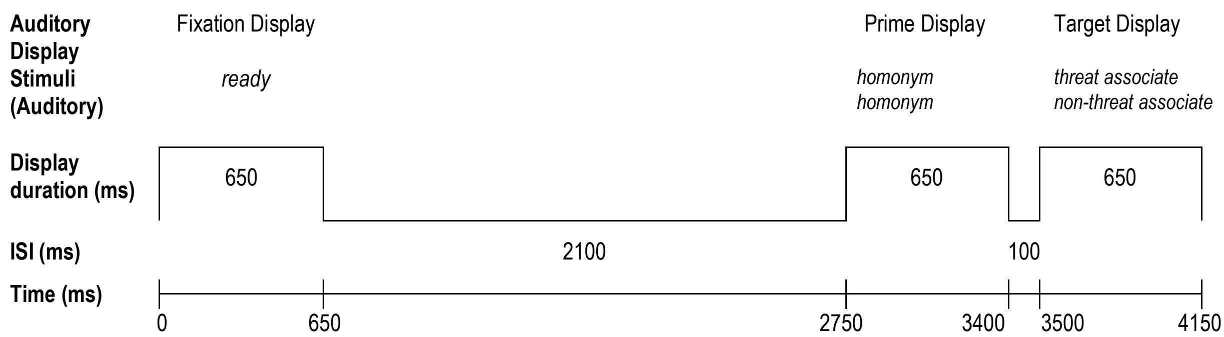
---

[14] This mean trait anxiety score was comparable with the STAI-T college student norm of 40, *SD* = 10 (Spielberger et al., 1983).

In summary, as shown in Figure 5, the task included a Prime Display that contained a *homonym*, followed by a Target Display that contained two *associates*, one of which, the target, was semantically related to one meaning in the Prime Display. The participants' task was to identify the location of the target.

Figure 5

The progression of a single trial in the Interpretation/Initial/Auditory Task.



Experimental hardware.

The stimuli were heard via Pro-Luxe KT-424 stereophonic earphones. Their presentation was controlled by a 952 MHz Intel Celeron Processor.

Procedure

The Procedure was identical to that described in Experiment 1, with two exceptions. First, participants wore earphones for the duration of the task. Second, participants were instructed to indicate their responses using different keys to those used in Experiment 1. If the target in the second display was presented via the left earphone, participants were directed to press the left-pointing arrow key, while if the target in the second display was presented via the right earphone, participants were directed to press the right-pointing arrow key.

Results

Overview

In parallel with the preceding experiments, the internal reliability of the Interpretation/Initial/Auditory Task is first reported, after which the sensitivity of the Interpretation/Initial/Auditory Task to anxiety-associated threat-biased interpretation is reported.

Exclusion of Inaccurate Participants

As with the results of the previous experiments, to ensure that participants complied with task instructions, their accuracy (percentage of correct responses across the task's 256 trials) was determined. A single sample t test revealed that the mean percentage accuracy across all participants was well above the chance level of 50%, $t(139) = 47.47$, $p < .001$. Since all participants demonstrated accuracy above this level they were all included in the analyses.

Internal Reliability

The Interpretation/Initial/Auditory Task's internal reliability was calculated in the manner described in Experiment 1.

Using the Spearman-Brown split-half formula, the split-half reliability of the Interpretation/Initial/Auditory Task was estimated as $r = .49$, $p < .001$. This shows that the Interpretation/Initial/Auditory Task has significant moderate internal consistency. This split half reliability coefficient suggests that the content of the task's items tend to be consistent with one another. Since the split half reliability coefficient meets statistical significance, it is considered to represent an acceptable level of internal reliability for the present research. The following section is intended to ascertain whether the task is sensitive to individual differences in anxiety.

The Sensitivity of the Interpretation/Initial/Auditory Task to Anxiety-associated Individual Differences in Threat-Biased Interpretation

This part of the results presents the analysis of the sensitivity of the Interpretation/Initial/Auditory Task to anxiety-associated threat biased interpretation. Analyses comparing the characteristics, accuracy and response latencies of the high and low trait anxiety groups are reported first. The correlation between trait anxiety and an index of threat-biased interpretation is then reported.

Comparison of Trait Anxiety Groups: Analysis of Variance

Participant Characteristics. High and low trait anxiety groups were obtained in the manner described in the previous experiments.

As was the case in the previous experiments, participants whose trait anxiety scores at the experimental test session were inconsistent with their classification as either high or low trait anxiety level at screening, were excluded from further analysis. This was achieved using the method described in Experiment 1. As a result, three participants in the Low Trait Anxiety Group whose trait anxiety scores at the experimental test session fell above the median trait anxiety score (STAI-T = 40) were eliminated, as were six participants in the High Trait Anxiety Group whose trait anxiety scores at the experimental test session fell below the median trait anxiety score.

The characteristics of the resulting two Trait Anxiety Groups at the experimental test session are presented in Table 13.

Table 13

Participant Characteristics at the Experimental Test Session (Standard Deviations in Parentheses)

	N	Number of Males	Number of Females	Mean Age (Years)	Mean STAI-T Trait Anxiety
Low Trait Anxiety Group	53	18	35	20.3 (5.5)	31.8 (4.1)
High Trait Anxiety Group	50	14	36	19.5 (2.6)	52.5 (7.1)

An independent samples *t* test showed that at the time of the experimental test session, the mean STAI-T (Spielberger et al., 1984) score of participants in the High Trait Anxiety Group was significantly greater than the mean STAI-T score of participants in the Low Trait Anxiety Group, $t(101) = 18.02$, $p < .001$. Another independent samples *t* test revealed no significant difference between the groups in age, $t(101) = .93$, $p = .35$. Likewise, a Chi square test for independence, using Yates' Continuity Correction, showed no significant difference between the two Anxiety Groups in terms of the distribution of males and females, X^2 (1) = .19, $p = .66$.

Accuracy. Table 14 displays the two participant groups' mean percentage accuracy for the Target Related to Threat condition and the Target Related to Non-threat condition.

Table 14

Mean Percentage of Correct Relatedness Judgement Responses (Standard Deviations in Parentheses)

Target Semantic Association Factor	Low Trait Anxiety Group	High Trait Anxiety Group
Target Related to Threat	83.61 (8.12)	81.66 (11.75)
Target Related to Non-threat	85.72 (8.05)	85.08 (9.58)

As in the previous experiments, to ensure that the accuracy of the Trait Anxiety Groups did not differ as a function of experimental condition, a repeated measures ANOVA, considering the effects of Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat) and Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) on accuracy was conducted. No main effect of Trait Anxiety Group was found, $F(1,101) = .52$, $p = .46$, meaning that there was no significant difference between the mean accuracy of participants in the High and Low Trait Anxiety Groups. A main effect of Target Semantic Association was found, $F(1,101) = 24.95$, $p < .001$, such that the mean accuracy of all participants was significantly greater in the Target Related to Non-threat condition, than in the Target Related to Threat condition. Therefore, if there is an effect of Target Semantic Association on response latency, it will be important to ensure that this is not due to a speed-accuracy trade-off. Finally, as desired there was no interaction between Trait Anxiety Group and Target Semantic Association, $F(1,101) = 1.40$, $p = .23$. This means that the mean accuracy of participants in the High Trait Anxiety Group was not significantly different to the mean accuracy of participants in the Low Trait Anxiety Group in either the Target Related to Threat condition, or in the Target Related to Non-threat condition.

Response Latency. The preceding analyses confirmed that the participants included in the analyses reported trait anxiety at test time that was representative of the Trait Anxiety Group to which they had been allocated. Likewise, the analyses showed that the participants completed the Interpretation/Initial/Auditory Task as instructed, and that the accuracy of the two Trait Anxiety Groups did not differ. Therefore, the issue of key importance, whether or not the Interpretation/Initial/Auditory Task revealed anxiety-associated differences in interpretation bias, is now considered.

As in Experiment 3, selective interpretation was measured by the differential speed with which participants correctly identified the target stimulus in the Target Related to Non-threat condition relative to the Target Related to Threat condition. As displayed in Table 15, the median response latency for each participant to correctly identify the target in each experimental condition was calculated.

Table 15

Average Median Response Latency (in ms) to Correctly Identify Targets (Standard Deviations in Parentheses)

Target Semantic Association Factor	Low Trait Anxiety Group	High Trait Anxiety Group
Target Related to Threat	1767.07 (502.54)	1742.56 (511.55)
Target Related to Non-threat	1647.69 (441.32)	1684.45 (491.54)

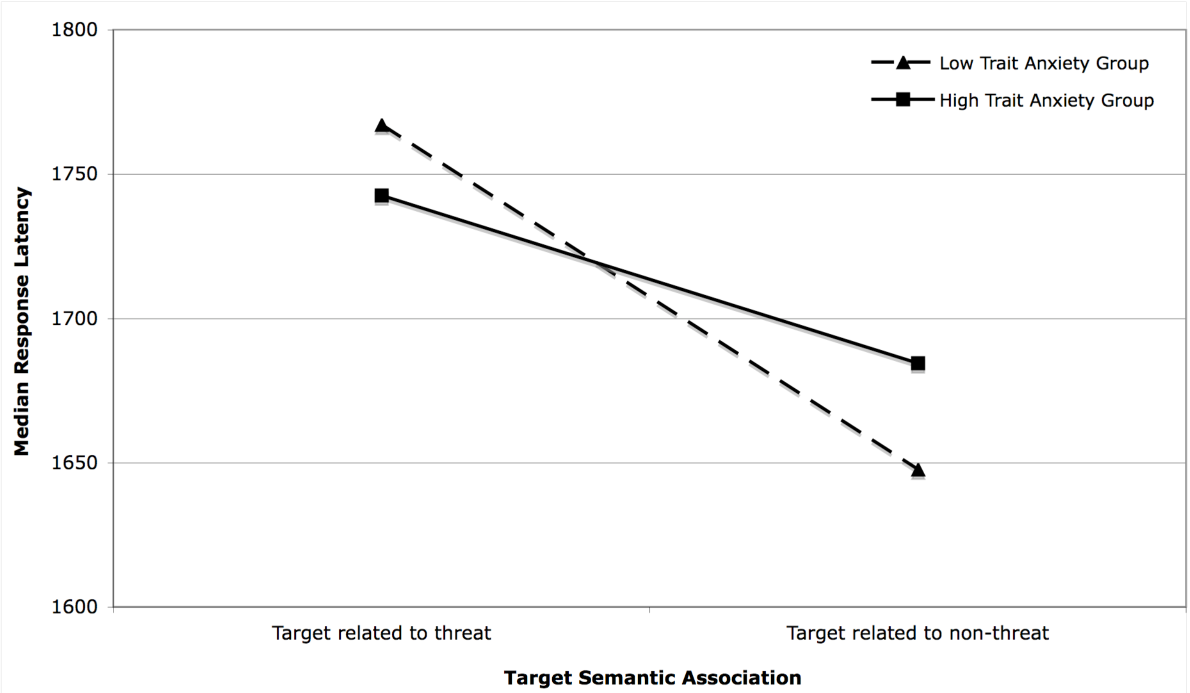
These reaction time data were analysed using a repeated measures ANOVA considering the effects of the between-subjects factor, Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) and the within-subjects factor, Target Semantic Association Factor (Target Related to Threat vs. Target Related to Non-threat).

A main effect of Target Semantic Association was found, such that the average median response latency was significantly faster in the Target Related to Non-threat Condition than the Target Related to Threat Condition, $F(1,101) = 34.94$, $p < .001$. This effect parallels the effect of Target Semantic Association found in the preceding accuracy analysis, which showed that participants were more accurate in the Target Related to Non-threat condition, relative to the Target Related to Threat Condition. Assuming that relative response latency is a measure of selective interpretation, this suggests that on average all participants were more likely to interpret the ambiguous visual stimulus in the Prime Display as non-threatening rather than threatening. However, no main effect of Trait Anxiety Group was found $F(1,101) = .004$, $p = .94$, meaning that there was no significant difference between the average median response latency of participants in the High and Low Trait Anxiety Groups. Finally, of greatest relevance to the issue under investigation was the existence of a significant interaction between Target Semantic Association and Trait Anxiety Group, $F(1,101) = 4.16$, $p < .05$. This interaction showed that the relative response latency for the Target Related to Threat Condition and the Target Related to Non-threat Condition, differed significantly between the two participant groups. As illustrated in Figure 6, the Low Trait Anxiety Group's responses were substantially speeded in the Target Related to Non-threat Condition relative to the Target Related to Threat Condition, suggesting a strong tendency to impose a non-threatening meaning on the ambiguous stimulus. However, although the High Trait Anxiety Group's responses were also speeded in the Target Related to Non-threat Condition relative to the Target Related to Threat Condition, this was attenuated suggesting that the tendency to impose non-threatening interpretations is reduced in the High Trait Anxiety Group. This interaction effect does *not* demonstrate that relative to the Low Trait Anxiety Group, the High Trait Anxiety Group has an absolute preference for threatening relative than non-threatening interpretations. However, it shows that relative to the Low Trait Anxiety Group, the High Trait Anxiety Group has a significantly attenuated preference for non-threatening interpretations relative to threatening interpretations. Therefore, although, this interaction differs from the interaction between Target Semantic Association and Trait Anxiety Group found in Experiment 2, it is also consistent with a relatively inflated tendency to selectively process threatening information in the High Trait Anxiety Group[15].

[15] Post Hoc paired samples t tests also demonstrated a significant effect of Target Semantic Association on response latency both within the Low Trait Anxiety Group, $t(52) = 5.53$, $p < .001$ and within the High Trait Anxiety Group, $t(49) = 2.79$, $p < .01$.

Figure 6

Graph showing the effect of Target Semantic Association on the median response latency of participants in the High and Low Trait Anxiety Groups.



Assuming that relative response latency is a measure of selective interpretation, the results of the preceding ANOVA show that the Interpretation/Initial/Auditory Task is sensitive to anxiety-associated selective interpretation. More specifically, it shows that the Interpretation/Initial/Auditory Task is able to distinguish individuals reporting high and low trait anxiety on the basis of their tendency to interpret ambiguous auditory information as being either threatening or non-threatening in meaning. The next part of the Results section considers whether the Interpretation/Initial/Auditory Task is also sensitive to a linear relationship between anxiety and selective interpretation using Pearson Correlational Analyses.

Linear Association between Anxiety and Biased Interpretation: Pearson Correlational Analyses

Participant Characteristics. In parallel with the Correlational Analyses in the previous experiments, participants falling in the Mid-Trait Anxiety Band were reinstated to the analyses. The requirements of consistency of trait anxiety level and accuracy, described in the Comparison of Trait Anxiety Groups Section above, applied for inclusion in the present correlational analyses. Since all participants in the Mid-Trait Anxiety Band met these requirements, all were included.

Accuracy. As in the previous experiments, a Pearson Correlational Analysis was conducted to ensure that there was no linear association between anxiety and the relative accuracy of responses to trials in the Target Related to Threat condition compared with trials in the Target Related to Non-threat condition.

The key measures included in the correlational analysis were identical those included in the Correlational Analysis of Accuracy in the previous experiments, which, as will be recalled, were:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. An Accuracy Threat Bias Index: Computed in the manner described in Experiment 3.

Since both the Accuracy Threat Bias Index and the Trait Anxiety Index were normally distributed, a Pearson correlation coefficient was calculated. The correlation coefficient representing the linear relationship between trait anxiety and the Accuracy Threat Bias Index was $r = .01$, $p = .86$. The proximity of this correlation coefficient to zero suggests that there is no relationship between the two variables. In light of the absence of a significant correlation between anxiety and the Accuracy Threat

Bias Index, we may be confident that any differences in response latency in the following analysis are not due to differences in task difficulty.

Response Latency. Since the preceding analyses confirmed that the there is no linear association between anxiety and the relative accuracy for the Target Related to Threat condition and the Target Related to Non-threat condition on the Interpretation/Initial/Auditory Task, we will determine whether the Interpretation/Initial/Auditory Task revealed a linear association between anxiety and threat-biased interpretation as measured by the relative response latency for targets correctly identified as related to threatening relative to non-threatening Prime Display stimuli.

The key measures included in this correlational analysis were identical to those employed in the Correlational Analysis of Response Latency in the previous experiments. As will be recalled, these were:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. A Threat Bias Index: Computed in the manner described in Experiment 3.

Like the distribution of the Trait Anxiety Index, the distribution of the Threat Bias Index was normal, therefore a Pearson Correlational Analysis was conducted. The Pearson correlation between trait anxiety and the Threat Bias Index was $r = .15$, $p = .06$. Although this is strictly outside the bounds of significance, this result is suggestive of a weak positive linear relationship between trait anxiety and the Threat Bias Index. Therefore, assuming that the Threat Bias Index provides a measure of biased interpretation, this could suggest that the Interpretation/Initial/Auditory Task is sensitive to a linear association between anxiety and selective interpretation.

Discussion

Summary of Findings

This experiment was designed to assess the sensitivity of the Interpretation/Initial/Auditory Task to individual differences in the interpretation of ambiguous stimuli as threatening. As was the case in the previous experiments this was determined on the basis of whether the task had significant internal reliability, and whether the task demonstrated anxiety-associated threat-biased interpretation.

The split-half reliability estimate of the Interpretation/Initial/Auditory Task showed that the task has significant moderate internal consistency. Since it meets statistical significance, the internal reliability of the Interpretation/Initial/Auditory Task is considered an acceptable level for the present research.

The group comparison revealed that the Interpretation/Initial/Auditory Task is sensitive to anxiety-associated individual differences in the biased interpretation of ambiguous auditory stimuli as threatening. The patterns of response latency for trials in which the target was related to the Prime Display's threatening meaning relative to trials in which the target was related to the Prime Display's non-threatening meaning were significantly different for participants in the High and Low Trait Anxiety Groups. Assuming that this relative response latency provides a measure of threat-biased interpretation, this demonstrates that the Interpretation/Initial/Auditory Task is sensitive to the association between anxiety and the biased interpretation of ambiguous stimuli as threatening. Further, a near-significant weak correlation between trait anxiety and the Threat Bias Index was found. Therefore, assuming that the Threat Bias Index measures threat-biased interpretation, the correlational analysis could suggest that the Interpretation/Initial/Auditory Task is sensitive to a linear relationship between anxiety and threat-biased interpretation.

Explanations for Findings

The present results demonstrate that the Interpretation/Initial/Auditory Task is sensitive to the anxiety-associated differences in threat-biased interpretation that have been extensively demonstrated in past research (reviewed in: MacLeod, 1999; MacLeod & Rutherford, 2004; Mathews & MacLeod, 1994, 2005). However, these results differ from those of Experiment 3. While the Interpretation/Initial/Visual Task in Experiment 3 was not sensitive to trait anxiety-associated individual differences in threat-biased interpretation, the Interpretation/Initial/Auditory Task in the present experiment was. Since the designs of these two tasks were identical, aside from the modality in which their stimuli were presented, the inconsistency of their results is unexpected.

The pattern of effects across the present experiment and Experiment 3, parallels the pattern of effects across Experiments 1 and 2. As will be recalled from Experiments 1 and 2, anxiety-associated threat-biased attention that was not initially constrained was evidenced when experimental stimuli were auditory rather than visual in modality. In the discussion of the results of Experiment 2, it was suggested that anxiety-associated threat-biased attention may occur more prominently when word stimuli are presented in the auditory rather than the visual modality. In parallel, the results of the present experiment and Experiment 3 revealed that anxiety-associated threat-biased interpretation occurred when word stimuli were auditory rather than visual in modality. Therefore, as in the case of anxiety-associated threat-biased attention, anxiety-associated threat-biased interpretation may occur more prominently when word stimuli are presented in the auditory rather than the visual modality.

As will be recalled from Experiment 2 discussion, it was suggested that anxiety-associated threat-biased attention may be more prominent for auditory rather than visual stimuli due to the greater ecological validity of auditory stimuli, and due to the earlier acquisition of auditory language relative to visual language. These explanations may equally explain the tendency for anxiety-associated threat-biased interpretation to be more prominent for auditory rather than visual stimuli.

Differences in the accessibility of the meaning of the auditory relative to the visual stimuli may also explain why the Interpretation/Initial/Auditory Task revealed anxiety-associated threat-biased interpretation, while the Interpretation/Initial/Visual Task did not. Since the meaning of the auditory stimuli was not available for as long as the meaning of the visual stimuli (Holcomb & Neville, 1994), in the Interpretation/Initial/Visual Task it may have been possible to consider alternative interpretations of the Prime Display stimuli, while in the Interpretation/Initial/Auditory Task only the initial interpretation may have been available. However, Richards and French (1992) found anxiety-associated threat-biased interpretation bias most reliably when ambiguous words were presented with a 750 ms stimulus onset asynchrony. Therefore, the presentation duration of the visual stimuli may not fully explain the insensitivity of the Interpretation/Initial/Visual Task.

Implications for Present Research Thesis

Regardless of the explanation for the sensitivity of the present Interpretation/Initial/Auditory Task to individual differences in threat-biased interpretation associated with anxiety, the ultimate purpose of this experiment was to determine the suitability of the Interpretation/Initial/Auditory Task for inclusion in the final analysis of the patterns of associations across all the experimental tasks. Following the criteria outlined in chapter 2, since the Interpretation/Initial/Auditory Task evidenced both significant internal reliability and sensitivity to anxiety-linked differences in threat-biased interpretation it was included in all three stages of the final analysis of the patterns of associations between the eight experimental tasks in chapter 11.

Conclusions

In conclusion, the results of Experiment 4 provided evidence of the sensitivity of the Interpretation/Initial/Auditory Task to anxiety-associated individual differences in the interpretation of ambiguous auditory stimuli as threatening. In particular, the Interpretation/Initial/Auditory Task was found to evidence both individual differences in anxiety-associated threat-biased interpretation and significant internal reliability. The present effects combined with the absence of effects in Experiment 3 (the Interpretation/Initial/Visual Task), may suggest that threat-biased interpretation, that has not previously been constrained, occurs primarily with auditory word stimuli. Since the Interpretation/Initial/Auditory Task evidenced both significant internal reliability and individual differences in threat-biased information processing associated with anxiety it was included in all three stages of the final analysis of the patterns of associations between the eight experimental tasks in chapter 11.

CHAPTER 7

EXPERIMENT 5:

The Attention/Revised/Visual Task

Experiment 5 assessed the capacity of the Attention/Revised/Visual Task to measure anxiety-linked individual differences in biased attention towards threat. The form of attention bias that the Attention/Revised/Visual Task was designed to measure was the ease with which the focus of attention can be revised and directed away from threatening relative to non-threatening visual stimuli, following the initial activation of either a threatening or a non-threatening representation.

The design of Experiment 5 was identical to that of the previous four experiments, with the exception of the experimental task that was employed. Experiment 5 used the Attention/Revised/Visual Task. Like all the experimental tasks, the Attention/Revised/Visual Task was a variant of the General Approach to Bias Assessment described in chapter 2. Its design was parallel to that of the Attention/Initial/Visual Task (Experiment 1). However, unlike the Attention/Initial/Visual Task, the Attention/Revised/Visual Task specifically measured the ease with which participants could revise their initial focus of attention away from threatening relative to non-threatening visual information, once attention had initially been allocated towards such stimuli. Herein, the ease with which the initial focus of attention is revised away from threatening relative to non-threatening information will be referred to as *revised attention from threat*. The Attention/Revised/Visual Task was identical to the Attention/Initial/Visual Task with the primary exception that it included an additional display (termed the Constraining Cue Display), which appeared prior to the Prime Display, and was designed to initially direct participants' attention towards one or other of the Prime Display meanings. Revised attention from threat was measured by the relative ease with which associates of each type of Prime Display member could be identified after attention had initially been focussed instead on the other Prime Display member. It was assumed that difficulty in revising initial focus of attention away from threat would be reflected by a disproportionate slowing in the identification of the location of targets related to a Prime Display's non-threatening member, following initial attentional focus on the Prime Display's threatening member, relative to the identification of the location of targets related to a Prime Display's threatening member, following initial attentional focus on the Prime Display's non-threatening member.

As was the case for the previous experiments, two criteria determined the sensitivity of an experimental task to individual differences in threat-biased information processing. One criterion required that the task displayed significant internal reliability, while the other required that the task was sensitive to individual differences in threat-biased information processing previously shown to be associated with anxiety (e.g., MacLeod et al., 1986; Mogg et al., 1996; Mogg et al., 1994). In the case of the Attention/Revised/Visual Task, the latter criterion specifically required that the task was sensitive to anxiety-associated individual differences in revised attention from threatening visual information. If the Attention/Revised/Visual Task is sensitive to anxiety-associated individual differences in revised attention from threat, then when the conditions in which the target is related to the cued Prime Display member are controlled, compared with those of participants in the low trait anxiety group, the responses of participants in the high trait anxiety group would be disproportionately slowed for targets related to the Prime Display's non-threatening member following their initial attentional focus on the Prime Display's threatening member, relative to their responses to targets related to the Prime Display's threatening member following their initial attentional focus on the Prime Display's non-threatening member. Alternatively, it was anticipated that if revised attention from threat, is a linear function of anxiety, then we would find a strong linear correlation between either trait anxiety and the index of revised attention from threat.

Consistent with the approach adopted with all the experimental tasks, dependent on whether the Attention/Revised/Visual Task demonstrated the aforementioned criteria, determined its inclusion in the final analysis of the associations between the experimental tasks, presented in chapter 11.

Method

Participants

Participants were selected in the manner outlined in chapter 2. This gave rise to a sample, who reported a wide range of trait anxiety scores from 24 to 66. The mean trait anxiety score was 42.01, *SD* = 9.49 (screened using the STAI-T; Spielberger et al., 1983) [16]. Participants included 49 males and 91 females. Their mean age was 20.42 (*SD* = 6.01).

Materials

Trait Anxiety Assessment Instrument

As in the previous experiments, trait anxiety was assessed using the STAI-T (Spielberger et al., 1983).

Word-stimuli

The word stimuli employed in the present task were taken from the quintets of experimental stimuli described in Appendix A and are represented in row iv. of Table 1

[16] This mean trait anxiety score was comparable with the STAI-T college student norm of 40, *SD* = 10 (Spielberger et al., 1983).

in chapter 2. The bulk of the stimuli used in the Attention/Revised/Visual Task were identical to those used in the Attention/Initial/Visual Task in Experiment 1, which, as will be recalled included: visual *threat synonyms* and visual *non-threat synonyms* presented in the Prime Display; and visual *threat associates* and visual *non-threat associates* presented in the Target Display. The visual word stimuli *RED* and *GREEN* were presented in the Constraining Cue Display. Visual *homonyms*, identical to those used in the Interpretation/Initial/Visual Task (Experiment 3), visual *threat synonyms* and visual *non-threat synonyms* were also employed in an additional display (termed the Cue Check Display) that followed the Target Display. Details of the Cue Check Display will be outlined in the following section.

Experimental task

The design of the Attention/Revised/Visual Task was essentially identical to that of the Attention/Initial/Visual Task in Experiment 1, with the primary difference that the present task contained two additional displays: the Constraining Cue Display and the Cue Check Display.

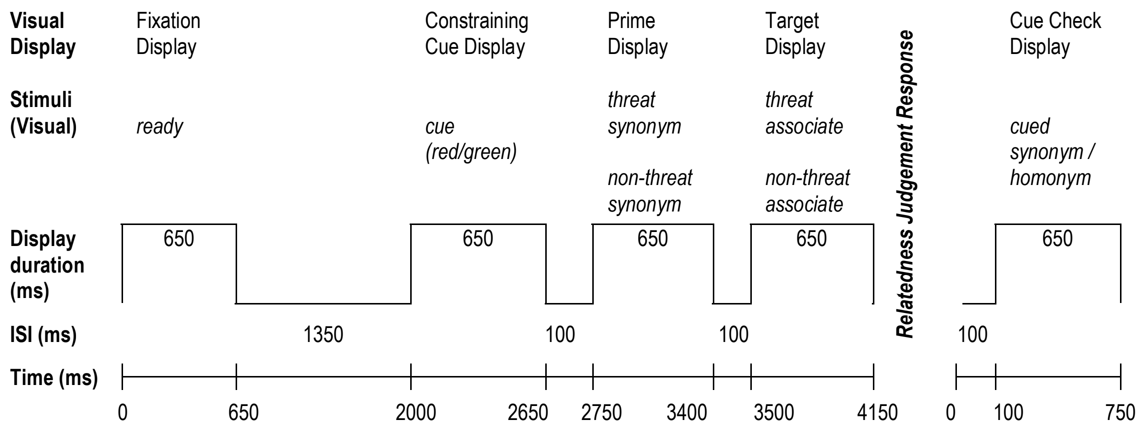
The following is a description of the progression of a trial in the present Attention/Revised/Visual Task. As in the Attention/Initial/Visual Task (Experiment 1), all experimental stimuli were in uppercase, regular Arial font, 1.10 cm high, presented against a black background on a computer screen. With the exception of the Prime Display stimuli, all stimuli were coloured white. The task began with a Fixation Display identical to that of the Attention/Initial/Visual Task, which, as will be recalled from the Attention/Initial/Visual Task, presented the word stimulus *READY* in the centre of the screen for 650 ms. After an interval of 1350 ms the Constraining Cue Display appeared. This was designed to instruct participants which member of the Prime Display they should direct their attention towards. During the

Constraining Cue Display, either the word stimulus *RED* (in white letters) or the word stimulus *GREEN* (in white letters) was presented in the centre of the computer screen for 650 ms. One hundred ms after the termination of the Constraining Cue Display, the Prime Display appeared. As in the Attention/Initial/Visual Task, the Prime Display contained an unambiguous threatening word and an unambiguous non-threatening word, presented simultaneously for 650 ms, one above and one below the screen's centre, vertically separated by a distance of 2.8 cm. However, unlike the Prime Display in the Attention/Initial/Visual Task, in the present experiment the letters of one of the Prime Display stimuli were coloured red and the letters of the other were coloured green. In all other respects the Prime Display in the present task and in the Attention/Initial/Visual Task were identical.

Participants were asked to attend to, and hold in mind the Prime Display stimulus of the colour specified by the Constraining Cue Display. Specifically, if the Constraining Cue Display was the word *RED*, participants were required to attend towards and hold in mind the Prime Display stimulus that was coloured red, while if the Constraining Cue Display was the word *GREEN*, participants were required to attend towards and hold in mind the Prime Display stimulus that was coloured green. One hundred ms after the termination of the Prime Display, the Target Display appeared, which was identical to the Target Display in the Attention/Initial/Visual Task. As will be recalled from the Attention/Initial/Visual Task, the Target Display contained two word stimuli, a target that was related in meaning to one of the Prime Display members, and a foil, which were presented simultaneously for 650 ms, one above and one below the screen's centre, vertically separated by a distance of 2.8 cm. Also as in the Attention/Initial/Visual Task, participants were asked to identify the location of the target word that was semantically related to either of the Prime Display stimuli, regardless of the colour of the semantically related Prime Display stimulus. One hundred ms after participants responded, they were presented with the final Cue Check Display. The Cue Check Display was designed to confirm compliance with the attentional instruction communicated by the initial Constraining Cue Display. During the Cue Check Display a visual word stimulus (white on black) was presented in the centre of the screen for 650 ms. Participants were asked to indicate whether or not this word was the member of the Prime Display that the Constraining Cue Display had directed them to attend towards[17]. The speed and accuracy of participants' responses were recorded by the task program. Figure 7 summarises the progression of a trial in the Attention/Revised/Visual Task.

Figure 7

The progression of a single trial in the Attention/Revised/Visual Task.



Since the Attention/Revised/Visual Task was designed to measure revised attention from threat, the experimental conditions were governed by the combination of two critical factors. First was the critical factor of Cued Prime Display Meaning. The Cued Prime Display Meaning Factor determined which of the Prime Display meanings was initially cued. Therefore, on half the trials, the Prime Display's threatening

[17]It is important to note that while the Cue Check Display demonstrates participants' compliance with the task instructions, it does not guarantee the preferential allocation of participants attention towards the member of the Prime Display indicated by the Constraining Cue Display.

meaning was cued, and on half the trials, the Prime Display's non-threatening meaning was cued. The second critical factor was Target Semantic Association. As in the previous experiments, the Target Semantic Association Factor determined the Prime Display meaning to which the target was related. On half the trials, the target was related to the threatening meaning presented in the Prime Display, while on half the trials the target was related to the non-threatening meaning presented in the Prime Display.

To ensure that any effects of the two critical factors were not confounded by differences in the appearance or position of the experimental stimuli, the experimental stimuli were balanced across the trials as follows. In the Prime Display, the threatening word stimulus was presented equally often in the two possible stimulus locations. Also in the Prime Display, the Prime Display stimulus presented above the centre of the screen was equally often coloured red or green. In the Target Display the target was presented equally often in the two possible stimulus locations. Finally, the Cue Check Display stimulus was equally often the same word as the member of the Prime Display to which the Constraining Cue Display had directed participants to attend, as it was a different word to the member of the Prime Display to which the Constraining Cue Display had directed participants to attend. Accounting for the balancing of the two critical factors and the differences in stimulus position and appearance, resulted in 64 different trial presentation conditions.

In each trial, the experimental word stimuli were allocated to the Prime Display and the Target Display in exactly the same manner as described in the Attention/Initial/Visual Task (Experiment 1). That is, the Prime Display contained a *threat synonym* and a *non-threat synonym* taken from a single quintet, while the Target Display contained two *associates*, of which one was a target and one a foil. Also, as will be recalled, the target was either the *threat associate* or the *non-threat associate* taken from the same quintet as the Prime Display's *threat synonym* and *non-threat synonym*, while the foil was taken from a different quintet to that of the Target and Prime Display word stimuli, and from among *associates* that had *not* appeared within that particular block of trials. On half of the trials, the word stimulus presented in the Cue Check Display was identical to one of the Prime Display stimuli from that same trial. On the other half of the trials, the word stimulus presented in the Cue Check Display was a *homonym* that had not already been presented within that block of trials.

Experimental hardware

As was the case in the Attention/Initial/Visual Task in Experiment 1, the stimuli were displayed on a 35 cm NEC Multi-Sync V530 monitor, controlled by a 952 MHz Intel Celeron Processor.

Procedure

Aside from differences resulting from the assessment of revised rather than initial information processing, the Procedure was identical to that described in Experiment 1. The procedural differences are highlighted by the following task instructions.

Participants were informed that the task involved making judgements about the relatedness of words whilst remembering other words, and instructed that each trial would commence with a fixation signal, the word *READY*, followed by four displays. They were told that the word presented in the first display indicated the colour of the word in the second display that they had to hold in mind for later recognition. They were informed that this colour would be communicated either by the word *RED* or the word *GREEN* in the first display, and that they were to hold in mind the word in the second display whose colour was indicated in the first display. Participants were told that the third display contained two words and that they were to identify the location of the word in the third display that was *semantically related* to the meaning of either of the words presented in the second display. As in the previous experiments, participants were advised that words were considered related if either they had the *same meaning* as each other (e.g., *QUICK* and *FAST*), or an *associated meaning* (e.g., *CAT* and *DOG*). They were assured that one of the words in the third display was always related to a meaning of one of the words in the second display. Participants were told that after making their response, a final fourth display, containing a single word would be presented and that they were to decide whether or not this word was the word that they had been asked to hold in mind from the second display. The need for accuracy was emphasized such that participants were instructed to work as quickly as possible without making mistakes. At no time were participants informed that the word-stimuli may be threat-related.

Participants were directed to indicate their identification of the target using the same keys as those used in Experiment 1. That is, if the top word in the third display was related to one of the meanings in the second display, they should press the upward-pointing arrow key, while if the bottom word in the third display was related to one of the words in the second display, they should press the downward-pointing arrow key. To indicate whether the word in the fourth display was the same as the word they were asked to hold in mind, participants were directed to press the key marked *S* if it was the same word, and to press the key marked *D* if it was a different word.

Results

Overview

As was the case with the preceding experiments, task internal reliability is first reported, after which the Attention/Revised/Visual Task's sensitivity to anxiety-linked individual differences in threat-biased attention is reported.

Exclusion of Inaccurate Participants

In parallel with previous experiments, before assessing the sensitivity of the Attention/Revised/Visual Task to individual differences in revised attention from threat, it was important to ensure that participants complied with task instructions. As will be recalled from the previous experiments it was assumed that the accuracy of participants' responses reflected their task-compliance. In this and the three following experiments, two measures of task accuracy were taken: target-location accuracy and cue-recognition accuracy. Target-location accuracy represented the percentage of responses reflecting the correct identification of the location of the target across the entire task's 256 trials. Cue-recognition accuracy represented the percentage of responses reflecting the correct identification of the Cue Check Display stimulus as either the same or different to the word specified by the Constraining Cue Display, across the entire task's 256 trials. Task compliance was assessed by considering participants' target-location accuracy and cue-recognition accuracy. Across all participants, the mean percentage target-location accuracy, was well above the chance level of 50%, $t(139) = 57.36$, $p < .001$, as was the mean percentage cue-recognition accuracy, $t(139) = 155.69$, $p < .0001$. Since all participants demonstrated target-location accuracy and cue-recognition accuracy above chance level they were all included in the analyses.

Like the previous experiments, it was intended that the sensitivity of the Attention/Revised/Visual Task to threat-biased attention would be determined on the basis of participants' response latency to identify the location of target stimuli. Therefore, assessment of participants' recognition of the Cue Check stimulus as being the same or different to the word specified by the Constraining Cue Display, was conducted only to ensure task compliance. Consequently, herein the analyses will examine only participants' responses identifying the location of the target, and not participants' responses recognising whether the Cue Check stimulus was the same or different to the word specified by the Constraining Cue Display.

Internal Reliability

The internal reliability of the Attention/Revised/Visual Task was determined using the same approach as described in Experiment 1. That is, a Threat Bias Index was subjected to the Spearman-Brown split-half reliability formula. However, since the Attention/Revised/Visual Task measured revised, rather than initial information processing, the Threat Bias Index used in the Attention/Revised/Visual Task was computed differently to the Threat Bias Indexes used in the previous experiments. The present Threat Bias Index was intended to reflect the effect of the revision of attentional focus away from the threatening Prime Display member relative to the effect of the revision of attentional focus away from the non-threatening Prime Display member on the response latency for identifying target stimuli, when the effects of those conditions that did not require revision of attentional focus were controlled. Thus the Threat Bias index in the present experiment was computed on the basis of the two experimental factors: Cued Prime Display Meaning (Threat Prime Display Meaning Cued vs. Non-threat Prime Display Meaning Cued) and Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat).

The present Threat Bias Index is most easily understood as being the difference between two subordinate indexes: the Revision Sub-Index, and the No-Revision Sub-index. The Revision Sub-Index was intended to represent the effect on target-location response latency of the revision of attentional focus away from the threatening Prime Display member relative to the effect of the revision of attentional focus away from the non-threatening Prime Display member. The Revision Sub-Index was calculated by subtracting the median correct target-location response latency on trials of the Non-threat Prime Display Meaning Cued / Target Related to Threat conditions, from the median correct target-location response latency on trials of the Threat Prime Display Meaning Cued / Target Related to Non-threat conditions. The No-Revision Sub-Index was intended to represent the effect on target-location response latency of the threatening Prime Display member relative to the effect of the non-threatening Prime Display member when no revision of attentional focus was required. The No-Revision Sub-Index was calculated by subtracting the median correct target-location response latency on trials of the Threat Prime Display Meaning Cued / Target Related to Threat condition, from the median correct target-location response latency on trials of the Non-threat Prime Display Meaning Cued / Target Related to Non-threat condition.

The Threat Bias Index was then calculated by subtracting the No-Revision Sub-index from the Revision Sub-Index. It was assumed that difficulty revising one's initial focus of attention away from threatening relative to non-threatening information was reflected by a greater Threat Bias Index.

Using the Spearman-Brown correction, the split-half reliability of the Attention/Revised/Visual Task was estimated as r =.31, $p < .01$. While this internal reliability coefficient is relatively weak, since it is statistically significant, it is considered representative of an acceptable level of internal reliability for the present research. This reliability coefficient suggests that the content of the task's items tend to be consistent with one another. The following section will determine whether this individual difference in revised attention from threat is associated with variability in anxiety.

The Sensitivity of the Attention/Revised/Visual Task to Anxiety-associated Individual Differences in Revised Attention from Threat

This part of the results presents the analysis of the sensitivity of the Attention/Revised/Visual Task to anxiety-associated individual differences in the revision of attentional focus from visual threatening information. Analyses comparing the characteristics, target-location accuracy and target-location response latencies of the high and low trait anxiety groups are reported first. Correlations between trait anxiety and the accuracy Threat Bias Index and the response latency Threat Bias Index are then reported.

Comparison of Trait Anxiety Groups: Analysis of Variance

Participant Characteristics. High and low trait anxiety groups were obtained in the manner described in the previous experiments.

Consistent with the previous experiments, checks were made to ensure that no individual participant reported a trait anxiety score at the experimental test session that was inconsistent with his/her original classification as either high or low trait anxiety level at screening. This was achieved using the method outlined in Experiment 1. As a result, three participants in the Low Trait Anxiety Group whose trait anxiety scores at the experimental test session were above the median trait anxiety score were eliminated, as were two participants in the High Trait Anxiety Group whose trait anxiety scores at the experimental test session were below the median trait anxiety score.

The characteristics of the resulting two Trait Anxiety Groups at the experimental test session are presented in Table 16.

Table 16

Participant Characteristics at the Experimental Test Session (Standard Deviations in Parentheses)

	N	Number of Males	Number of Females	Mean Age (Years)	Mean STAI-T Trait Anxiety
Low Trait Anxiety Group	53	17	36	21.4 (6.6)	31.6 (4.6)
High Trait Anxiety Group	54	20	34	19.7 (6.0)	51.8 (5.6)

An independent samples *t* test showed that during the experimental test session participants in the High and Low Trait Anxiety Groups differed significantly in terms of trait anxiety as measured by the STAI-T (Spielberger et al., 1984), $t(105) = 20.12$, $p < .001$. Another independent samples *t* test showed no significant difference between the groups in age, $t(105) = 1.39$, $p = .16$. Likewise, a Chi square test for independence, using Yates' Continuity Correction, showed no significant difference between the two Anxiety Groups in terms of the distribution of males and females, X^2 (1) = .11, $p = .73$.

Accuracy. Table 17 displays the two participant groups' mean percentage target-location accuracy for the conditions of the factors: Cued Prime Display Meaning (Threat Prime Display Meaning Cued, Non-threat Prime Display Meaning Cued) and Target Semantic Association (Target Related to Threat condition, Target Related to Non-threat condition).

Table 17

Mean Percentage of Correct Relatedness Judgement Responses (Standard Deviations in Parentheses)

Cued Prime Display Meaning	Target Semantic Association	Low Trait Anxiety Group	High Trait Anxiety Group
Threat Prime Display Meaning Cued	Target Related to Threat	87.50 (8.65)	88.91 (7.72)
	Target Related to Non-threat	88.17 (11.75)	88.62 (10.45)
Non-threat Prime Display Meaning Cued	Target Related to Threat	84.64 (9.93)	85.93 (10.95)
	Target Related to Non-threat	92.06 (6.72)	92.01 (6.03)

As in the previous experiments, since the response latency for identifying the location of targets, or the target-location response latency, was intended to reveal differences in task difficulty, it was desirable that the target-location accuracy of the Trait Anxiety Groups did not differ as a function of experimental condition. Therefore, to check this, a repeated measures ANOVA was conducted which considered the effects of Cued Prime Display Meaning (Threat Prime Display Meaning Cued vs. Non-threat Prime Display Meaning Cued), Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat) and Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) on target-location accuracy.

There was no main effect of Trait Anxiety Group, $F(1,105) = .25$, $p = .61$, meaning that there was no significant difference between the target-location accuracy of participants in the High Trait Anxiety Group and participants in the Low Trait Anxiety Group. There was no main effect of Cued Prime Display Meaning, $F(1,105) = .83$, $p = .36$, meaning that there was no significant difference between participants' target-location accuracy for the Threat Prime Display Meaning Cued trials relative to the Non-threat Prime Display Meaning Cued trials. A main effect of Target Semantic Association was found, $F(1,105) = 55.94$, $p < .001$, such that the mean target-location accuracy of all participants was significantly greater in the Target Related to Non-threat condition relative to the Target Related to Threat condition. Therefore if there is an effect of Target Semantic Association on target-location response latency, it will be important to ensure that this is not due to a speed-accuracy trade-off.

A significant interaction between Target Semantic Association and Cued Prime Display Meaning was found, $F(1,105) = 25.74$, $p < .01$, such that mean target-location accuracy increased when the emotional valence of the Cued Prime Display Meaning matched the valence of the Target Semantic Association. Therefore, if there is an interaction effect of Target Semantic Association and Cued Prime Display Meaning on target-location response latency, it will be important to ensure that this is not due to a speed-accuracy trade-off. As desired, there was no interaction between Trait Anxiety Group and Target Semantic Association, $F(1,105) = 1.56$, $p = .21$. This means that the mean target-location accuracy of participants in the High Trait Anxiety Group was not significantly different to the mean target-location accuracy of participants in the Low Trait Anxiety Group in either the Target Related to Threat condition or the Target Related to Non-threat condition. Also as desired, there was no interaction between Trait Anxiety Group and Cued Prime Display Meaning, $F(1,105) = .15$, $p = .69$. Therefore, the mean target-location accuracy of participants in the High Trait Anxiety Group was not significantly different to the mean target-location accuracy of participants in the Low Trait Anxiety Group in either the Threat Prime Display Meaning Cued condition or the Non-threat Prime Display Meaning Cued condition. Finally, there was no interaction between Trait Anxiety Group, Target Semantic Association and Cued Prime Display Meaning, $F(1,105) = .02$, $p = .88$. This last result means that the mean target-location accuracy of participants in the High Trait Anxiety Group was not significantly different to the mean target-location accuracy of participants in the Low Trait Anxiety Group when accounting for the effects of both Target Semantic Association and Cued Prime Display Meaning.

Response Latency. The preceding analyses confirmed that the participants included in the analyses reported trait anxiety at test time that was representative of the Trait Anxiety Group to which they had been allocated. Likewise they showed that participants completed the Attention/Revised/Visual Task as instructed and that the target-location accuracy of the two Trait Anxiety Groups did not differ. Therefore, the issue of key importance, whether or not the Attention/Revised/Visual Task revealed anxiety-associated differences in revised attention from threat, can now be considered.

Revised attention from threat was measured by the differential speed with which participants correctly identified the target stimulus as a function of the experimental conditions derived from the two factors Target Semantic Association and Cued Prime Display Valence. It was expected that the more difficulty a person had revising their initial attentional focus away from threat, the greater time it would take to respond to the target. Table 18 displays the median response latency for each participant to correctly identify the target in each experimental condition.

Table 18

Average Median Response Latency (in ms) to Correctly Identify Targets (Standard Deviations in Parentheses)

Cued Prime Display Meaning	Target Semantic Association	Low Trait Anxiety Group	High Trait Anxiety Group
Threat Prime Display Meaning Cued	Target Related to Threat	1501.14 (565.71)	1606.10 (618.01)
	Target Related to Non-threat	1541.03 (468.56)	1662.87 (500.23)
Non-threat Prime Display Meaning Cued	Target Related to Threat	1593.34 (524.83)	1729.75 (638.46)
	Target Related to Non-threat	1406.10 (535.57)	1508.36 (498.42)

These reaction time data were analysed using a repeated measures ANOVA considering the effects of the between-subjects factor, Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) and the within-subjects factors, Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat) and Cued Prime Display Meaning (Threat Prime Display Meaning Cued vs. Non-threat Prime Display Meaning Cued).

A significant main effect of Target Semantic Association was found such that all participants demonstrated faster median target-location response latencies in the Target Related to Non-threat condition, than in the Target Related to Threat Condition, $F(1,105) = 16.52$, $p < .001$. This finding is consistent with the effect of Target Semantic Association on target-location accuracy as reported in the preceding target-location accuracy analysis, which showed that participants were more accurate in the Target Related to Non-threat condition, relative to the Target Related to Threat Condition. No main effect of Cued Prime Display Meaning was found, $F(1,105) = 1.29$, $p = .25$, such that there was no difference between the median target-location response latency for the Threat Prime Display Meaning Cued trials relative to the Non-threat Prime Display Meaning Cued trials. There was also no main effect of Trait Anxiety Group, $F(1,105) = 1.34$, $p = .25$. This means that the median target-location response latency of participants in the High Trait Anxiety Group was not significantly different to the median target-location response latency of participants in the Low Trait Anxiety Group.

There was no significant interaction between Trait Anxiety Group and Target Semantic Association, $F(1,105) = .05$, $p = .82$, therefore there was no group difference in the effect of Target Semantic Association. There was also no significant interaction between Trait Anxiety Group and Cued Prime Display Meaning, $F(1,105) = .03$, $p = .85$, which indicates there was no group difference in the effect of Cued Prime Display Meaning. A significant interaction between Target Semantic Association and Cued Prime Display Meaning was found, $F(1,105) = 36.07$, $p < .001$. This means that median target-location response latency was more greatly speeded when the emotional valence of the Cued Prime Display Meaning matched the valence of the Target Semantic Association compared with when the emotional valence of the Cued Prime Display Meaning did not match the valence of the Target Semantic Association. This finding is consistent with the preceding target-location accuracy analysis which showed that target-location accuracy was greater when there was a match between the emotional valence of the Cued Prime Display Meaning and the Target Semantic Association compared with when there was a mismatch between the emotional valence of the Cued Prime Display Meaning and the Target Semantic Association. Assuming that relative target-location response latency is a measure of revised attention from threat, this suggests that on average all participants were more likely to have difficulty revising their initial focus of attention away from non-threat stimuli than revising their initial focus of attention away from threat stimuli. There was no significant interaction between Target Semantic Association, Cued Prime Display Meaning and Trait Anxiety Group, $F(1,105) = .36$, $p = .54$. Therefore, there was no group difference in the interaction effect of Target Semantic Association and Cued Prime Display Meaning.

If we assume that relative target-location response latency is a measure of revised attention from threat, the preceding results suggest that the Attention/Revised/Visual Task is not sensitive to anxiety-associated group differences in revised attention from threat. However, it is possible that the Attention/Revised/Visual Task is sensitive to a linear relationship between anxiety and revised selective attention, that was not picked up by the analysis of variance. Therefore, the following section uses Pearson Correlational Analysis to analyse the relationship between anxiety and revised selective attention.

Linear Association between Trait Anxiety and Revised Attention from threat: Pearson Correlational Analyses

Participant Characteristics. In parallel with the Correlational Analyses in the previous experiments, participants falling in the Mid-Trait Anxiety Band were reinstated to the analyses. As in the previous experiments, the requirements of consistency of trait anxiety level and target-location accuracy, as described in the Comparison of Trait Anxiety Groups Section above, applied for inclusion in the present correlational analyses. Since all participants falling within the Mid-Trait Anxiety Band met these requirements, all were included.

Accuracy. As was the case for the Pearson Correlational Analyses in the previous experiments, target-location response latency was intended to reveal differences in task difficulty, therefore it was desirable to ensure that there was no linear association between anxiety and the relative target-location accuracy of responses to trials of the different experimental conditions. This was done in the same manner as in the previous experiments: a measure of trait anxiety and a measure of the relative target-location accuracy of responses on trials of the different experimental conditions, were subjected to a Pearson correlational analysis.

The key measures included in this correlational analysis were:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. An Accuracy Threat Bias Index: computed in the same way as the Threat Bias Index in the preceding Analysis of Internal reliability, except that the measure used to compute the Accuracy Threat Bias Index was mean target-location accuracy, rather than median correct target-location response latency which was used to compute the Threat Bias Index.

Since both the Accuracy Threat Bias Index and the Trait Anxiety Index were normally distributed, a Pearson correlation coefficient was calculated. The correlation coefficient representing the linear relationship between trait anxiety and the Accuracy Threat Bias Index was $r = -.02$, $p = .80$. The small size of this correlation coefficient indicates that there is no relationship between these variables. Therefore, we can be confident that any differences in response latency in the following analysis are not due to differences in task difficulty.

Response Latency. Since the preceding analyses confirmed that the there is no linear association between anxiety and the relative target-location accuracy for different experimental conditions on the Attention/Revised/Visual Task, the data were further analysed to determine whether the Attention/Revised/Visual Task revealed a linear association between anxiety and threat-biased attention as measured by the relative target-location response latency for targets correctly identified as related to threatening relative to non-threatening Prime Display stimuli, when the valence of the cued Prime Display stimulus is taken into account.

The key measures included in this correlational analysis were:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. A Threat Bias Index: computed in exactly the manner described in the preceding Analysis of Internal Reliability.

Like the Trait Anxiety Index, the Threat Bias Index was normally distributed. Therefore, a Pearson correlation coefficient was calculated. The correlation coefficient representing the linear relationship between trait anxiety and the Threat Bias Index was $r = -.05$, $p = .50$, indicating no relationship between these two variables. Assuming that the Threat Bias Index provides a measure of revised attention from threat, these correlation coefficients provides no evidence that the Attention/Revised/Visual Task is sensitive to a linear association between trait anxiety and revised attention from threat.

Discussion

Summary of Findings

The present experiment was designed to assess the sensitivity of the Attention/Revised/Visual Task to anxiety-linked individual differences in the revision of attention away from threatening relative to non-threatening visual information. As was the case in the previous experiments, this was determined in two ways: first on the basis of the strength of the task's internal reliability; and second on the basis of the task's capacity to demonstrate anxiety-associated attention bias to threat.

The Attention/Revised/Visual Task's significant split-half reliability estimate shows that the Attention/Revised/Visual Task has acceptable internal consistency for the purpose of the present research program.

Neither the group comparison nor the correlational analyses provided evidence to suggest that the sensitivity of the Attention/Revised/Visual Task to individual differences in revised attention from threat is associated with individual differences in anxiety. Compared with those trials in which the target was related to the cued Prime Display stimulus, participants in the High and Low Trait Anxiety Groups displayed similar patterns of target-location response latency for trials in which the Prime Display's threatening member was cued and the target was related to the Prime Display's non-threatening member, relative to trials in which the Prime Display's non-threatening member was cued and the target was related to the Prime Display's threatening member. Therefore assuming that relative target-location response latency is a measure of individual differences in revised attention from threat, the Attention/Revised/Visual Task did not pick up any anxiety group differences in revised focus of attention from threat. Likewise, trait anxiety was not found to be linearly correlated with the Threat Bias Index. Therefore, assuming that the Threat Bias Index measures revised attention from threat, there is also no evidence of a linear relationship between anxiety and revised attention from threat.

Explanations for Findings

Given the extensive literature demonstrating anxiety-associated individual differences in revised attention from threat (reviewed in: MacLeod, 1999; MacLeod & Rutherford, 2004; Mathews & MacLeod, 1994, 2005), the present null results arguably can be attributed to the insensitivity of the Attention/Revised/Visual Task. The present section will consider possible reasons for this insensitivity.

One explanation for the insensitivity of the Attention/Revised/Visual Task to anxiety-associated individual differences in revised attention from threat may be associated with the way in which the target stimuli were presented. Past research has shown that the performance of anxious individuals on tasks where they are required to direct their attention away from threat is most greatly disrupted when they are required to search for the location of a target among multiple threatening distracters (Fox, 1994; Mathews et al., 1990). In the Attention/Revised/Visual Task, participants were required to search for the target from among two alternative locations. It is possible, that presenting the target in only two locations did not provide participants with a sufficient number of alternative locations to search, and therefore limited the sensitivity of the Attention/Revised/Visual Task to anxiety-associated differences in revised attention from threat. However, measures such as the cuing task (Fox et al., 2001; Koster et al., 2006), which have been found to evidence anxiety-linked differences in revised attention from visual threat and yet only require participants to search for a target stimulus from amongst two locations. Therefore, it is not certain that this argument sufficiently explains the present results.

Another possible reason why the Attention/Revised/Visual Task did not pick up anxiety-linked differences in revised attention from threat may be due to the cognitive processes required to perform the Attention/Revised/Visual Task. Measures of revised attention from visual threat that have been shown to be sensitive to variability in anxiety typically only require participants to complete one task within a trial. For example, trials of the cuing task only require that participants locate a visual probe (Broomfield & Turpin, 2005). Conversely, trials of the Attention/Revised/Visual Task, require that participants perform two tasks: they must hold in mind the Prime Display word indicated by the Constraining Cue Display; and they must locate the Target Display word that is semantically related to one of the Prime Display words. Therefore, to perform the Attention/Revised/Visual Task memory resources in addition to attentional resources may be needed. It is possible that if the Attention/Revised/Visual Task relies on memory resources in addition to attentional resources, anxiety's effect on revised attention from threat could be obscured. However, Eysenck et al. (2007) posit that adverse effects of anxiety on task performance become greater as overall task demands increase. Therefore, the reliance of the Attention/Revised/Visual Task on both attentional resources and memory resources may not explain the absence of anxiety-linked differences in task performance.

The results of this experiment are consistent with the pattern of effects seen across the previous four experiments. Across the tasks that measured the initial focus of attention towards threat (Experiments 1 and 2), and the tasks that measured the initial interpretation of ambiguous stimuli as threatening (Experiments 3 and 4), sensitivity to anxiety-associated threat-biased information processing was revealed only when the experimental stimuli were presented in the auditory modality. As will be recalled from these first four experiments, this pattern of effects was explained as possibly being attributable to relatively more efficient processing of auditory relative to visual stimuli. In the previous experiments it was proposed that auditory stimuli may be more readily processed than visual stimuli due to the greater ecological validity of auditory stimuli relative to visual stimuli, and the earlier acquisition of auditory language relative to visual language. Extending this reasoning to the present results, it is possible that they are due to the modality in which the experimental stimuli were presented. If correct, then, as in the case of the measures of initial information processing towards threat, the measures of revised information processing from threat may be more sensitive to threat-biased information processing when the experimental stimuli are presented in the auditory modality. The next experiment, Experiment 6, examines the sensitivity to individual differences in revised attention from threat using an Attention/Revised/Auditory Task that is identical to the Attention/Revised/Visual Task, except that its stimuli are presented in the auditory modality. Accordingly, Experiment 6 will provide a basis for examining the impact of auditory stimuli on sensitivity to individual differences in revised attention from threat will be examined.

Implications for Present Research Thesis

Irrespective of the explanation for the insensitivity of the Attention/Revised/Visual Task to individual differences in threat-biased attention associated with anxiety, the ultimate purpose of this experiment was to determine the suitability of the Attention/Revised/Visual Task for inclusion in the final analysis of the patterns of associations across all the experimental tasks presented in chapter 11. On the basis of the criteria set out in chapter 2, since the Attention/Revised/Visual Task was shown to possess acceptable internal reliability, but was not sensitive to anxiety-associated individual differences in threat-biased attention, it was included in stages one and two of the final analysis in chapter 11.

Conclusions

In conclusion, the results of Experiment 5 showed that the Attention/Revised/Visual Task possessed an acceptable level of internal reliability for the present research program. These effects combined with those of the previous four Experiments, may suggest that threat-biased information processing, occurs more readily with auditory stimuli. Since the Attention/Revised/Visual Task evidenced significant internal reliability it will be included in the first and second stages of the final analysis of the patterns of associations between the experimental tasks in chapter 11.

CHAPTER 8

EXPERIMENT 6:

The Attention/Revised/Auditory Task

Experiment 6 evaluated the sensitivity of the Attention/Revised/Auditory Task to individual differences in the ease with which the focus of attention can be revised and directed away from threatening relative to non-threatening auditory word stimuli, following the initial activation of either a threatening or a non-threatening representation.

The design of Experiment 6 was the same as those of the previous experiments, with the exception of the experimental task that was employed. In Experiment 6 this task was the Attention/Revised/Auditory Task. The Attention/Revised/Auditory Task was a variant of the General Approach to Bias Assessment described in chapter 2. It was the auditory parallel of the Attention/Revised/Visual Task (Experiment 5) and identical in design with the exception of the modality in which the task's stimuli were presented. Therefore, in each display auditory stimuli were presented via earphones.

The task's sensitivity to individual differences in threat-biased information processing was determined on the basis of the same criteria as those used in the in the previous experiments. As will be recalled, one criterion required that the task demonstrated significant internal reliability, while the other required that the task was sensitive to individual differences in threat-biased information processing associated with anxiety. In the case of the Attention/Revised/Auditory Task, the latter criterion specifically required that the task was sensitive to anxiety-associated individual differences in revised attention from threatening auditory information. If the Attention/Revised/Auditory Task is sensitive to anxiety-associated individual differences in revised attention from auditory threat, then when the conditions in which the target is related to the cued Prime Display meaning are controlled, the responses of participants in the high trait anxiety group, compared with participants in the low trait anxiety group, would be disproportionately slowed for targets related to the Prime Display's non-threatening meaning following their initial attentional focus on the Prime Display's threatening meaning relative to their responses to targets related to the Prime Display's threatening meaning following their initial attentional focus on the Prime Display's non-threatening meaning. Alternatively, if revised attention from threat is a linear function of anxiety, then we would find a linear correlation between trait anxiety and the index of revised attention from threat.

Consistent with the approach adopted with all the experimental tasks, dependent on whether the Attention/Revised/Auditory Task demonstrated the aforementioned criteria, determined its inclusion in the final analysis of the associations between the experimental tasks, presented in chapter 11.

Method

Participants

Participants were selected in the manner outlined in chapter 2 . This gave rise to a sample, who reported a wide range of trait anxiety scores from 22 to 66. The mean trait anxiety score of 41.93, *SD* = 9.70 (screened using the STAI-T; Spielberger et al., 1983)[18]. Participants included 43 males and 97 females. Their mean age was 20.30, *SD* = 5.93.

[18] This mean trait anxiety score was comparable with the STAI-T college student norm of 40, *SD* = 10 (Spielberger et al., 1983).

Materials

Trait Anxiety Assessment Instrument

As in the previous experiments, trait anxiety was assessed using the STAI-T (Spielberger et al., 1983).

Word-stimuli

The word stimuli employed in the present task were taken from the quintets of experimental stimuli described in Appendix A, and included those materials represented in row viii. of Table 1 in chapter 2 The word-stimuli were identical to those described in the Attention/Revised/Visual Task from Experiment 5, with the following exceptions: first, all were displayed in their auditory form; and second in place of the visual word stimuli *RED* and *GREEN*, were the auditory word stimuli *MALE* and *FEMALE*. Therefore, the word stimuli included in the Attention/Revised/Auditory Task were: the auditory words *MALE* and *FEMALE*, presented in the Constraining Cue Display; auditory *threat synonyms* and auditory *non-threat synonyms*, presented in the Prime Display; auditory *threat associates* and auditory *non-threat associates*, presented in the Target Display; and auditory *homonyms,* identical to those used in the Interpretation/Initial/Auditory Task in Experiment 4, presented in the Cue Check Display.

Experimental task

The Attention/Revised/Auditory Task was essentially identical to the Attention/Revised/Visual Task described Experiment 5, with the primary exception that the task was presented via earphones rather than on a computer screen. Apart from the word stimuli in the Prime Display, all were presented in a merged male-female voice, created by digitally combining each word when spoken by a native Australian-English speaking male with the same word when spoken by a native Australian-

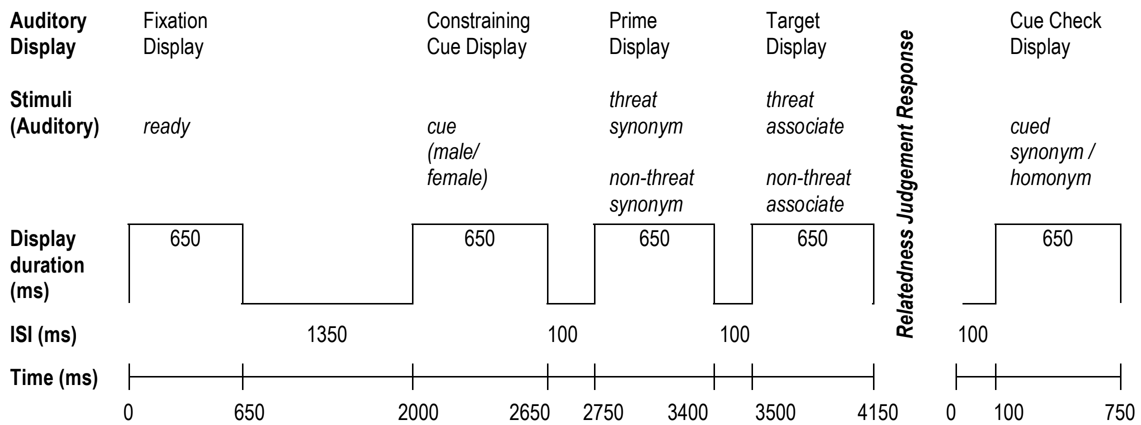
English speaking female. In parallel with the stimuli in the Attention/Initial/Auditory Task in Experiment 2, the words were spoken at an even pitch and volume. To match the stimuli in Experiments 1 to 5, the present word stimuli were digitally edited to meet a length of 650 ms. As will be recalled from the Attention/Initial/Auditory Task, when, in the Prime and Target Displays, two word stimuli were presented simultaneously, one via the left earphone and the other via the right earphone. Conversely, when a single word was presented, it was presented simultaneously via both earphones.

Since the Attention/Revised/Auditory Task was presented in the auditory modality, the Constraining Cue Display and the Prime Display slightly differed from those in the Attention/Revised/Visual Task in the last chapter. During the Constraining Cue Display, either the auditory word stimulus *MALE* or the auditory word stimulus *FEMALE* was presented via both earphones. The Prime Display was identical to the Prime Display in the Attention/Initial/Auditory Task, except that one of the Prime Display stimuli was presented in a male voice via one earphone, while the other was presented in a female voice via the other earphone. Participants were asked to hold in mind the Prime Display stimulus that was spoken by the gender denoted by the Constraining Cue Display. Specifically, if the Constraining Cue Display contained the word *MALE*, participants were required to hold in mind the Prime Display stimulus that was spoken by the male voice, while if the Constraining Cue Display contained the word *FEMALE*, participants were required to hold in mind the Prime Display stimulus that was spoken by the female voice.

In summary, as shown in Figure 8, trials in the Attention/Revised/Auditory Task included a Constraining Cue Display that contained either the auditory word stimulus *MALE* or the auditory word stimulus *FEMALE*. This was followed by a Prime Display containing an auditory *threat synonym* and an auditory *non-threat synonym*, one of which was spoken in a male voice and one of which was spoken in a female voice. After the Prime Display was a Target Display containing two *associates*, one of which, the target, was semantically related to one meaning in the Prime Display. Participants were asked to identify the location of the target word that was semantically related to either of the Prime Display stimuli, regardless of the gender in which the word was spoken. After the participants had responded, the Cue Check Display was presented. In this display either a *homonym* or the word stimulus that had appeared in the Constraining Cue Display was presented. Participants were then asked whether or not this final word stimulus was the member of the Prime Display that the Constraining Cue Display had directed them to attend towards.

Figure 8

The progression of a single trial in the Attention/Revised/Auditory Task.



The critical factors governing the conditions of the Attention/Revised/Auditory Task were identical to those governing the Attention/Revised/Visual Task in Experiment 5. As will be recalled from the Attention/Revised/Visual Task, these were: Cued Prime Display Meaning and Target Semantic Association. To prevent any confounds, the stimuli in the Attention/Revised/Auditory Task were balanced in the same way as those in the Attention/Revised/Visual Task. In parallel with the balancing of the perceptual characteristics and locations of the Prime Display stimuli in the Attention/Revised/Visual Task, in the Attention/Revised/Auditory Task, the Prime Display stimulus presented via the left earphone was equally often presented in the male voice and the female voice.

Experimental hardware

As was the case in the previous auditory tasks in Experiments 2 and 4, the stimuli were heard via Pro-Luxe KT-424 stereophonic earphones, and their presentation was controlled by a 952 MHz Intel Celeron Processor.

Procedure

Aside from some differences associated with the modality of the stimuli and the assessment of revised rather than initial information processing, the Procedure was identical to that described in Experiment 1. Since the stimuli were auditory in modality, participants wore earphones throughout the task. The other procedural differences are highlighted by the following task instructions.

Like the Attention/Revised/Visual Task in Experiment 5, participants were told that the task involved making judgements about the relatedness of words, whilst remembering other words. Participants were instructed that each trial commenced with a fixation signal, the word *READY*, followed by four displays. First, participants were told that the word presented in the first display indicated the gender of the speaking voice of the word in the second display that was to be held in mind for later recognition. They were informed that this gender would be communicated either by the spoken word *MALE* or the word *FEMALE* in this first display. Participants were instructed to hold in mind the word in the second display whose gender was indicated in the first display. Next, as was the case in the Attention/Revised/Visual Task, participants were told that the third display contained two words and were asked to identify the location of the word in this display that was *semantically related* to the meaning of either word presented in the second display[19]. They were assured that one of the words in the third display was always related to a meaning of one of the words in the second display. After identifying the targets' location, participants were told that a final display, containing a single word, would be presented and participants were asked to decide whether or not this word was the word that they had been asked to hold in mind from the second display. The need for accuracy was emphasized such that participants were instructed to work as quickly as possible without making mistakes. At no time were participants informed as to the nature of the word-stimuli.

Participants were requested to identify the location of the word in the third display that was related to a meaning in the second display by either pressing the left-pointing standard arrow key if in the third display the word presented via the left earphone was related to one of the meanings in the second display, or by pressing the right-pointing arrow key if the word presented in the third display via the right earphone was related to one of the words in the second display. As was the case in the Attention/Revised/Visual Task, participants used the key marked *S* to indicate that the word in the fourth display was the same as the word they were asked to hold in mind, and the key marked *D* to indicate that the word in the fourth display was different to the word they were asked to hold in mind.

Results

Overview

Like the results sections of the previous experiments, task internal reliability is first reported, after which the Attention/Revised/Auditory Task's sensitivity to anxiety-linked individual differences in threat-biased attention is reported.

[19] As in the previous experiments, participants were advised that words were considered related if either they had the *same meaning* as each other (e.g., *QUICK* and *FAST*), or they had an *associated meaning* (e.g., *CAT* and *DOG*).

Exclusion of Inaccurate Participants

As was the case for the results of the previous experiments, to ensure that participants complied with task instructions their accuracy was computed. In parallel with Experiment 5, two measures of task accuracy: target-location accuracy and cue-recognition accuracy (each computed in the manner described in Experiment 5), were considered when determining compliance with task instructions[20]. Across all participants, the mean percentage target-location accuracy was well above the chance level of 50%, $t(139) = 28.97$, $p < .001$, as was the mean percentage cue-recognition accuracy, $t(139) = 90.55$, $p < .001$. All participants demonstrated above chance cue-recognition accuracy, and the one participant who did not demonstrate above chance target-location accuracy was excluded from further analyses.

In parallel with the previous experiments, the sensitivity of the Attention/Revised/Auditory Task to threat-biased attention was based on participants' response latency to identify the location of target stimuli. Therefore, herein the analyses examine only participants' responses identifying the location of the target, and not participants' responses recognising whether the Cue Check stimulus was the same or different to the word specified by the Constraining Cue Display.

Internal Reliability

The internal reliability of the Attention/Revised/Auditory Task was determined using the method described in Experiment 1. As such, a Threat Bias Index was subjected to the Spearman-Brown split-half reliability formula. In parallel with Experiment 5, the Threat Bias Index reflected the effect of the revision of attentional focus away from the threatening Prime Display member relative to the effect of the revision of attentional focus away from the non-threatening Prime Display member on

[20] Target-location accuracy represented the percentage of responses in which the target was correctly located, given across the entire task's 256 trials. Cue-recognition accuracy represented the percentage of responses in which the Cue Check Display stimulus was correctly identified as either the same or different to the word specified by the Constraining Cue Display, given across the entire task's 256 trials.

the response latency for identifying target stimuli, when the effects of those conditions that did not require revision of attentional focus were controlled. The Threat Bias Index was computed using exactly the same method as used to compute the Threat Bias Index in Experiment 5.

Using the Spearman-Brown split-half formula the internal reliability of the Attention/Revised/Auditory Task was estimated as r =.13, p = ns, suggesting that the Attention/Revised/Auditory Task has very weak internal consistency. This non-significant internal reliability estimate shows that the internal reliability of the Attention/Revised/Auditory Task is not acceptable for the present research program. However, despite its unacceptable level of internal reliability, the following section considers the Attention/Revised/Auditory Task's sensitivity to trait anxiety-associated individual differences in attention bias to threat.

The Sensitivity of the Attention/Revised/Auditory Task to Anxiety-associated Individual Differences in Revised Attention from Threat

This part of the results presents the analysis of the sensitivity of the Attention/Revised/Visual Task to anxiety-associated individual differences in the revision of attentional focus from auditory threatening information. Analyses comparing the characteristics, target-location accuracy and target-location response latencies of the high and low trait anxiety groups are reported first. The correlation between trait anxiety and the accuracy Threat Bias Index and the response latency Threat Bias Index are then reported.

Comparison of Trait Anxiety Groups: Analysis of Variance

Participant Characteristics. High and low trait anxiety groups were obtained in the manner described in Experiment 1.

As was the case in the previous experiments, it was considered important to ensure that no individual participant reported a trait anxiety score at the experimental test session that was inconsistent with his/her original classification as either high or low trait anxiety level at screening. This was achieved using the method described in Experiment 1. As a consequence, three participants in the Low Trait Anxiety Group whose trait anxiety scores at the experimental test session fell above the median trait anxiety score (STAI-T = 40) were eliminated, as were three participants in the High Trait Anxiety Group whose trait anxiety scores at the experimental test session fell below the median trait anxiety score.

The characteristics of the resulting two Trait Anxiety Groups at the experimental test session are presented in Table 19.

Table 19

Participant Characteristics at the Experimental Test Session (Standard Deviations in Parentheses)

	N	Number of Males	Number of Females	Mean Age (Years)	Mean STAI-T Trait Anxiety
Low Trait Anxiety Group	53	15	38	20.6 (4.7)	31.9 (4.2)
High Trait Anxiety Group	52	18	34	20.5 (6.7)	51.0 (6.0)

An independent samples *t* test showed that participants in the High and Low Trait Anxiety Groups differed significantly on the STAI-T (Spielberger et al., 1983) during the experimental test session, $t(103) = 18.89$, $p < .001$. However, another independent samples *t* test showed no significant difference between the groups in age, $t(103) = .07$, $p = .94$. Likewise, a Chi square test for independence, using Yates' Continuity Correction, showed that there was no significant difference between the two

Anxiety Groups in terms of the distribution of males and females, X^2 (1) = .23, p = .62.

Accuracy. Table 20 displays the two participant groups' mean percentage target-location accuracy for the conditions of the factors: Cued Prime Display Meaning (Threat Prime Display Meaning Cued, Non-threat Prime Display Meaning Cued) and Target Semantic Association (Target Related to Threat condition, Target Related to Non-threat condition).

Table 20

Mean Percentage of Correct Relatedness Judgement Responses (Standard Deviations in Parentheses)

Cued Prime Display Meaning	Target Semantic Association	Low Trait Anxiety Group	High Trait Anxiety Group
Threat Prime Display Meaning Cued	Target Related to Threat	78.47 (9.03)	77.88 (11.31)
	Target Related to Non-threat	73.52 (13.52)	69.98 (13.43)
Non-threat Prime Display Meaning Cued	Target Related to Threat	70.57 (12.02)	67.78 (13.07)
	Target Related to Non-threat	82.19 (9.39)	79.95 (11.34)

As in the previous experiments, to ensure that the target-location accuracy of the Trait Anxiety Groups did not differ as a function of experimental condition a repeated measures ANOVA, considering the effects of Cued Prime Display Meaning (Threat Prime Display Meaning Cued vs. Non-threat Prime Display Meaning Cued), Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat) and Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) on target-location accuracy was conducted.

There was no main effect of Trait Anxiety Group, $F(1,103) = 1.46$, $p = .22$, that is there was no significant difference between the target-location accuracy of participants in the High Trait Anxiety Group and participants in the Low Trait Anxiety Group. There was no main effect of Cued Prime Display Meaning, $F(1,103) = .14$, $p = .70$, meaning that there was no significant difference between participants' target-location accuracy for the Threat Prime Display Meaning Cued trials relative to the Non-threat Prime Display Meaning Cued trials. A main effect of Target Semantic Association was found, $F(1,103) = 34.73$, $p < .001$, such that the mean target-location accuracy of all participants was significantly greater in the Target Related to Non-threat condition relative to the Target Related to Threat condition. Therefore if there is an effect of Target Semantic Association on target-location response latency, it will be important to ensure that this is not due to a speed-accuracy trade-off.

A significant interaction between Target Semantic Association and Cued Prime Display Meaning was found, $F(1,103) = 65.76$, $p < .001$. This result shows that mean target-location accuracy increased when the emotional valence of the Cued Prime Display Meaning matched the valence of the Target Semantic Association. Therefore, if there is an interaction effect of Target Semantic Association and Cued Prime Display Meaning on target-location response latency, it will be important to ensure that this is not due to a speed-accuracy trade-off. As desired, there was no interaction between Trait Anxiety Group and Target Semantic Association, $F(1,103) = 1.66$, $p = .19$. This means that the mean target-location accuracy of participants in the High Trait Anxiety Group was not significantly different to the mean target-location accuracy of participants in the Low Trait Anxiety Group in either the Target Related to Threat condition, or in the Target Related to Non-threat condition. Also as desired, there was no interaction between Trait Anxiety Group and Cued Prime Display Meaning, $F(1,103) = .27$, $p = .60$. Therefore, the mean target-location accuracy of participants in the High Trait Anxiety Group was not significantly different to the mean target-location accuracy of participants in the Low Trait Anxiety Group in either the Threat Prime Display Meaning Cued condition or the Non-threat Prime Display Meaning Cued condition. Finally, there was no interaction between Trait Anxiety Group, Target Semantic Association and Cued Prime Display Meaning, $F(1,103) = .60$, $p = .44$. This means that the mean target-location accuracy of participants in the High Trait Anxiety Group was not significantly different to the mean target-location accuracy of participants in the Low Trait Anxiety Group when accounting for the effects of both Target Semantic Association and Cued Prime Display Meaning.

Response Latency. The preceding analyses confirmed that the participants included in the analyses reported trait anxiety at test time that was representative of the Trait Anxiety Group to which they had been allocated. Likewise, these analyses showed that the participants included in the analyses completed the Attention/Revised/Auditory Task as instructed and that the target-location accuracy of the two Trait Anxiety Groups did not differ. Therefore, the issue of key importance: whether or not the Attention/Revised/Auditory Task revealed anxiety-associated differences in revised attention from threat, is now considered.

Revised attention from threat was measured by the differential speed with which participants correctly identified the target stimulus as a function of the experimental conditions derived from the two factors of Target Semantic Association and Cued Prime Display Valence. It was expected that the more difficulty a person had revising their initial attentional focus away from threat, the longer it would take to respond to the target. As displayed in Table 21, the median response latency for each participant to correctly identify the target in each experimental condition was calculated.

Table 21

Average Median Response Latency (in ms) to Correctly Identify Targets (Standard Deviations in Parentheses)

Cued Prime Display Meaning	Target Semantic Association	Low Trait Anxiety Group	High Trait Anxiety Group
Threat Prime Display Meaning Cued	Target Related to Threat	1947.16 (596.02)	1879.21 (591.10)
	Target Related to Non-threat	2120.66 (568.06)	2160.99 (777.31)
Non-threat Prime Display Meaning Cued	Target Related to Threat	2210.37 (722.34)	2269.95 (806.81)
	Target Related to Non-threat	1892.55 (529.19)	1839.05 (574.81)

These reaction time data were analysed using a repeated measures ANOVA considering the effects of the between-subjects factor, Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) and the within-subjects factors, Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat) and Cued Prime Display Meaning (Threat Prime Display Meaning Cued vs. Non-threat Prime Display Meaning Cued).

A significant main effect of Target Semantic Association was found where all participants demonstrated faster median target-location response latencies in the Target Related to Non-threat condition, than in the Target Related to Threat Condition, $F(1,103) = 10.89$, $p < .001$. This finding is consistent with the effect of Target Semantic Association on target-location accuracy as reported in the preceding target-location accuracy analysis, which showed that participants were more accurate in the Target Related to Non-threat condition, relative to the Target Related to Threat Condition. No main effect of Cued Prime Display Meaning was found, $F(1,103) = 2.43$, $p = .12$, such that there was no difference between the median target-location response latency for the Threat Prime Display Meaning Cued trials relative to the Non-threat Prime Display Meaning Cued trials. There was also no main effect of Trait Anxiety Group, $F(1,103) = .002$, $p = .96$. This means that the median target-location response latency of participants in the High Trait Anxiety Group was not significantly different to the median target-location response latency of participants in the Low Trait Anxiety Group.

There was no significant interaction between Trait Anxiety Group and Target Semantic Association, $F(1,103) = .003$, $p = .95$, therefore there was no group difference in the effect of Target Semantic Association. There was also no significant interaction between Trait Anxiety Group and Cued Prime Display Meaning, $F(1,103) = .25$, $p = .61$, meaning that there was no group difference in the effect of Cued Prime Display Meaning. A significant interaction between Target Semantic Association and Cued Prime Display Meaning was found, $F(1,103) = 58.11$, $p < .001$. This means that median target-location response latency was more greatly speeded when the emotional valence of the Cued Prime Display Meaning matched the valence of the Target Semantic Association compared with when the emotional valence of the Cued Prime Display Meaning did not match the valence of the Target Semantic Association. This finding is consistent with the preceding target-location accuracy analysis which showed that target-location accuracy was greater when there was a match between the emotional valence of the Cued Prime Display Meaning and the Target Semantic Association compared with when there was a mismatch between the emotional valence of the Cued Prime Display Meaning and the Target Semantic Association. Assuming that relative target-location response latency is a measure of revised attention from threat, this suggests that on average all participants were more likely to have difficulty revising their initial focus of attention away from non-threat stimuli than from threat stimuli.

There was no significant interaction between Target Semantic Association, Cued Prime Display Meaning and Trait Anxiety Group, $F(1,103) = 1.96$, $p = .16$, which means there was no group difference in the interaction effect of Target Semantic Association and Cued Prime Display Meaning.

If we assume that relative target-location response latency is a measure of revised attention from threat, the preceding results suggest that the Attention/Revised/Auditory Task is not sensitive to anxiety-associated group differences in revised attention from threat. However, it is possible that the Attention/Revised/Auditory Task is sensitive to a linear relationship between anxiety and revised selective attention, that was not picked up by the analysis of variance. Therefore, the following section uses Pearson Correlational Analysis to analyse the relationship between anxiety and revised selective attention.

Linear Association between Trait Anxiety and Revised Attention from threat: Pearson Correlational Analyses

Participant Characteristics. In parallel with the Correlational Analyses in the previous experiments, participants falling in the Mid-Trait Anxiety Band were reinstated to the analyses. As previously, the requirements of consistency of trait anxiety level and target-location accuracy, as described in the Comparison of Trait Anxiety Groups Section above, applied to inclusion in the correlational analyses. Since all participants falling within the Mid-Trait Anxiety Band met these requirements, all were included.

Accuracy. As was the case in the previous experiments, to ensure that there was no linear association between anxiety and the relative target-location accuracy of responses to trials of the different experimental conditions a measure of trait anxiety and a measure of the relative target-location accuracy of responses on trials of the different experimental conditions, were subjected to a Pearson correlational analysis.

The key measures included in this correlational analysis were identical those included in the Correlational Analysis of Accuracy in Experiment 5. These were:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. An Accuracy Threat Bias Index: Computed in the same manner as the Threat Bias Index in Experiment 5 was computed, except that the measure used to compute the Accuracy Threat Bias Index was mean target-location accuracy, rather than median correct target-location response latency which was used to compute the Threat Bias Index.

Since both the Accuracy Threat Bias Index and the Trait Anxiety Index were normally distributed, a Pearson correlation coefficient was calculated. The correlation coefficient representing the linear relationship between trait anxiety and the Accuracy Threat Bias Index was $r = .05$, $p = .51$. The small magnitude of this correlation coefficient indicates no relationship between the two variables. The absence of a significant correlation between anxiety and the Accuracy Threat Bias Index, gives us confidence that any differences in response latency in the following analysis are not due to differences in task difficulty.

Response Latency. The preceding analyses confirmed that the there is no linear association between anxiety and the relative target-location accuracy for different experimental conditions on the Attention/Revised/Auditory Task. Therefore, we can proceed to analyse whether the Attention/Revised/Auditory Task revealed a linear association between anxiety and threat-biased attention, as measured by the relative target-location response latency for targets correctly identified as related to threatening relative to non-threatening Prime Display stimuli when the valence of the cued Prime Display stimulus is taken into account.

The key measures included in this correlational analysis were identical to those employed in the Correlational Analyses of Response Latency in Experiment 5. They were:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. A Threat Bias Index: computed in the manner described in Experiment 5.

Like the Trait Anxiety Index, the Threat Bias Index was normally distributed. Therefore, a Pearson correlational analysis was conducted. The Pearson correlation coefficient representing the linear relationship between trait anxiety and the Threat Bias Index was $r = -.05$, $p = .52$. This small correlation coefficient suggests that there is no relationship between the two variables. Assuming that the Threat Bias Index provides a measure of revised attention from threat, this correlation coefficient provides no evidence that the Attention/Revised/Auditory Task is sensitive to a linear association between trait anxiety and revised attention from threat.

Discussion

Summary of Findings

The present experiment was intended to assess the sensitivity of the Attention/Revised/Auditory Task to anxiety-linked individual differences attention bias to threat. The specific form of attention bias to threat that the Attention/Revised/Auditory Task was designed to measure was the revision of focus of attention away from threatening relative to non-threatening auditory information. As was the case in the previous experiments, this was determined on the basis of the strength of the task's internal reliability and on the basis of the task's capacity to demonstrate anxiety-associated attention bias to threat.

The split-half reliability estimate shows that the Attention/Revised/Auditory Task has weak internal reliability that fails to meet the choice level required to be considered acceptable for the present research. This finding demonstrates the importance of the innovation of measuring the internal reliability of measures of selective information processing.

The results of the group comparison and the correlational analysis also suggested that the Attention/Revised/Auditory Task is insensitive to individual differences in revised attention from threat associated with anxiety. Compared with those trials in which the target was related to the cued Prime Display stimulus, participants in the High and Low Trait Anxiety Groups displayed similar patterns of target-location response latency for trials in which the Prime Display's threatening member was cued, but the target was related to the Prime Display's non-threatening member, relative to trials in which the Prime Display's non-threatening member was cued, but the target was related to the Prime Display's threatening member. Therefore, assuming that relative target-location response latency is a measure of individual differences in revised attention from threat, the Attention/Revised/Auditory Task did not pick up any anxiety group differences in revised focus of attention from threat. Likewise, trait anxiety was not found to be linearly correlated with an index of revised focus of attention from threat. Therefore, assuming that the Threat Bias Index measures revised attention from threat, there is also no evidence of a linear relationship between anxiety and revised attention from threat.

Explanations for Findings

In light of the literature demonstrating anxiety-associated individual differences in revised attention from threat (reviewed in: MacLeod, 1999; MacLeod & Rutherford, 2004; Mathews & MacLeod, 1994, 2005), the present null results arguably may be attributed to the insensitivity of the Attention/Revised/Auditory Task. This section will consider possible reasons for this insensitivity.

The insensitivity of the Attention/Revised/Auditory Task to anxiety-associated individual differences in threat-biased attention may be explained in the same terms as those used to explain the insensitivity of the Attention/Revised/Visual Task in Experiment 5. As will be recalled these included: an insufficient number of locations in which to search for the target (Fox, 1994; Mathews, et al., 1990); and the potential need to rely on cognitive resources other than attentional processing to complete the task.

In Experiment 5, it was anticipated that as was the case for the tasks measuring initial information processing towards threat (Experiments 1-4), the sensitivity of the tasks in the present thesis measuring revised information processing from threat, may more greatly apparent when stimuli are presented in the auditory modality. However, the insensitivity of the present Attention/Revised/Auditory Task fails to support this prediction. Rather, it seems to be the case that the present tasks measuring initial information processing towards threat are only sensitive to individual differences in information processing bias towards threat when stimuli are presented in the auditory modality, whereas the present tasks measuring revised attention from threat are not sensitive to individual differences in revised attention from threat at all. The following Experiments 8 and 9 will determine whether stimulus modality affects the sensitivity of tasks measuring revised interpretation from threat.

Implications for Present Research Thesis

Regardless of the explanation for the insensitivity of the Attention/Revised/Auditory Task to individual differences in threat-biased attention associated with anxiety, the ultimate purpose of this experiment was to determine the suitability of the Attention/Revised/Auditory Task for inclusion in the final analysis of the patterns of associations across all the experimental tasks presented in chapter 11. On the basis of the criteria set out in chapter 2, since the Attention/Revised/Auditory Task did not possess significant internal reliability and was not sensitive to anxiety-associated individual differences in threat-biased attention, it was only included in the first stage of the final analysis.

Conclusions

In conclusion, the results of Experiment 6 showed that the Attention/Revised/Auditory Task did not evidence significant internal reliability or significant sensitivity to individual differences in revised attention from threat associated with anxiety. Therefore, it will be included in only the first stage of the final analysis of the patterns of associations between the experimental tasks presented in chapter 11.

CHAPTER 9

EXPERIMENT 7:

The Interpretation/Revised/Visual Task

Experiment 7 was designed to evaluate the sensitivity of the Interpretation/Revised/Visual Task to individual differences in the threat-biased interpretation. The form of threat-biased interpretation that this task was intended to measure was the ease with which the initial interpretation of ambiguous visual word stimuli as threatening, can be revised and reinterpreted as non-threatening.

The design of Experiment 7 was identical to those of the previous experiments, except that the experimental task included was the Interpretation/Revised/Visual Task. Like the previous experimental tasks, the Interpretation/Revised/Visual Task was a variant of the General Approach to Bias Assessment described in chapter 2. Its design was parallel to that of the Interpretation/Initial/Visual Task in Experiment 3. However, rather than measuring an individual's initial threat-biased interpretation, it was designed to measure the subsequent revision of interpretation away from threat, following the initial interpretation of an ambiguous stimulus as threatening, herein known as *revised interpretation from threat*. The Interpretation/Revised/Visual Task was identical to the Interpretation/Initial/Visual Task with the primary exception that it included an additional display, the Constraining Cue Display, which appeared prior to the Prime Display and Target Display, and was designed to semantically prime one of the meanings in the Prime Display. To fulfil subsequent task requirements, participants then needed to revise their initial interpretation of the Prime Display stimulus, reinterpreting the Prime Display stimulus in terms of its alternative meaning. Revised interpretation from threat was measured by the relative ease with which associates of each type of Prime Display member were identified after the Prime Display stimulus had initially been interpreted in terms of the alternative meaning. It was assumed that difficulty revising one's initial interpretation of ambiguous stimuli as threatening would be reflected by a disproportionate slowing in the identification of the location of targets related to the Prime Display's non-threatening meanings following initial interpretation of the Prime Display stimulus as threatening, relative to the identification of the location of targets related to the Prime Display's threatening meanings, following initial interpretation of the Prime Display stimulus as non-threatening.

Consistent with the previous experiments, two criteria determined the sensitivity of an experimental task to individual differences in threat-biased information processing: one required that the task demonstrate significant internal reliability; and the other required that the task was sensitive to individual differences in threat-biased information processing previously shown to be associated with anxiety (e.g., MacLeod et al., 1986; Mogg et al., 1996; Mogg et al., 1994). In the case of the Interpretation/Revised/Visual Task, the latter criterion specifically required that the task was sensitive to anxiety-associated individual differences in revised interpretation from threatening visual information. If the Interpretation/Revised/Visual Task is sensitive to anxiety-associated individual differences in revised interpretation from threat, then when the conditions in which the target is related to the cued Prime Display meaning are controlled, the responses of participants in the high trait anxiety group compared with those of participants in the low trait anxiety group, would be disproportionately slowed for targets related to the Prime Display's non-threatening meaning following their initial interpretation of the Prime Display as threatening *relative to* their responses to targets related to the Prime Display's threatening meaning following their initial interpretation of the Prime Display as non-threatening. In the case of the latter method of analysis, it was anticipated that if the revised interpretation from threat is a linear function of anxiety, then we would find a significant linear correlation between trait anxiety and the index of revised interpretation from threat. Like the previous experiments, if there is either a significant trait anxiety group difference in response latency or a significant correlation between trait anxiety and an index of revised interpretation from threat, the Interpretation/Revised/Visual Task will be considered sensitive to anxiety-associated individual differences in revised interpretation from threat.

Consistent with the approach adopted with all the experimental tasks, dependent on whether the Interpretation/Revised/Visual Task demonstrated the aforementioned criteria, determined its inclusion in the final analysis of the associations between the experimental tasks, presented in chapter 11.

Method

Participants

Participants were selected in the manner outlined in chapter 2. This gave rise to a sample, who reported a wide range of trait anxiety scores from 22 to 62. The mean trait anxiety score was 41.98, *SD* = 9.35 (screened using the STAI-T; Spielberger et al., 1983)[21]. Participants included 51 males and 89 females. Their mean age was 20.27, *SD* = 5.16.

Materials

Trait Anxiety Assessment Instrument

As in the previous experiments, trait anxiety was assessed using the STAI-T (Spielberger et al., 1983).

[21] This mean trait anxiety score was comparable with the STAI-T college student norm of 40, *SD* = 10 (Spielberger et al., 1983).

Word-stimuli

The word-stimuli used in the Interpretation/Revised/Visual Task were taken from the quintets of experimental stimuli described in Appendix A, and represented in row iii. of Table 1 in chapter 2. The bulk of these stimuli were identical to those used in the Interpretation/Initial/Visual Task in Experiment 3. As will be recalled from the Interpretation/Initial/Visual Task, these included: visual *homonyms*, presented in the Prime Display, and visual *threat associates* and visual *non-threat associates,* presented in the Target Display. Visual *threat synonyms* and visual *non-threat synonyms*, identical to those used in the Attention/Initial/Visual Task in Experiment 1, were presented in the Constraining Cue and the Cue Check Displays.

Experimental task

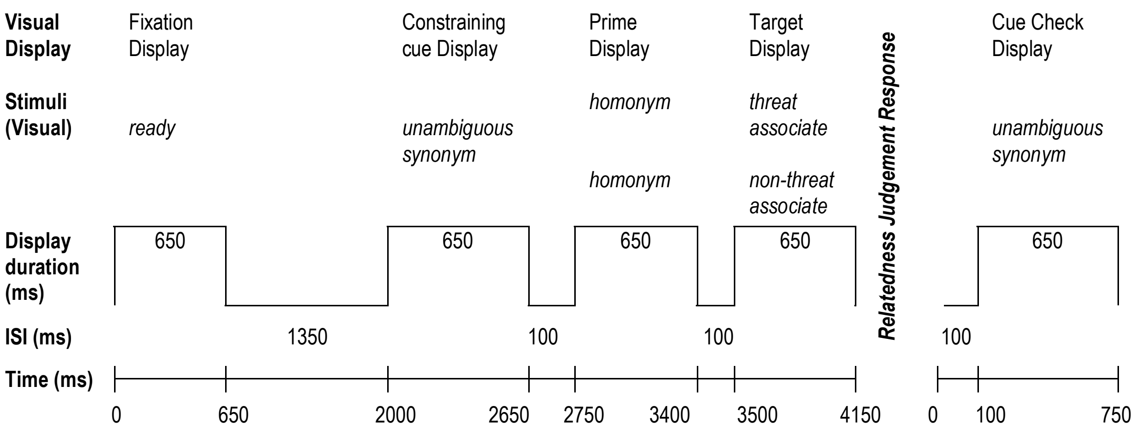
The design of the Interpretation/Revised/Visual Task may best be understood by reference to the Interpretation/Initial/Visual Task in Experiment 3, and the Attention/Revised/Visual Task in Experiment 5. The Prime Display and Target Display of the Interpretation/Revised/Visual Task were identical to the Prime Display and Target Display of the Interpretation/Initial/Visual Task. However, in addition to the Prime Display and Target Display, the Interpretation/Revised/Visual Task also contained a Constraining Cue Display and a Cue Check Display. Although the Constraining Cue Display and the Cue Check Display in the present task differed from those contained in the Attention/Revised/Visual Task, their purpose was the same.

The following is a description of the progression of a trial in the Interpretation/Revised/Visual Task. As in the Interpretation/Initial/Visual Task (Experiment 3), all experimental stimuli were coloured white, in uppercase, regular Arial font, 1.10 cm high, presented against a black background on a computer screen. The task began with a Fixation Display identical to that of the

Interpretation/Initial/Visual Task: the word stimulus *READY* was presented in the centre of the screen for 650 ms. After an interval of 1350 ms the Constraining Cue Display appeared. This was designed to semantically prime one meaning of the following Prime Display stimulus. During the Constraining Cue Display, either the *threat synonym* or the *non-threat synonym* taken from the same quintet as the *homonym* in the following Prime Display, was presented in the centre of the computer screen for 650 ms. Participants were instructed to hold in mind the word that was presented during the Constraining Cue Display. 100 ms after the termination of the Constraining Cue Display, the Prime Display appeared. The Prime Display was identical to that in the Interpretation/Initial/Visual Task and contained a *homonym*, presented in duplicate in two spatially separate locations, one above and one below the screen's centre, vertically separated by a distance of 2.8 cm, for 650 ms. 100 ms after the termination of the Prime Display, the Target Display appeared. The Target Display was identical to that in the Interpretation/Initial/Visual Task and contained two word stimuli: a target that was semantically related to one of meaning the Prime Display stimulus, and a foil. The Target Display stimuli were presented simultaneously for 650 ms, one above and one below the screen's centre, vertically separated by a distance of 2.8 cm. Participants were asked to identify the location of the target word that was semantically related to the Prime Display stimulus. One hundred ms after participants responded, they were presented with the final Cue Check Display. The Cue Check Display was designed to confirm compliance with the instruction communicated by the initial Constraining Cue Display. During the Cue Check Display either the *synonym* that had been presented within that trial's Constraining Cue Display, or a different *synonym*, taken from a different quintet to the *homonym*, and that had not appeared within that block of trials, was presented in the centre of the screen for 650 ms. Participants were asked to indicate whether or not this was the word presented in the Constraining Cue Display. The speed and accuracy of participants' responses were recorded by the task program. Figure 9 summarises the progression of a trial in the Interpretation/Revised/Visual Task.

Figure 9

The progression of a single trial in the Interpretation/Revised/Visual Task.



The critical factors governing the conditions of the Interpretation/Revised/Visual Task were identical to those that governed the conditions of the Attention/Revised/Visual Task (Experiment 5) which were: Cued Prime Display Meaning and Target Semantic Association. As will be recalled, the Cued Prime Display Meaning Factor determined whether the threatening or the non-threatening Prime Display meaning was initially cued, while the Target Semantic Association Factor determined whether the target was related to the Prime Display's threatening or non-threatening meaning.

To prevent any confounds, the stimuli in the Interpretation/Revised/Visual Task were balanced as follows. In the Target Display the target was presented equally often in the two possible stimulus locations. Further, the Cue Check Display stimulus was equally often the same as it was different to the Constraining Cue Display stimulus. Accounting for the balancing of the two critical factors and the differences in stimulus position and stimulus type, resulted in 16 different possible trial presentation conditions.

Experimental hardware

As in Experiments 1, 3 and 5, the stimuli were displayed on a 35 cm NEC Multi-Sync V530 monitor, controlled by a 952 MHz Intel Celeron Processor.

Procedure

Apart from differences resulting from the assessment of revised rather than initial information processing, the Procedure was the same as that of Experiment 1. The procedural differences are highlighted by the following task instructions.

With minor exceptions relating to presentation modality, the instructions were equivalent across the present Interpretation/Revised/Visual Task and the Interpretation/Revised/Auditory Task in Experiment 8. In both of these tasks, participants were directed as follows. They were told that the task involved making judgements about the relatedness of words, whilst remembering other words. Participants were instructed that each trial commenced with a fixation signal, the word *READY*, followed by four displays. Participants were directed to hold in mind the word presented in the first display for later recognition. They were asked to identify the location of the word in the third display that was *semantically related* to a meaning presented in the second display[22]. They were assured that one of the words in the third display was always related to a meaning in the second display. Participants were told that after making their response, a final fourth display, containing a single word would be presented. They were asked to decide whether a word in a final fourth display was the word that they had been asked to hold in mind. The need for accuracy was emphasized such that participants were instructed to work as quickly as possible

[22] As in the previous experiments, participants were advised that words were considered related if either they had the *same meaning* as each other (e.g., *QUICK* and *FAST*), or they had an *associated meaning* (e.g., *CAT* and *DOG*).

without making mistakes. At no time were participants informed as to the nature of the word-stimuli. In the Interpretation/Revised/Visual Task, participants were directed to indicate their responses using the same arrow keys as those described in Experiment 5.

Results

Overview

This results section is organised in exactly the same manner as the results sections of the earlier experiments: the task's internal reliability is reported first, next the task's sensitivity to anxiety-associated revised interpretation from threat is reported.

Exclusion of Inaccurate Participants

As with the results of the previous experiments, to ensure that participants complied with task instructions, their accuracy was computed. Two measures of task accuracy were taken: participants' target-location accuracy and participants' cue-recognition accuracy[23], each computed in the manner described in Experiment 5. Across all participants, the mean percentage target-location accuracy was well above the chance level of 50%, $t(139) = 52.58$, $p < .001$, as was the mean percentage cue-recognition accuracy, $t(139) = 115.04$, $p < .001$. Since all participants demonstrated target-location accuracy and cue-recognition accuracy above chance level, all were included in the analyses.

As was the case for the previous experiments, the sensitivity of the Interpretation/Revised/Visual Task to threat-biased interpretation was based on participants' response latency to identify the location of target stimuli. Therefore, herein the analyses examine only participants' responses identifying the location of the

[23] Target-location accuracy represented the percentage of responses in which the target was correctly located, given across the entire task's 256 trials. Cue-recognition accuracy represented the percentage of responses in which the Cue Check Display stimulus was correctly identified as either the same or different to the word specified by the Constraining Cue Display, given across the entire task's 256 trials.

target, and not participants' responses recognising whether the Cue Check stimulus was the same or different to the word specified by the Constraining Cue Display.

Internal Reliability

The internal reliability of the Interpretation/Revised/Visual Task was determined using the same approach as that used in the previous experiments - the split-half method with the Spearman-Brown correction. For this purpose, a Threat Bias Index was computed to reflect the effect on target location response latency of revision of interpretation away from the threatening Prime Display meaning, *relative to* the effect on target location response latency of revision of interpretation away from the non-threatening Prime Display meaning, when the effects of conditions that did not require revision of interpretation were controlled.

The Threat Bias Index was calculated in exactly the same manner as the Threat Bias Index in Experiment 5 was calculated. It was assumed that difficulty revising one's initial interpretation away from threatening relative to non-threatening information was reflected by a greater Threat Bias Index.

Using the Spearman-Brown split-half formula, the internal reliability of the Interpretation/Revised/Visual Task was estimated as r =.03, p = ns. This suggests that the Interpretation/Revised/Visual Task has extremely weak internal consistency. For the purpose of the present research, this level of internal reliability is not acceptable. Nevertheless, the following section considers the task's sensitivity to trait anxiety-associated individual differences in interpretation bias to threat.

The Sensitivity of the Interpretation/Revised/Visual Task to Anxiety-associated Individual Differences in Revised Interpretation from Threat

This part of the results presents the analysis of the sensitivity of the Interpretation/Revised/Visual Task to anxiety-associated individual differences in the revision of interpretation away from visual threatening information. Analyses comparing the characteristics, target-location accuracy and target-location response latencies of the high and low trait anxiety groups are reported first. Correlations between trait anxiety and the accuracy Threat Bias Index and the response latency Threat Bias Index are then reported.

Comparison of Trait Anxiety Groups: Analysis of Variance

Participant Characteristics. High and low trait anxiety groups were obtained in the manner described in the Experiment 1.

As was the case in the previous experiments, it was considered important to ensure that no individual participant reported a trait anxiety score at the experimental test session that was inconsistent with his/her original classification as either high or low trait anxiety level at screening. This was achieved using the method described in Experiment 1. As a result seven participants in the Low Trait Anxiety Group whose trait anxiety scores at the experimental test session fell above the median trait anxiety score (STAI-T = 40) were eliminated, as were three participants in the High Trait Anxiety Group whose trait anxiety scores at the experimental test session fell below the median trait anxiety score.

The characteristics of the resulting two Trait Anxiety Groups at the experimental test session are presented in Table 22.

Table 22

Participant Characteristics at the Experimental Test Session (Standard Deviations in Parentheses)

	N	Number of Males	Number of Females	Mean Age (Years)	Mean STAI-T Trait Anxiety
Low Trait Anxiety Group	49	18	31	21.2 (5.9)	31.2 (5.2)
High Trait Anxiety Group	53	19	34	20.0 (5.0)	52.2 (6.1)

An independent samples *t* test showed that participants in the High and Low Trait Anxiety Groups differed significantly in terms of trait anxiety as measured by the STAI-T (Spielberger et al., 1984) during the experimental test session, $t(100) = 18.55$, $p < .001$. Another independent samples *t* test showed no significant difference between the groups in age, $t(100) = 1.12$, $p = .26$. Likewise, a Chi square test for independence, using Yates' Continuity Correction, showed that there was no significant difference between the two Anxiety Groups in terms of the distribution of males and females, $X^2 (1) = .00$, $p = 1.00$.

Accuracy. Table 23 displays the two participant groups' mean percentage target-location accuracy for the conditions of the factors: Cued Prime Display Meaning (Threat Prime Display Meaning Cued, Non-threat Prime Display Meaning Cued) and Target Semantic Association (Target Related to Threat condition, Target Related to Non-threat condition).

Table 23

Mean Percentage of Correct Relatedness Judgement Responses (Standard Deviations in Parentheses)

Cued Prime Display Meaning	Target Semantic Association	Low Trait Anxiety Group	High Trait Anxiety Group
Threat Prime Display Meaning Cued	Target Related to Threat	90.56 (5.49)	84.84 (12.94)
	Target Related to Non-threat	89.09 (6.54)	83.04 (11.83)
Non-threat Prime Display Meaning Cued	Target Related to Threat	85.71 (7.35)	79.59 (14.28)
	Target Related to Non-threat	93.75 (4.88)	90.35 (8.94)

As in the previous experiments, to ensure that the target-location accuracy of the Trait Anxiety Groups did not differ as a function of experimental condition a repeated measures ANOVA, considering the effects of Cued Prime Display Meaning (Threat Prime Display Meaning Cued vs. Non-threat Prime Display Meaning Cued), Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat) and Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) on target-location accuracy was conducted.

There was no main effect of Cued Prime Display Meaning, $F(1,100) = 1.58$, $p = .21$, meaning that there was no significant difference between participants' target-location accuracy for the Threat Prime Display Meaning Cued trials relative to the Non-threat Prime Display Meaning Cued trials. A main effect of Target Semantic Association was found, $F(1,100) = 66.19$, $p < .001$, such that the mean target-location accuracy of all participants was significantly greater in the Target Related to Non-threat condition relative to the Target Related to Threat condition. Therefore, if there is an effect of Target Semantic Association on target-location response latency, it will be important to ensure that this is not due to a speed-accuracy trade-off. There was also a main effect of Trait Anxiety Group, $F(1,100) = 9.56$, $p < .01$, such that the target-location accuracy of the Low Trait Anxiety participants was significantly greater than the target-location accuracy of the High Trait Anxiety participants. Therefore, if there is a group difference on target-location response latency, it will be necessary to ensure that this is not due to a speed-accuracy trade-off.

A significant interaction between Target Semantic Association and Cued Prime Display Meaning was found, $F(1,100) = 74.01$, $p < .001$, such that mean target-location accuracy increased when the emotional valence of the Cued Prime Display Meaning matched the valence of the Target Semantic Association. Therefore if there is an interaction effect of Target Semantic Association and Cued Prime Display Meaning on target-location response latency, it will be important to ensure that this is not due to a speed-accuracy trade-off. As desired, there was no interaction between Trait Anxiety Group and Target Semantic Association, $F(1,100) = 1.57$, $p = .21$. This means that the mean target-location accuracy of participants in the High Trait Anxiety Group was not significantly different to the mean target-location accuracy of participants in the Low Trait Anxiety Group in either the Target Related to Threat condition, or in the Target Related to Non-threat condition. Also as desired, there was no interaction between Trait Anxiety Group and Cued Prime Display Meaning, $F(1,100) = 2.29$, $p = .13$. Therefore, the mean target-location accuracy of participants in the High Trait Anxiety Group was not significantly different to the mean target-location accuracy of participants in the Low Trait Anxiety Group in either the Threat Prime Display Meaning Cued condition or the Non-threat Prime Display Meaning Cued condition. Finally, there was no interaction between Trait Anxiety Group, Target Semantic Association and Cued Prime Display Meaning, $F(1,100) = 1.42$, $p = .23$. This means that the mean target-location accuracy of participants in the High Trait Anxiety Group was not significantly different to the mean target-location accuracy of participants in the Low Trait Anxiety Group when accounting for the effects of both Target Semantic Association and Cued Prime Display Meaning.

Response Latency. The preceding analyses confirmed that the participants included in the analyses reported trait anxiety at test time that was representative of the Trait Anxiety Group to which they had been allocated. These analyses also showed that the participants completed the Interpretation/Revised/Visual Task as instructed and that the target-location accuracy of the two Trait Anxiety Groups did not differ. Therefore, we can now turn to the issue of key importance: whether or not the Interpretation/Revised/Visual Task revealed anxiety-associated differences in revised interpretation from threat.

Revised interpretation from threat was measured by the differential speed with which participants correctly identified the target stimulus as a function of the experimental conditions derived from the two factors Target Semantic Association and Cued Prime Display Valence. It was expected that the more difficulty a person had revising his/her initial interpretation away from threat, the longer it would take him/her to respond to the target. As displayed in Table 24, the median response latency for each participant to correctly identify the target in each experimental condition was calculated.

Table 24

Average Median Response Latency (in ms) to Correctly Identify Targets (Standard Deviations in Parentheses)

Cued Prime Display Meaning	Target Semantic Association	Low Trait Anxiety Group	High Trait Anxiety Group
Threat Prime Display Meaning Cued	Target Related to Threat	1368.10 (353.07)	1369.22 (441.02)
	Target Related to Non-threat	1445.39 (414.05)	1486.94 (442.26)
Non-threat Prime Display Meaning Cued	Target Related to Threat	1614.31 (424.73)	1575.17 (521.53)
	Target Related to Non-threat	1251.17 (282.61)	1262.35 (344.31)

These reaction time data were analysed using a repeated measures ANOVA considering the effects of the between-subjects factor, Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group), and the within-subjects factors, Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat) and Cued Prime Display Meaning (Threat Prime Display Meaning Cued vs. Non-threat Prime Display Meaning Cued).

A significant main effect of Target Semantic Association was found where all participants demonstrated faster median target-location response latencies in the Target Related to Non-threat condition, than in the Target Related to Threat Condition, $F(1,100) = 47.62$, $p < .001$. This finding is consistent with the effect of Target Semantic Association on target-location accuracy as reported in the preceding target-location accuracy analysis, which showed that participants were more accurate in the Target Related to Non-threat condition, relative to the Target Related to Threat Condition. No main effect of Cued Prime Display Meaning was found, $F(1,100) = .45$, $p = .50$, such that there was no difference between the median target-location response latency for the Threat Prime Display Meaning Cued trials relative to the Non-threat Prime Display Meaning Cued trials. There was also no main effect of Trait Anxiety Group, $F(1,100) = .002$, $p = .96$. Therefore, despite the difference between the two Trait Anxiety groups' target-location accuracy, there was no significant difference between their median target-location response latency.

There was no significant interaction between Trait Anxiety Group and Target Semantic Association, $F(1,100) = 1.69$, $p = .19$, therefore there was no group difference in the effect of Target Semantic Association. There was also no significant interaction between Trait Anxiety Group and Cued Prime Display Meaning, $F(1,100) = 2.01$, $p = .15$, meaning that there was no group difference in the effect of Cued Prime Display Meaning. A significant interaction between Target Semantic Association and Cued Prime Display Meaning was found, $F(1,100) = 100.66$, $p < .001$. This means that median target-location response latency tended to be speeded when the emotional valence of the Cued Prime Display Meaning matched the valence of the Target Semantic Association compared with when the emotional valence of the Cued Prime Display Meaning did not match the valence of the Target Semantic Association. This finding is consistent with the preceding target-location accuracy analysis which showed that target-location accuracy was greater when there was a match between the emotional valence of the Cued Prime Display Meaning and the Target Semantic Association compared with when there was a mismatch between the emotional valence of the Cued Prime Display Meaning and the Target Semantic Association. Assuming that relative target-location response latency is a measure of revised interpretation from threat, this suggests that on average all participants were more likely to have difficulty revising their initial focus of interpretation away from non-threat than revising their initial focus of interpretation away from threat. There was no significant interaction between Target

Semantic Association, Cued Prime Display Meaning and Trait Anxiety Group, $F(1,100) = .01$, $p = .90$. Therefore, there was no group difference in the interaction effect of Target Semantic Association and Cued Prime Display Meaning.

If we assume that relative target-location response latency is a measure of revised interpretation from threat, the preceding results suggest that the Interpretation/Revised/Visual Task is not sensitive to anxiety-associated group differences in revised interpretation from threat. However, it is possible that it is sensitive to a linear relationship between anxiety and revised selective interpretation, that was not picked up by the analysis of variance. Therefore, the following section uses Pearson Correlational Analysis to analyse the relationship between anxiety and revised selective interpretation.

Linear Association between Trait Anxiety and Revised Interpretation from threat: Pearson Correlational Analyses

Participant Characteristics. In parallel with the Correlational Analyses in the previous experiments, participants falling in the Mid-Trait Anxiety Band were reinstated to the analyses. As was the case in the previous experiments, the requirements of consistency of trait anxiety level and target-location accuracy, as described in the Comparison of Trait Anxiety Groups Section above, applied for inclusion in the correlational analyses. Since all participants falling within the Mid-Trait Anxiety Band met these requirements, all were included.

Accuracy. As was the case in the previous experiments, to ensure that there was no linear association between anxiety and the relative target-location accuracy of responses to trials of the different experimental conditions a measure of trait anxiety and a measure of the relative target-location accuracy of responses on trials of the different experimental conditions, were subjected to Pearson correlational analysis.

The key measures included in the correlational analyses were:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. An Accuracy Threat Bias Index: Computed in the same manner as the Threat Bias Index in Experiment 5 was computed, except that the measure used to compute the Accuracy Threat Bias Index was mean target-location accuracy, rather than median correct target-location response latency which was used to compute the Threat Bias Index.

Since both the Accuracy Threat Bias Index and the Trait Anxiety Index were normally distributed, a Pearson correlation coefficient was calculated. The Pearson correlation coefficient representing the linear relationship between trait anxiety and the Accuracy Threat Bias Index was $r = -.04$, $p = .60$. The size of this correlation coefficient indicates that there is no relationship between these variables. On the basis of this result we can be confident that any differences in response latency in the following analysis are not due to differences in task difficulty.

Response Latency. Since the preceding analysis confirmed that the there is no linear association between anxiety and the relative target-location accuracy for different experimental conditions on the Interpretation/Revised/Visual Task, we will determine whether the Interpretation/Revised/Visual Task revealed a linear association between anxiety and threat-biased interpretation as measured by the relative target-location response latency for targets correctly identified as related to threatening relative to non-threatening Prime Display stimuli, when the valence of the cued Prime Display stimulus is taken into account.

The key measures included in this correlational analysis were:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. A Threat Bias Index: computed in the same manner as the Threat Bias Index in Experiment 5 was computed.

Like the Trait Anxiety Index the Threat Bias Index was normally distributed. Therefore, a Pearson Correlational Analysis was conducted. The Pearson correlation coefficient representing the linear relationship between trait anxiety and the Threat Bias Index was $r = .17$, $p = .05$ (see Figure 12, Appendix B, for scatterplot of this relationship). While, this effect lies on the threshold of significance, it provides some evidence of a weak linear association between trait anxiety and revised interpretation from threat. Therefore, this effect could suggest that the Interpretation/Revised/Visual Task is sensitive to a linear association between trait anxiety and revised interpretation from threat.

The low and non-significant split-half reliability estimate of the Interpretation/Revised/Visual Task shows that it has poor internal consistency. However, the results of the correlational analysis between trait anxiety and a measure of revised interpretation from threat, could suggest that the Interpretation/Revised/Visual Task may be sensitive to a weak linear association between different levels of trait anxiety and differences in revised interpretation from threat. Nevertheless, caution is advised when interpreting this effect given that it is marginal.

Discussion

Summary of Findings

The present experiment was intended to assess the sensitivity of the Interpretation/Revised/Visual Task to individual differences in interpretation bias to threat. The specific form of interpretation bias to threat that the task was designed to measure was the revision of interpretation away from the threatening meaning relative to the non-threatening meaning of an ambiguous visual stimulus. As was the case in the previous experiments, this was determined on the basis of the strength of the task's internal reliability and the task's capacity to demonstrate anxiety-associated interpretation bias to threat.

The split-half reliability estimate of the Interpretation/Revised/Visual Task failed to meet the level considered to represent acceptable internal reliability for the purpose of the present research. Once again, this demonstrates the value of determining the internal reliability of measures of information processing bias. This is particularly important when, as is the case in the present research, the correlation between different measures is examined, since a task's internal reliability can affect its capacity to correlate with other tasks.

The group comparison failed to provide evidence that the Interpretation/Revised/Visual Task was sensitive to anxiety-associated differences in revised interpretation from threat. Compared with those trials in which the target was related to the cued Prime Display meaning, participants in the High and Low Trait Anxiety Groups displayed similar patterns of target-location response latency for trials in which the Prime Display's threatening meaning was cued but the target was related to the Prime Display's non-threatening meaning, *relative to* trials in which the Prime Display's non-threatening meaning was cued but the target was related to the Prime Display's threatening meaning. Therefore assuming that relative target-location response latency is a measure of individual differences in revised interpretation from threat, the Interpretation/Revised/Visual Task did not pick up any anxiety group differences in revised focus of interpretation from threat. However, the Interpretation/Revised/Visual Task did pick up a marginally significant, weak, positive linear relationship between trait anxiety and revised interpretation from threat. This last result could suggest that the Interpretation/Revised/Visual Task is sensitive to anxiety-associated individual differences in revised interpretation from threat.

Explanations for Findings

While it must be acknowledged that the statistical significance of the correlation between trait anxiety and the index of revised threat-biased interpretation is marginal, the present results could suggest that the Interpretation/Revised/Visual Task is sensitive to the anxiety-associated individual differences in threat-biased interpretation that have been demonstrated in past research (reviewed in: MacLeod, 1999; MacLeod & Rutherford, 2004; Mathews & MacLeod, 1994, 2005).

A striking observation about the present results is that while the internal reliability of the Interpretation/Revised/Visual Task was extremely low, nevertheless there was a marginally significant correlation between trait anxiety and the index of revised threat-biased interpretation. This validates the point made in the Methodological Overview, which suggests that under unusual circumstances a task with low internal reliability could correlate with another variable. Arguably, the present finding emphasizes that the demonstrated sensitivity of measures in the literature to either anxiety-linked threat-biased information processing cannot be taken as evidence that they also possess high internal reliability. This finding further highlights the importance of assessing a measure's internal reliability, which is rarely reported in studies of anxiety and information processing bias (Mauer & Borkenau, 2007).

Consistent with the research of Blanchette and Richards (2003), the marginally significant association between trait anxiety and the revised threat bias index on the Interpretation/Revised/Visual Task suggests that there are anxiety-associated differences in the cognitive processes by which ambiguous information is interpreted. However, whereas the present research found that higher levels of trait anxiety were associated with greater difficulty revising interpretation away from threat, Blanchette and Richards found that higher levels of state anxiety were associated with a more general tendency to have greater difficulty revising one's initial interpretation of an ambiguous stimulus, regardless of whether that ambiguous stimulus was initially interpreted as emotional or neutral. This discrepancy could suggest differences between the effects of transient state anxiety versus more enduring trait anxiety. Alternatively, it may be due to the different stimuli employed in the two tasks. Whereas threatening and non-threatening stimuli were used in the Interpretation/Revised/Visual Task, generally emotional and neutral stimuli were used by Blanchette and Richards.

Since the linear association between trait anxiety and the index of revised threat-biased interpretation revealed by the Interpretation/Revised/Visual Task was only marginally significant, any implications drawn on the basis of this result would be premature before establishing that this effect is reliable and replicable. However, if future research did establish that this finding is reliable, it would have implications for our understanding of the patterns of effects evidenced across the preceding six experiments. Across the first four experiments[24], sensitivity to anxiety-associated individual differences in initial information processing bias towards threat was restricted to the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task. Therefore, it was proposed that sensitivity to anxiety-associated individual differences in initial information processing bias towards threat may be more likely to occur in tasks that present stimuli in the auditory modality. Conversely, across this experiment and Experiments 5 and 6[25], only the present experiment, which employs visual stimuli, was sensitive to revised information processing from threat. Therefore, stimulus modality may not affect the sensitivity of tasks to anxiety-associated individual

[24] Experiments 1 to 4 involved the following tasks, respectively: Attention/Initial/Visual; Attention/Initial/Auditory; Interpretation/Initial/Visual; and Interpretation/Initial/Auditory.

[25] Experiment 5 involved the Attention/Revised/Visual Task, and Experiment 6 the Attention/Revised/Auditory Task.

differences in revised information processing from threat in the same way that it affects the sensitivity of tasks to anxiety-associated individual differences in initial information processing towards threat. By examining the sensitivity of a task that measures revised interpretation from auditory threat, it will be possible to provide a more informed explanation of the pattern of effects across the tasks. The following chapter will examine such an experiment.

Implications for Present Research Thesis

Regardless of the explanation for the sensitivity of the present Interpretation/Revised/Visual Task to anxiety-associated individual differences in threat-biased interpretation, the ultimate purpose of this experiment was to determine the suitability of the Interpretation/Revised/Visual Task for inclusion in the final analysis of the patterns of associations across all the experimental tasks presented in chapter 11. Following the criteria set out in chapter 2, since the Interpretation/Revised/Visual Task was sensitive to anxiety-associated individual differences in threat-biased interpretation, but did not demonstrate significant internal reliability , it was included in the first and second stages of the final analysis.

Conclusions

In conclusion, the results of Experiment 7 showed that while the Interpretation/Revised/Visual Task had weak internal reliability it was sensitive to individual differences in revised interpretation from threat associated with anxiety. Therefore, it will be included in the first and second stages of the final analysis of the patterns of associations between the experimental tasks presented in chapter 11.

CHAPTER 10

EXPERIMENT 8:

The Interpretation/Revised/Auditory Task

Experiment 8 was designed to evaluate the sensitivity of the Interpretation/Revised/Auditory Task to individual differences in the ease with which the initial interpretation of ambiguous auditory word stimuli as threatening, can be revised and reinterpreted as non-threatening (known as *revised interpretation from threat*).

The design of Experiment 8 was identical to those of the previous experiments, except that the task employed with the Interpretation/Revised/Auditory Task. The Interpretation/Revised/Auditory Task was a variant of the General Approach to Bias Assessment described in chapter 2. It was the auditory parallel of the Interpretation/Revised/Visual Task (Experiment 7) and identical in design with the exception of the modality in which the stimuli were presented. As such the stimuli in each display were auditory in modality and presented via earphones. Revised interpretation from threat was measured by the relative ease with which each type of Prime Display meaning was subsequently suppressed. It was assumed that difficulty revising one's threatening interpretation of ambiguous auditory information would be reflected by a disproportionate slowing in the identification of the location of targets related to a Prime Display's non-threatening meanings, following the activation of the Prime Display's threatening meanings, relative to the identification of the location of targets related to a Prime Display's threatening meanings, following the activation of the Prime Display's non-threatening meanings.

Consistent with the previous experiments, two criteria determined the sensitivity of an experimental task to individual differences in threat-biased information processing. One criterion required that the task demonstrated acceptable internal reliability, while the other required that the task was sensitive to individual differences in threat-biased information processing previously shown to be associated with anxiety (e.g., MacLeod et al., 1986; Mogg et al., 1996; Mogg et al., 1994). If the Interpretation/Revised/Auditory Task is sensitive to anxiety-associated individual differences in revised interpretation from threat, then when the conditions in which the target is related to the cued Prime Display meaning are controlled, compared with participants in the low trait anxiety group, the responses of participants in the high trait anxiety group would be disproportionately slowed for targets related to the Prime Display's non-threatening meaning following their initial interpretation of the Prime Display as threatening, *relative to* their responses to targets related to the Prime Display's threatening meaning following their initial interpretation of the Prime Display as non-threatening. Alternatively, if the revised interpretation from threat, is a linear function of anxiety, then we would find a strong linear correlation between trait anxiety and the index of revised interpretation from threat. As in the previous experiments, if either significant anxiety group differences, and/or a significant linear correlation between trait anxiety and an index of revised interpretation from threat is found the Interpretation/Revised/Auditory Task will be considered sensitive to anxiety-associated individual differences in revised interpretation from threat.

Consistent with the approach adopted with all the experimental tasks, dependent on whether the Interpretation/Revised/Auditory Task demonstrated the aforementioned criteria, determined its inclusion in the final analysis of the associations between the experimental tasks, presented in chapter 11 of this thesis.

Method

Participants

Participants were selected in the manner outlined in chapter 2. This gave rise to a sample, who reported a wide range of trait anxiety scores from 25 to 66. The mean trait anxiety score was 41.94 (*SD* = 9.02; screened using the STAI-T; Spielberger et al., 1983)[26]. Participants included 45 males and 95 females. Their mean age was 20.16 (*SD* = 4.93).

Materials

Trait Anxiety Assessment Instrument

As in the previous experiments, trait anxiety was assessed using the STAI-T (Spielberger et al., 1983).

Word-stimuli

The word-stimuli used in the Interpretation/Revised/Auditory Task were taken from the experimental stimuli described in Appendix A and were identical to those described in the Interpretation/Revised/Visual Task (Experiment 7) except that they were displayed in their auditory form. As represented in row vii. of Table 1 in chapter 2, the word stimuli included: auditory *threat synonyms* and auditory *non-threat synonyms* presented in the Constraining Cue and the Cue Check Displays; auditory *homonyms* presented in the Prime Display; and auditory *threat associates* and auditory *non-threat associates* presented in the Target Display.

Experimental task

The Interpretation/Revised/Auditory Task was presented aurally via earphones but in all other respects was identical to the Interpretation/Revised/Auditory Task

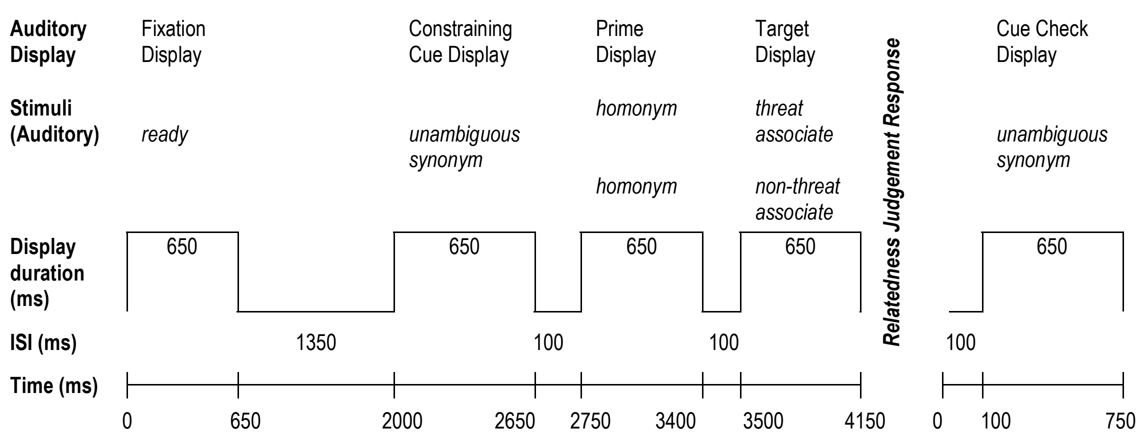
[26] This mean trait anxiety score was comparable with the STAI-T college student norm of 40, *SD* = 10 (Spielberger et al., 1983).

(Experiment 7). The perceptual characteristics of the auditory word stimuli were the same as those used in both the Attention/Initial/Auditory Task (Experiment 2), and the Interpretation/Initial/Auditory Task in (Experiment 4).

In summary, as shown in Figure 10, trials in the Interpretation/Revised/Auditory Task commenced with a Constraining Cue Display, in which an auditory *synonym*, synonymous with one meaning of the trial's following *homonym*, was presented. Participants were directed to hold the *synonym* in mind for the duration of the trial. After the Constraining Cue Display was a Prime Display that contained the auditory *homonym*. This was followed by a Target Display in which two auditory *associates* were presented. Participants' task was to identify the location of the target *associate* that was semantically related to one meaning in the Prime Display. After participants had responded, a final Cue Check Display was presented. This contained an auditory *synonym* that was either the *synonym* from the Constraining Cue Display, or a *synonym* taken from a different quintet to the *homonym* presented in that trial's Prime Display and which had not appeared within the current block of trials. Participants were asked whether or not this was the word that they had held in mind.

Figure 10

The progression of a single trial in the Interpretation/Revised/Auditory Task.



The critical factors governing the conditions of the Interpretation/Revised/Auditory Task were identical to those that governed the conditions of the Attention/Revised/Visual Task in Experiment 5. As will be recalled from the Attention/Revised/Visual Task, these were: Cued Prime Display Meaning and Target Semantic Association. As will be remembered: the Cued Prime Display Meaning Factor determined whether the threatening or the non-threatening Prime Display meaning was initially cued; while the Target Semantic Association Factor determined whether the target was related to the Prime Display's threatening or non-threatening meaning.

Experimental hardware

The stimuli were heard via Pro-Luxe KT-424 stereophonic earphones. Their presentation was controlled by a 952 MHz Intel Celeron Processor.

Procedure

Aside from differences associated with the modality of the stimuli and the assessment of revised rather than initial information processing, the Procedure was identical to that described in Experiment 1. Since the stimuli were auditory in modality, participants wore earphones throughout the task.

The bulk of the instructions were identical to those described in Experiment 7. As will be recalled from Experiment 7, participants were instructed that for each experimental trial four stimulus displays would be presented. First, participants were instructed to hold in mind the word in the first display. Next, participants were instructed to identify the location of the target word in the third display that was *semantically related* to a meaning presented in the second display. Last, after identifying the location of the target, participants were asked to determine whether or not the word in the fourth display was the word that they had to hold in mind.

In the Interpretation/Revised/Auditory Task, participants were directed to indicate their responses using the same keys as those described in the Attention/Revised/Auditory Task in Experiment 6.

Results

Overview

This results section is organised in exactly the same manner as the results sections of the earlier experiments. Therefore, the internal reliability of the Interpretation/Revised/Auditory Task's internal reliability is reported first, after which the sensitivity of the Interpretation/Revised/Auditory Task to anxiety-associated revised interpretation from threat is reported.

Exclusion of Inaccurate Participants

As was the case in the results of the previous experiments, to ensure that participants complied with task instructions, accuracy was determined. Two measures of task accuracy were taken: target-location accuracy and cue-recognition accuracy[27], each computed in the manner described in Experiment 5. The mean percentage target-location accuracy across all participants was well above the chance level of 50%, $t(139) = 46.02$, $p < .001$, as was the mean percentage cue-recognition accuracy across all participants, $t(139) = 125.71$, $p < .001$. All participants demonstrated above chance cue-recognition accuracy, and the one participant who did not demonstrate above chance target-location accuracy was excluded from further analyses.

As was the case for the preceding experiments, the sensitivity of the Interpretation/Revised/Auditory Task to threat-biased interpretation, was based on participants' response latency to identify the location of target stimuli. Therefore,

[27] Target-location accuracy represented the percentage of responses in which the target was correctly located, given across the entire task's 256 trials. Cue-recognition accuracy represented the percentage of responses in which the Cue Check Display stimulus was correctly identified as either the same or different to the word specified by the Constraining Cue Display, given across the entire task's 256 trials.

herein the analyses will examine only participants' responses identifying the location of the target, and not participants' responses recognising whether the Cue Check stimulus was the same or different to the word specified by the Constraining Cue Display.

Internal Reliability

The internal reliability of the Interpretation/Revised/Auditory Task was determined using the approach described in Experiment 1. That is, a Threat Bias Index was subjected to a Spearman-Brown split-half reliability analysis. In parallel with the Threat Bias Index of Experiment 7, a Threat Bias Index, reflecting the effect of the revision of interpretation away from the threatening Prime Display meaning relative to the effect of the revision of interpretation away from the non-threatening Prime Display meaning on the response latency for identifying target stimuli, when the effects of those conditions that did not require revision of interpretation were controlled, was computed. This Threat Bias Index was computed in the manner described in Experiment 5.

Using the Spearman-Brown correction, the split-half reliability of the Interpretation/Revised/Auditory Task was estimated as $r = .34$, $p < .001$. This internal reliability coefficient represents fairly weak, but statistically significant internal reliability. Since it is statistically significant, this level of internal reliability is considered acceptable for the present research program. The following section will determine whether this individual difference in threat-biased interpretation is associated with variability in anxiety.

The Sensitivity of the Interpretation/Revised/Auditory Task to Anxiety-associated Individual Differences in Revised Interpretation from Threat

This part of the results presents the analysis of the sensitivity of the Interpretation/Revised/Auditory Task to anxiety-associated individual differences in the revision of interpretation away from auditory threatening information.

Analyses comparing the characteristics, target-location accuracy and target-location response latencies of the high and low trait anxiety groups are reported first. The correlation between trait anxiety and the Threat Bias Index is reported next.

Comparison of Trait Anxiety Groups: Analysis of Variance

Participant Characteristics. High and low trait anxiety groups were obtained in the manner described in Experiment 1.

As was the case in the previous experiments, it was considered important to ensure that no individual participant reported a trait anxiety score at the experimental test session that was inconsistent with his/her original classification as either high or low trait anxiety level at screening. This was achieved in the manner described in Experiment 1. As a result, four participants in the Low Trait Anxiety Group whose trait anxiety scores at the experimental test session fell above the median trait anxiety score were eliminated, as were seven participants in the High Trait Anxiety Group whose trait anxiety scores at the experimental test session fell below the median trait anxiety score.

The characteristics of the resulting two Trait Anxiety Groups at the experimental test session are presented in Table 25.

Table 25

Participant Characteristics at the Experimental Test Session (Standard Deviations in Parentheses)

	N	Number of Males	Number of Females	Mean Age (Years)	Mean STAI-T Trait Anxiety
Low Trait Anxiety Group	52	16	36	21.4 (6.0)	32.0 (4.4)
High Trait Anxiety Group	49	15	34	19.4 (4.3)	50.3 (7.0)

An independent samples *t* test showed that during the experimental test session participants in the High and Low Trait Anxiety Groups differed significantly in terms of trait anxiety as measured by the STAI-T (Spielberger et al., 1984), $t(99) = 15.73$, $p < .001$. Another independent samples t test showed no significant difference between the groups in age, $t(99) = 1.91$, $p = .06$. Similarly, a Chi square test for independence, using Yates' Continuity Correction, showed that there was no significant difference between the two Anxiety Groups in terms of the distribution of males and females, X^2 (1) = .00, $p = 1.00$.

Accuracy. Table 26 displays the two participant groups' mean percentage target-location accuracy for the conditions of the factors: Cued Prime Display Meaning (Threat Prime Display Meaning Cued, Non-threat Prime Display Meaning Cued) and Target Semantic Association (Target Related to Threat condition, Target Related to Non-threat condition).

Table 26

Mean Percentage of Correct Relatedness Judgement Responses (Standard Deviations in Parentheses)

Cued Prime Display Meaning	Target Semantic Association	Low Trait Anxiety Group	High Trait Anxiety Group
Threat Prime Display Meaning Cued	Target Related to Threat	85.03 (9.37)	87.05 (7.89)
	Target Related to Non-threat	83.65 (9.13)	83.51 (9.68)
Non-threat Prime Display Meaning Cued	Target Related to Threat	81.52 (8.81)	79.40 (11.51)
	Target Related to Non-threat	90.17 (6.87)	89.34 (8.12)

As in the previous experiments, to ensure that the target-location accuracy of the Trait Anxiety Groups did not differ as a function of experimental condition a repeated measures ANOVA, considering the effects of Cued Prime Display Meaning

(Threat Prime Display Meaning Cued vs. Non-threat Prime Display Meaning Cued), Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat) and Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) on target-location accuracy was conducted.

There was no main effect of Trait Anxiety Group, $F(1,99) = .02$, $p = .86$, that is there was no significant difference between the target-location accuracy of participants in the High Trait Anxiety Group and participants in the Low Trait Anxiety Group. There was no main effect of Cued Prime Display Meaning, $F(1,99) = 54$, $p = .46$, meaning that there was no significant difference between participants' target-location accuracy for the Threat Prime Display Meaning Cued trials relative to the Non-threat Prime Display Meaning Cued trials. A main effect of Target Semantic Association was found, $F(1,99) = 64.59$, $p < .001$, such that the mean target-location accuracy of all participants was significantly greater in the Target Related to Non-threat condition relative to the Target Related to Threat condition. Therefore if there is an effect of Target Semantic Association on target-location response latency, it will be important to ensure that this is not due to a speed-accuracy trade-off.

There was no significant interaction between Target Semantic Association and Cued Prime Display Meaning, $F(1,99) = .25$, $p = .61$. Therefore, there was no difference between mean target-location accuracy regardless of whether the emotional valence of the Cued Prime Display Meaning matched the valence of the Target Semantic Association. There was also no interaction between Trait Anxiety Group and Target Semantic Association, $F(1,99) = .25$, $p = .61$. This means that the mean target-location accuracy of participants in the High Trait Anxiety Group was not significantly different to the mean target-location accuracy of participants in the Low Trait Anxiety Group in either the Target Related to Threat condition, or in the Target Related to Non-threat condition. There was an interaction between Trait Anxiety Group and Cued Prime Display Meaning, $F(1,99) = 8.98$, $p < .01$. This showed that regardless of the Target Semantic Association condition, the mean target-location accuracy of participants in the High Trait Anxiety Group was greater in the Threat Prime Display Meaning Cued condition relative to the Non-threat Prime Display Meaning Cued condition, while the mean target-location accuracy of participants in the Low Trait Anxiety Group was greater in the Non-threat Prime Display Meaning Cued condition relative to the Threat Prime Display Meaning Cued condition. Therefore, if there is an interaction effect of Cued Prime Display Meaning and Trait Anxiety Group on target-location response latency then it will be important that this is not due to a speed-accuracy trade-off. Finally, there was no interaction between Trait Anxiety Group, Target Semantic Association and Cued Prime Display Meaning, $F(1,99) = 2.03$, $p = .15$. This means that the mean target-location accuracy of participants in the High Trait Anxiety Group was not significantly different to the mean target-location accuracy of participants in the Low Trait Anxiety Group when accounting for the effects of both Target Semantic Association and Cued Prime Display Meaning.

Response Latency. The preceding analyses confirmed that the participants included in the analyses reported trait anxiety at test time that was representative of the Trait Anxiety Group to which they had been allocated. Likewise the analyses showed that participants completed the Interpretation/Revised/Auditory Task as instructed and that the target-location accuracy of the two Trait Anxiety Groups did not differ. Therefore, we now turn to the issue of key importance: whether or not the Interpretation/Revised/Auditory Task revealed anxiety-associated differences in revised interpretation from threat.

As in Experiment 7, revised interpretation from threat was measured by the differential speed with which participants correctly identified the target stimulus as a function of the experimental conditions derived from the two factors Target Semantic Association and Cued Prime Display Valence. It was expected that the more difficulty a person had revising his/her initial interpretation away from threat, the longer it would take to respond to the target. As displayed in Table 27, the median response latency for each participant to correctly identify the target in each experimental condition was calculated.

Table 27

Average Median Response Latency (in ms) to Correctly Identify Targets (Standard Deviations in Parentheses)

Cued Prime Display Meaning	Target Semantic Association	Low Trait Anxiety Group	High Trait Anxiety Group
Threat Prime Display Meaning Cued	Target Related to Threat	1551.12 (490.09)	1776.15 (635.50)
	Target Related to Non-threat	1685.55 (1594.50)	1899.96 (523.34)
Non-threat Prime Display Meaning Cued	Target Related to Threat	1884.46 (578.53)	2113.57 (686.82)
	Target Related to Non-threat	1414.58 (387.71)	1628.78 (438.76)

These reaction time data were analysed using a repeated measures ANOVA considering the effects of the between-subjects factor, Trait Anxiety Group (High Trait Anxiety Group vs. Low Trait Anxiety Group) and the within-subjects factors, Target Semantic Association (Target Related to Threat vs. Target Related to Non-threat) and Cued Prime Display Meaning (Threat Prime Display Meaning Cued vs. Non-threat Prime Display Meaning Cued).

A significant main effect of Target Semantic Association was found where all participants demonstrated faster median target-location response latencies in the Target Related to Non-threat condition, than in the Target Related to Threat Condition, $F(1,99) = 57.58$, $p < .001$. This finding is consistent with the effect of Target Semantic Association on target-location accuracy as reported in the preceding target-location accuracy analysis, which showed that participants were more accurate in the Target Related to Non-threat condition, relative to the Target Related to Threat Condition. There was also a significant main effect of Trait Anxiety Group, such that on average the median response latency of Low Trait Anxiety Group participants was faster than the median response latency of the High Trait Anxiety Group, $F(1,99) = 4.93$, $p < .05$. A main effect of Cued Prime Display Meaning was also found, $F(1,99) = 5.31$, $p < .05$, such that across all participants, median response latencies were faster in the Threat Prime Display Meaning Cued trials relative to the Non-threat Prime Display Meaning Cued trials.

There was no significant interaction between Trait Anxiety Group and Target Semantic Association, $F(1,99) = .07$, $p = .78$, therefore there was no group difference in the effect of Target Semantic Association. There was also no significant interaction between Trait Anxiety Group and Cued Prime Display Meaning, $F(1,99) = .005$, $p = .94$, meaning that there was no group difference in the effect of Cued Prime Display Meaning. A significant interaction between Target Semantic Association and Cued Prime Display Meaning was found, $F(1,99) = 151.95$, $p < .001$. This means that median target-location response latency was more greatly speeded when the emotional valence of the Cued Prime Display Meaning matched the valence of the Target Semantic Association compared with when the emotional valence of the Cued Prime Display Meaning did not match the valence of the Target Semantic Association. Assuming that relative target-location response latency is a measure of revised interpretation from threat, this suggests that on average all participants were more likely to have difficulty revising their initial focus of interpretation away from non-threat than revising their initial focus of interpretation away from threat. There was no significant interaction between Target Semantic Association, Cued Prime Display Meaning and Trait Anxiety Group, $F(1,99) = .002$, $p = .96$. Therefore, there was no group difference in the interaction effect of Target Semantic Association and Cued Prime Display Meaning.

If we assume that relative target-location response latency is a measure of revised interpretation from threat, the preceding results suggest that the Interpretation/Revised/Auditory Task is not sensitive to anxiety-associated group differences in revised interpretation from threat. However, it is possible that it is sensitive to a linear relationship between anxiety and revised selective interpretation, that was not picked up by the analysis of variance. Therefore, the following section uses Pearson Correlational Analysis to analyse the relationship between anxiety and revised selective interpretation.

Linear Association between Trait Anxiety and Revised Interpretation from threat: Pearson Correlational Analyses

Participant Characteristics. Consistent with the Correlational Analyses in the previous experiments, participants falling in the Mid-Trait Anxiety Band were reinstated to the analyses. As was the case in the previous experiments, the requirements of consistency of trait anxiety level and target-location accuracy, as described in the Comparison of Trait Anxiety Groups Section above, applied for inclusion in the correlational analyses. On this basis, one participant falling within the Mid-Trait Anxiety Band was excluded from the analyses.

Accuracy. As in the previous experiments, to ensure that there was no linear association between anxiety and the relative target-location accuracy of responses to trials of the different experimental conditions, a measure of trait anxiety and a measure of the relative target-location accuracy of responses on trials of the different experimental conditions, were subjected to a Pearson correlational analysis.

The key measures included in the correlational analysis were:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. An Accuracy Threat Bias Index: Computed in the same manner as the Threat Bias Index in Experiment 5 was computed, except that the measure used to compute the Accuracy Threat Bias Index was mean target-location accuracy, rather than median correct target-location response latency which was used to compute the Threat Bias Index.

Since both the Accuracy Threat Bias Index and the Trait Anxiety Index were normally distributed, a Pearson correlation coefficient was calculated. The Pearson correlation coefficient representing the linear relationship between trait anxiety and the Accuracy Threat Bias Index was $r = .19$, $p < .05$. As shown in Figure 13 in Appendix B, this correlation coefficient indicates a weak positive relationship between trait anxiety and accuracy. As such as trait anxiety increased, so too did the size of the Accuracy Threat Bias Index. Therefore, if a linear relationship between trait anxiety and the response latency Threat Bias Index, occurs, it will be important to exclude the possibility that this is the result of a speed-accuracy trade-off.

Response Latency. The present analysis will determine whether the Interpretation/Revised/Auditory Task revealed a linear association between anxiety and threat-biased interpretation as measured by the relative target-location response latency for targets correctly identified as related to threatening relative to non-threatening Prime Display stimuli, when the valence of the cued Prime Display stimulus is taken into account.

The key measures included in this correlational analysis were:

i. A Trait Anxiety Index: the STAI-T (Spielberger et al., 1983) trait anxiety measure obtained during the experimental test session; and

ii. A Threat Bias Index: computed in the manner described in Experiment 5.

Like the Trait Anxiety Index, the Threat Bias Index was normally distributed. Therefore a Pearson Correlational Analysis was conducted. The Pearson correlation coefficient representing the linear relationship between trait anxiety and the Threat Bias Index was $r = .02$, $p = .79$. This small correlation coefficient suggests that there is no relationship between the two variables. Therefore, although higher levels of trait anxiety were associated with greater accuracy, there was no comparable association between trait anxiety and the Threat Bias Index. Assuming that the Threat Bias Index provides a measure of revised interpretation from threat, this correlation coefficient provides no evidence that the Interpretation/Revised/Auditory Task is sensitive to a linear association between trait anxiety and revised interpretation from threat.

The split-half reliability coefficient showed that the Interpretation/Revised/Auditory Task possesses acceptable internal reliability. However, the results of the group comparison analysis and the correlational analysis, show that the Interpretation/Revised/Auditory Task is not sensitive to variability in anxiety.

Discussion

Summary of Findings

Experiment 8 was designed to assess the sensitivity of the Interpretation/Revised/Auditory Task to anxiety-linked individual differences in interpretation bias to threat. The Interpretation/Revised/Auditory Task was specifically designed to measure the revision of interpretation away from threatening relative to non-threatening auditory information. As was the case in the previous experiments, this was determined in two ways: on the basis of the strength of the task's internal reliability; and on the basis of the task's capacity to demonstrate anxiety-associated interpretation bias to threat.

The results of the split-half reliability analysis show that the Interpretation/Revised/Auditory Task has acceptable internal consistency for the purpose of the present research.

Neither the group comparison nor the correlational analysis provided evidence that the Interpretation/Revised/Auditory Task was sensitive to individual differences in revised interpretation from threat associated with anxiety. Compared with those trials in which the target was related to the cued Prime Display stimulus, participants in the High and Low Trait Anxiety Groups displayed similar patterns of target-location response latency for trials in which the Prime Display's threatening member was cued but the target was related to the Prime Display's non-threatening member, *relative to* trials in which the Prime Display's non-threatening member was cued but the target was related to the Prime Display's threatening member. Therefore assuming that relative target-location response latency is a measure of individual differences in revised interpretation from threat, the Interpretation/Revised/Auditory Task did not pick up any anxiety group differences in revised focus of interpretation from threat. Likewise, trait anxiety was not found to be linearly correlated with an index of revised interpretation from threat. Therefore, assuming that the Threat Bias Index measures revised interpretation from threat, there is also no evidence of a linear relationship between anxiety and revised interpretation from threat.

Explanations for Findings

Given the literature demonstrating anxiety-associated individual differences in revised interpretation from threat (reviewed in: MacLeod, 1999; MacLeod & Rutherford, 2004; Mathews & MacLeod, 1994, 2005), the present null results may arguably be attributed to the insensitivity of the Interpretation/Revised/Auditory Task. The present section will consider possible reasons for this insensitivity.

The pattern of effects occurring across this experiment and the last, suggest that sensitivity to anxiety-associated differences in revised interpretation from threat may rely on different conditions to those required for sensitivity to anxiety-associated differences in initial information processing. As will be recalled, the pattern of effects across Experiments 1-4[28] suggested that sensitivity to both initial threat-biased attention and initial threat-biased interpretation required the presentation of auditory rather than visual stimuli. However, across this Experiment and Experiment 7, the opposite pattern of effects occurred. That is, the Interpretation/Revised/Visual Task in Experiment 7 employed visual stimuli, but demonstrated sensitivity to anxiety-linked revised interpretation from threat, whereas the present Interpretation/Revised/Auditory Task employed auditory stimuli, but did not demonstrate sensitivity to anxiety-linked revised interpretation from threat. In addition, the fact that the pattern of effects across this experiment and Experiment 7, differs from the pattern of effects across Experiments 5 and 6[29], could suggest that revised interpretation from threat relies on different conditions to those required for sensitivity to anxiety-associated differences in revised attention from threat.

---

[28] Experiments 1 to 4 involved the following tasks, respectively: Attention/Initial/Visual; Attention/Initial/Auditory; Interpretation/Initial/Visual; and Interpretation/Initial/Auditory.

[29] Experiment 5 involved the Attention/Revised/Visual Task, and Experiment 6 the Attention/Revised/Auditory Task.

Implications for Present Research Thesis

Regardless of the explanation for the insensitivity of the present Interpretation/Revised/Auditory Task to anxiety-associated individual differences in threat-biased interpretation, the ultimate purpose of this experiment was to determine the task's suitability for inclusion in the final analysis of the patterns of associations across all the experimental tasks presented in chapter 11. On the basis of the criteria set out in chapter 2, since the Interpretation/Revised/Auditory Task demonstrated acceptable internal reliability, but was not sensitive to anxiety-associated individual differences in threat-biased interpretation, it was included in stages one and two of the final analyses presented in chapter 11.

Conclusions

In conclusion, the results of Experiment 8 provided evidence that the Interpretation/Revised/Auditory Task has acceptable internal reliability. The findings of this experiment and Experiment 7 could suggest that the revision of interpretation away from threat, occurs primarily with visual stimuli. Since the Interpretation/Revised/Auditory Task evidenced significant internal reliability it will be included in the first and second stages of the final analysis of the patterns of associations between the experimental tasks presented in chapter 11.

CHAPTER 11

PATTERNS OF ASSOCIATION BETWEEN THREAT BIAS INDEXES ACROSS THE EXPERIMENTAL TASKS

Overview

As will be recalled from the Introduction in chapter 1, the overarching experimental question addressed by this thesis is whether threat-biased attention and threat-biased interpretation reflect a single common mechanism or separate dissociable mechanisms. The present chapter was designed to address this question by examining the patterns of associations between the threat bias indexes yielded by each of the eight experimental tasks.

Until this chapter, each of the eight experimental tasks has been considered in isolation. However, as will be recalled from the Methodological Overview in chapter 2, the ultimate function of each of the experimental tasks has been to yield a threat bias index. It was intended that the patterns of associations between the threat bias indexes of the eight tasks would be examined to determine whether threat-biased attention and threat-biased interpretation are reflections of a single common mechanism or multiple independent mechanisms.

As will be remembered from the Methodological Overview, to examine the associations between the threat bias indexes of the two information processing biases, each participant completed a pair of tasks. Since each participant completed two tasks, each obtained two threat bias index scores, one from each task. Therefore, across participants, it was possible to compute the association between the threat bias index obtained on each task with the threat bias index obtained on every other task.

To examine the patterns of associations between the tasks, a matrix that displayed the correlation between each possible pairing of the eight tasks was constructed. Within the matrix, two classes of associations were identified. The first class, herein known as *Within Process* associations were defined as associations between the threat bias indexes of two tasks each of which measured the same information processing bias. There were two types of *Within Process* associations: *Attention Within Process* associations, which were associations between the threat bias indexes of two tasks measuring attention bias, and *Interpretation Within Process* associations, which were associations between the threat bias indexes of two tasks that measured interpretation bias. The second class of associations, herein known as *Between Process* associations, were defined as associations between the threat bias indexes of two tasks, each of which measured a different information processing bias. Therefore *Between Process* associations were associations between the threat bias index of a task that measured attention bias and the threat bias index of another task that measured interpretation bias. To determine whether threat-biased attention and threat-biased interpretation reflect a single common mechanism or independent mechanisms, the patterns of *Within Process* associations were compared with the patterns of *Between Process* associations.

The Common Mechanism Account and the Independent Mechanisms Account both generate alternative predictions regarding the strength of the *Within Process* associations relative to the *Between Process* associations. While both accounts lead us to expect stronger *Within Process* associations among the attention bias tasks, and stronger *Within Process* associations among the interpretation bias tasks, they differ with respect to the predictions they generate about the *Between Process* associations. According to the Common Mechanism Account, the *Between Process* associations should generally be relatively strong, and approximately equivalent in strength to that of the *Within Process* associations. Conversely, according to the Independent Mechanisms Account, the *Between Process* associations should generally be weaker, and indeed substantially weaker than the strength of the *Within Process* associations.

In the present thesis, strength of association is determined on the basis of three measures: the statistical significance of correlation coefficients, the magnitude of correlation coefficients and the overall correlation across the different classes of associations across correlation coefficients. The predictions generated by the Common Mechanism Account and the Independent Mechanisms Account for each of these three measures is outlined below.

Measure 1. Relative statistical significance of associations:

- The Independent Mechanisms Account predicts that a greater proportion of *Within Process* correlation coefficients will be statistically significant than *Between Process* correlation coefficients.
- The Common Mechanism Account predicts that the proportion of statistically significant *Within Process* correlation coefficients will be equivalent to the proportion of statistically significant *Between Process* correlation coefficients.

Measure 2. Relative magnitude of associations:

- The Independent Mechanisms Account predicts that the *Within Process* correlation coefficients will tend to be larger in magnitude than the *Between Process* correlation coefficients.
- The Common Mechanism Account predicts that the magnitude of the *Within Process* correlation coefficients will tend to be similar to the magnitude of the *Between Process* correlation coefficients.

Measure 3. Relative overall associations:

- The Independent Mechanisms Account predicts that the overall *Within Process* correlations will be greater than the overall *Between Process* correlations.
- The Common Mechanism Account predicts that the overall *Within Process* correlations will be equivalent to the overall *Between Process* correlations.

As will be recalled from the Methodological Overview in chapter 2, the associations between tasks that evidenced both significant internal reliability and also significant trait anxiety sensitivity were key to the experimental question. However, since the patterns of associations between tasks that did not evidence significant internal reliability or trait anxiety sensitivity could also reveal patterns of interest, the associations between these tasks were also considered. Therefore, tasks were included in the final analysis as determined by three increasingly strict sets of criteria. On the basis of these three sets of criteria, the present chapter is divided into three parts. The first stage of the analysis includes threat bias indexes derived from each of the eight experimental tasks. The second stage of the analysis includes threat bias indexes derived from the experimental tasks that either possessed acceptable internal consistency, or revealed biased information processing towards threat associated with anxiety, were conducted. The last stage of the analysis includes threat bias indexes derived from the experimental tasks that possessed high internal consistency and revealed biased information processing were conducted. Within each of these three stages of analysis: patterns of significance and patterns of effect size across the *Within Process* associations and the *Between Process* associations are examined; the mean effect size of the *Within Process* associations and the *Between Process* associations are computed; and the overall strength of association between the *Within Process* associations is compared with the overall strength of association between the *Between Process* associations.

560 participants were tested across the eight experiments, with each pair of tasks completed by twenty participants. As will be recalled from the Methodological Overview in chapter 2, participant selection was designed with the intention that four participants from each of the original trait anxiety bands would complete each pair of experimental tasks. Further, the order in which each pair of tasks was completed was balanced so that each task would be completed first, by half of the participants from each trait anxiety band.

The threat bias indexes included in the present analyses were those threat bias indexes computed in each of the eight experimental tasks to determine the Pearson correlation between anxiety and threat biased information processing. Detailed descriptions of these indexes may be found in the results sections of each of the eight experiments in chapters 3-10.

Computation of the matrix of associations between tasks

To determine the association between two tasks, the pairs of threat bias indexes obtained by each participant who completed those two tasks, were subjected to a Pearson correlational analysis. This yielded a Pearson correlation coefficient that represented the strength and direction of the relationship between every pair of tasks.

As presented in Table 28, each mean correlation coefficient was placed in a matrix to enable examination of the patterns of *Within Process* and *Between Process* correlations. Displayed in the matrix are the Pearson correlation coefficients with their significance levels, and the number of participants included in each Pearson correlational analysis. Since Pearson correlation coefficients are measures of effect size (Rosenthal & DiMatteo, 2001), on the basis of Cohen's (1977, cited in

Rosenthal, Rosnow, & Rubin, 2000) guidelines, summary descriptors of the size of the effects are also included in the table. As can be seen from the table: cells containing correlations between the threat bias indexes of two interpretation tasks are shaded blue; cells containing correlations between the threat bias indexes of two attention tasks are shaded yellow; while cells containing correlations between interpretation threat bias indexes and attention threat bias indexes are shaded green.

Table 28

Matrix of correlations between the Threat Bias Indexes of all task pairs (Effect size descriptors in parentheses).

			Attention				Interpretation			
			Revised		Initial		Revised		Initial	
			Auditory	Visual	Auditory	Visual	Auditory	Visual	Auditory	Visual
Interpretation	Initial	Visual	*r* =-.65 *p* <.01 [Large] N = 18	*r* =.03 *p* =.88 [Small] N = 19	*r* =.15 *p* =.52 [Small] N = 20	*r* =.28 *p* =.26 [Medium] N = 17	*r* =-.53 *p* <.05 [Large] N = 17	*r* =.08 *p* =.73 [Small] N = 18	*r* =.24 *p* =.36 [Small] N = 16	*r* =1
		Auditory	*r* =.16 *p* =.49 [Small] N = 19	*r* =-.15 *p* =.50 [Small] N = 20	*r* =.24 *p* =.30 [Small] N = 20	*r* =-.04 *p* =.85 [Small] N = 18	*r* =-.01 *p* =.95 [Small] N = 19	*r* =.25 *p* =.28 [Medium] N = 19	*r* =1	
	Revised	Visual	*r* =.12 *p* =.60 [Small] N = 20	*r* =-.02 *p* =.91 [Small] N = 19	*r* =.24 *p* =.33 [Small] N = 17	*r* =-.28 *p* =.23 [Medium] N = 19	*r* =-.23 *p* =.35 [Small] N = 18	*r* =1		
		Auditory	*r* =.24 *p* =.30 [Small] N = 20	*r* =-.09 *p* =.71 [Small] N = 19	*r* =-.07 *p* =.77 [Small] N = 17	*r* =.25 *p* =.29 [Medium] N = 19	*r* =1			
Attention	Initial	Visual	*r* =-.79 *p* <.001 [Large] N = 19	*r* =-.36 *p* =.12 [Medium] N = 19	*r* =.18 *p* =.46 [Small] N = 18	*r* =1				
		Auditory	*r* =.34 *p* =.14 [Medium] N = 19	*r* =-.007 *p* =.97 [Small] N = 20	*r* =1					
	Revised	Visual	*r* =-.01 *p* =.93 [Small] N = 19	*r* =1						
		Auditory	*r* =1							

Stage 1. Examination of associations between threat bias indexes across all tasks

Tasks included

The first stage of the analysis examined the associations between the threat bias indexes of each of the eight experimental tasks.

Observed patterns of association

First, the statistical significance of the *Within Process* associations relative to the *Between Process* associations is examined. Observation of the matrix in Table 28, revealed only three statistically significant correlations between pairs of threat bias indexes. Specifically: the threat bias index from the Interpretation/Revised/Auditory Task was significantly correlated with the threat bias index from the Interpretation/Initial/Visual Task, $r = -.53$, $p < .05$; the threat bias index from the Attention/Revised/Auditory Task was correlated with the threat bias index from the Attention/Initial/Visual Task, $r = -.79$, $p < .001$; and the threat bias index from the Attention/Revised/Auditory Task was correlated with the threat bias index from the Interpretation/Initial/Visual Task, $r = -.65$, $p < .01$.

The patterns of significant correlation coefficients were considered in terms of their classification as either *Within Process* or *Between Process*. One significant correlation occurred between two tasks that measured attention, one significant correlation occurred between two tasks that measured interpretation and one significant correlation occurred between a task that measured attention and a task that measured interpretation. This observation could suggest that the *Between Process* correlation coefficients are equally as likely to be significant as the *Within Process* correlation coefficients. However, when we consider the number of significant correlation coefficients as a proportion of the total number of correlation coefficients within a class, a substantially smaller proportion of *Between Process* correlation coefficients

(1/16) is significant relative to either the proportion of significant attention *Within Process* correlation coefficients (1/6) or the proportion of significant interpretation *Within Process* correlation coefficients (1/6). A Chi square test for independence confirmed that the proportion of significant attention *Within Process* correlation coefficients was significantly greater than the proportion of significant *Between Process* correlation coefficients, X^2 (1, N = 2) = 12.19, p <.01. Likewise, the proportion of significant interpretation *Within Process* correlation coefficients was significantly greater than the proportion of significant *Between Process* correlation coefficients, X^2 (1, N = 2) = 12.19, p <.01. Therefore, in terms of the first measure of strength of association, this observation is consistent with the prediction generated by the Independent Mechanisms Account, which posits that a greater proportion of *Within Process* associations would be statistically significant than *Between Process* associations. Nevertheless, given that only a very small proportion of correlation coefficients were significant regardless of their classification, any interpretation of them must be cautious. Furthermore, this caution is particularly prudent since the correlation coefficients have not been corrected for multiple testing. Indeed, only one of the three correlation coefficients (representing the association between the Threat Bias Indexes of the Attention/Initial/Auditory Task and the Attention/Revised/Visual Task) survived Bonferroni's correction for multiple testing[30], therefore it would be inappropriate to lay too much emphasis on them as they may represent a Type I Error.

Next, the magnitude of the *Within Process* associations was compared with the magnitude of the *Between Process* associations. On the basis of Cohen's (1977, cited in Rosenthal et al., 2000) criteria, correlation coefficients approximating .1 were labelled small, correlation coefficients approximating .3 were labelled medium, while correlation coefficients approximating or exceeding .5 were labelled large. As

[30] Since 28 correlation coefficients were calculated in stage one, the Bonferroni adjusted p value was .001.

displayed in Table 28, each correlation coefficient was classified on the basis of these criteria.

Unsurprisingly, the only correlation coefficients that were large in size were also those that were statistically significant. Therefore, observation of the large correlation coefficients provided little additional information regarding the patterns of association between the *Within Process* correlation coefficients and the *Between Process* correlation coefficients. Consequently, the patterns of both medium and large correlation coefficients were considered as a function of their classification as *Within Process* or *Between Process*. A quarter (4/16) of the *Between Process* correlation coefficients were either medium or large in magnitude, a third (2/6) of the interpretation *Within Process* correlation coefficients were either medium or large in magnitude, while half (3/6) of the attention *Within Process* correlation coefficients were either medium or large in magnitude. Therefore, relative to the *Between Process* correlation coefficients, a greater proportion of both types of the *Within Process* correlation coefficients were either medium or large in magnitude. A Chi square test for independence confirmed that the proportion of medium and large attention *Within Process* correlation coefficients was greater than the proportion of medium and large *Between Process* correlation coefficients, X^2 (1, N = 2) = 13.68, p <.01. Likewise, a Chi square test for independence confirmed that the proportion of medium and large interpretation *Within Process* correlation coefficients was greater than the proportion of medium and large *Between Process* correlation coefficients, X^2 (1, N = 2) = 9.99, p <.01. Therefore, in terms of the second measure of strength of association, this observation is consistent with the prediction generated by the Independent Mechanisms Account, that the *Within Process* associations would be larger in magnitude than the *Between Process* associations.

Finally, the overall strength of association of the *Within Process* associations was compared with the overall strength of association of the *Between Process* associations. Since Pearson correlation coefficients are also measures of effect size (Rosenthal & DiMatteo, 2001) it was possible to compare the *Within Process* associations and the *Between Process* associations using some of the procedures of Meta-analysis. Following Rosenthal's (1991) guidelines, the mean strength of association within the classes of associations were computed, as shown in Table 29, and two contrast analyses were conducted to determine whether the *Between Process* correlation coefficients were higher or lower than the either type of the *Within Process* correlation coefficients.

The first contrast analysis tested whether the *Between Process* correlation coefficients differed from the interpretation *Within Process* correlation coefficients. First, each Pearson correlation coefficient was subjected to an *r*-to-*z* transformation. Theoretical contrast weights that corresponded with each correlation coefficient were then selected to test the question of whether the six attention *Within Process* correlation coefficients differ from the sixteen *Between Process* correlation coefficients. A *Z* value representing the contrast, was then calculated by dividing the sum of each *z* score weighted by its contrast weight, by the square root of the sum of the square of each contrast weight divided by the inverse of the variance of each *z* score. This contrast analysis revealed no significant difference between the strength of association between the interpretation *Within Process* correlation coefficients and the strength of association between the *Between Process* correlation coefficients, $Z = -.45$, $p = .32$. In terms of the third measure of strength of association, this result initially appears consistent with the prediction generated by the Common Mechanism Account, that the overall *Within Process* associations would not substantially differ from the overall *Between Process* associations. However, as shown in Table 29, neither the mean correlation within the interpretation *Within Process* associations, nor the mean correlation within the *Between Process* associations, differed significantly from zero. Therefore, the fact that there was no significant difference between the interpretation *Within Process* correlations compared with the *Between Process* correlations, may reflect the absence of any mean association between the task pairs that each measured interpretation bias, and the absence of any mean association between the task pairs that each measured the alternative information processing bias. Thus, the support for the Common Mechanism Account's prediction that the overall *Within Process* associations would be equivalent to the overall *Between Process* associations, provided by the contrast analysis, is questionable.

Using the same method of analysis as the first, the second contrast analysis tested whether the *Between Process* correlation coefficients differed from the attention *Within Process* correlation coefficients. This contrast analysis revealed a near- but non-significant difference between the strength of association between the attention *Within Process* correlation coefficients and the strength of association between the *Between Process* correlation coefficients, $Z = -1.54$, $p = .06$. Although this is strictly outside the bounds of significance, it is more suggestive of an association between the pairs of tasks that measured attention bias, than of an association between the pairs of tasks that measured the two different information processing biases. Thus, in terms of the third measure of strength of association, this result is more consistent with the prediction generated by the Independent Mechanisms Account, that the overall *Within Process* associations would be greater than the overall *Between Process* associations. However, as was the case with the mean correlation within the interpretation *Within Process* associations, the mean correlation within the attention *Within Process* associations also did not differ significantly from zero. Thus, there is also no evidence of any mean association between the tasks that measured attention.

Table 29

Table showing unweighted and degrees of freedom weighted mean correlation coefficients for the two classes of Within Process associations and for Between Process associations.

	Unweighted mean	Degrees of freedom weighted mean*
Attention *Within Process*	r =-.40, p = .16	r =-.17, p = .15
Interpretation *Within Process*	r =-.10, p = .35	r =-.04, p = .36
Between Process	r =.06, p = .25	r =.02, p = .24

Notes.

* To account for any differences in sample sizes, means weighted by the degrees of freedom of each individual pair of tasks, are included.

Conclusions

On balance, the observations made in the first stage of the present analysis are consistent with the predictions generated by the Independent Mechanisms Account on the measures of the relative strength of association of the *Within Process* and *Between Process* associations. While caution is advised, given the small sample sizes and limited number of statistically significant correlations, a greater proportion of *Within Process* associations were statistically significant than *Between Process* associations. Likewise, more *Within Process* associations were of large or medium magnitude relative to the *Between Process* associations. Finally, the absence of a difference between the overall correlations within the *Within Process* associations relative to the *Between Process* associations initially appeared consistent with predictions of the Common Mechanism Account. However, since the mean correlations within each type of the *Within Process* associations and within the *Between Process* associations, did not differ from zero, this was not considered to be valid support for the Common Mechanism Account. In fact, the weak, non-significant correlations within the attention *Within Process associations* and within the interpretation *Within Process* associations may call in to question the assumption that the indexes measuring a single information processing bias measure a single common construct.

Stage 2. Examination of associations between threat bias indexes of tasks demonstrating either acceptable internal consistency or sensitivity to anxiety

Tasks included

This second stage of the analysis was designed to determine whether the patterns of associations between the threat bias indexes that were yielded through examination of the eight experimental tasks, remained when only tasks meeting stricter inclusion criteria were considered. Tasks included in the present analyses were those that either demonstrated significant internal reliability or sensitivity to anxiety. Due to their significant internal reliability and sensitivity to anxiety-associated threat-biased information processing, the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task were retained. Due to their acceptable internal reliability, the Interpretation/Initial/Visual Task, the Attention/Revised/Visual Task and the Interpretation/Revised/Auditory Task were retained. Last, due to its sensitivity to anxiety, the Interpretation/Revised/Visual Task was retained.

The mean correlation coefficient of each pair of the aforementioned tasks was placed in a sub-matrix in Table 30, so that the *Within Process* correlation coefficients and the *Between Process* correlation coefficients among this sub-group of tasks could be compared. Table 30 is similar to Table 28, but only those tasks that demonstrate anxiety sensitivity or significant internal reliability are included. Once again, cells containing correlations between interpretation threat bias indexes only are shaded blue; cells containing correlations between attention threat bias indexes only are shaded yellow; while cells containing correlations between interpretation threat bias indexes and attention threat bias indexes are shaded green.

Table 30

Matrix of correlations between Threat Bias Indexes of pairs of tasks, each of which demonstrated either significant internal reliability and/or sensitivity to anxiety-associated threat-biased information processing (Effect size descriptors in parentheses).

			Attention		Interpretation			
			Revised	Initial	Revised		Initial	
			Visual	Auditory	Visual	Auditory	Visual	Auditory
Interpretation	Initial	Auditory	r =-.15 p =.50 [Small] N = 20	r =.24 p =.30 [Small] N = 20	r =.25 p =.28 [Medium] N = 19	r =-.01 p =.95 [Small] N = 19	r =.24 p =.36 [Small] N = 16	r =1
		Visual	r =.03 p =.88 [Small] N = 19	r =.15 p =.52 [Small] N = 20	r =.08 p =.73 [Small] N = 18	r =-.53 p <.05 [Large] N = 17	r =1	
	Revised	Auditory	r =-.09 p =.71 [Small] N = 19	r =-.07 p =.77 [Small] N = 17	r =-.23 p =.35 [Small] N = 18	r =1		
		Visual	r =-.02 p =.91 [Small] N = 19	r =.24 p =.33 [Small] N = 17	r =1			
Attention	Initial	Auditory	r =-.007 p =.97 [Small] N = 20	r =1				
	Revised	Visual	r =1					

Observed patterns of association

As was the case in stage 1, examination of the statistical significance of the *Within Process* associations relative to the *Between Process* associations is reported first. Observation of Table 30, revealed that the stricter inclusion criteria eliminated all but one statistically significant correlation coefficient, between the Interpretation/Initial/Visual Task and the Interpretation/Revised/Auditory Task, $r = -.53$, $p < .05$. In terms of the first measure of strength of association, this finding is consistent with the prediction generated by the Independent Mechanisms Account that a greater proportion of *Within Process* associations would be statistically significant than *Between Process* associations. However, it would be unwise to lay too much weight on the interpretation of this result given the general lack of statistically significant correlations. This caution is particularly pertinent since the only statistically significant correlation coefficient would not survive Bonferroni's correction for multiple testing[31].

The magnitude of the *Within Process* associations was next compared with the magnitude of the *Between Process* associations. On the basis of the stricter inclusion criteria of stage two, only two correlation coefficients of either medium or large magnitude remained. These two remaining medium or large-sized correlation coefficients occurred between tasks measuring interpretation bias. In terms of the second measure of strength of association, this observation is consistent with the prediction generated by the Independent Mechanisms Account, that the *Within Process* associations would be larger in magnitude than the *Between Process* associations. However, given the paucity of correlation coefficients of sizable magnitude, this is only tenuous support.

Last, the relative overall association of the *Within Process* associations and the *Between Process* associations was compared by computing the mean strength of

[31] Since 15 correlation coefficients were calculated in stage two, the Bonferroni adjusted p value was .003.

association within the classes of associations as shown in Table 31, and by conducting a contrast analysis using the methods of Rosenthal (1991) that were outlined in the preceding section. Since only one pair of tasks measuring attention bias remained, it was not possible to compute the mean correlation within the attention *Within Process* associations, or to contrast the overall strength of association between the attention *Within Process* correlation coefficients with the overall strength of association between the *Between Process* correlation coefficients. The contrast analysis that compared the overall strength of association of the interpretation *Within Process* correlation coefficients with that of the *Between Process* correlation coefficients revealed no significant difference between the strength of association between the interpretation *Within Process* correlation coefficients and the strength of association between the *Between Process* correlation coefficients, $Z = -.53$, $p = .29$. This result is consistent with the finding in the first stage of the analysis, and therefore appears to support the prediction generated by the Common Mechanism Account, that the overall *Within Process* associations would not substantially differ from the overall *Between Process* associations. However, as shown in Table 31, neither the mean correlation within the interpretation *Within Process* associations, nor the mean correlation within the *Between Process* associations, differed significantly from zero. Thus, suggesting that there was no association between the tasks that measured interpretation bias only, and no association between the tasks that measured interpretation and the tasks that measured attention. Therefore, the equivalence of the overall correlation between the interpretation *Within Process* correlations and the *Between Process* correlations, seems most likely due to the absence of any differential correlations within either class of associations.

Table 31

Unweighted and degrees of freedom weighted mean correlation coefficients for the two classes of Within Process associations and for Between Process associations for tasks that were either significantly reliable or sensitive to anxiety-associated threat-biased information processing.

	Unweighted mean	Degrees of freedom weighted mean*
Attention *Within Process*	NA	NA
Interpretation *Within Process*	r =-.12, p = .31	r =-.04, p = .36
Between Process	r =.09, p = .34	r =.03, p = .35

Notes.

*As in Table 29, to account for any differences in sample sizes, means weighted by the degrees of freedom of each individual pair of tasks, are included.

Conclusions

Inclusion in the second stage of the analysis required that tasks demonstrate either significant internal reliability or sensitivity towards anxiety-associated information processing bias. Despite the stricter inclusion criteria, the results obtained in the second stage were consistent with those yielded through the examination of the patterns of associations between all eight tasks, specifically they did not support the predictions of the Common Mechanism Account and were more consistent with the predictions of the Independent Mechanisms Account. In summary, while one must be cautious given the paucity of statistically significant and sizable correlation coefficients across the associations, the greater proportion of statistically significant correlation coefficients among the *Within Process* associations relative to the *Between Process* associations was considered consistent with the prediction of the Independent Mechanisms Account. Likewise, the greater proportion of *Within Process* correlation coefficients of sizable magnitudes relative to the *Between Process* correlation coefficients was also deemed consistent with the Independent Mechanisms

Account. Finally, in parallel with the results in the first stage of the analysis, the absence of a difference between the overall correlations within the *Within Process* associations relative to the *Between Process* associations, initially appeared consistent with the Common Mechanism Account. However, this result was better explained by the non-significant mean correlation within both the interpretation *Within Process* associations and the *Between Process associations.* Furthermore, the weak non-significant correlation within the interpretation *Within Process* associations could question the assumption that the indexes measuring a single information processing bias measure a single common construct.

Stage 3. Examination of associations between threat bias indexes of tasks demonstrating both acceptable internal consistency and sensitivity to anxiety

Tasks included

The third stage of the analysis was intended to examine the key patterns of associations between the threat bias indexes when only those tasks that met the most strict inclusion criteria were considered. Tasks included in these analyses were required to demonstrate both strong internal reliability and sensitivity to anxiety. Two tasks met these criteria: the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task. As will be recalled from Experiment 2 in chapter 4 and Experiment 4 in chapter 6, both tasks were able to distinguish individuals on the basis of their levels of anxiety. Furthermore, both tasks were found to possess good internal consistency. Notably, aside from the information processing bias that each task was designed to measure, the two tasks are identical. Therefore, arguably any association found between the two tasks must be attributable to an association between the two cognitive biases.

Since only one association remained in the third stage of the analysis it was not possible to address the predictions made by the Common Mechanism Account and the Independent Mechanisms Account for each of the three measures of strength of association. Rather, the correlation coefficient representing the association between the threat bias index of the Attention/Initial/Auditory Task and the threat bias index of the Interpretation/Initial/Auditory Task was considered. The relationship between the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task represents a *Between Process* association. The Common Mechanism Account predicts that this correlation will be strong, while the Independent Mechanisms Account predicts that this correlation will be weak.

Observed patterns of association

The correlation between the threat bias index of the Attention/Initial/Auditory Task and the threat bias index of the Interpretation/Initial/Auditory Task was $r = .24$, $p = .30$. This non-significant correlation coefficient, with its small magnitude, fails to provide evidence of a reliable association between threat biased interpretation and threat biased attention even when tasks that reliably index anxiety-linked patterns of selective information processing are examined.

Conclusions

The absence of a significant between the threat bias index of the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task suggests that the two information processing biases are not associated. Therefore, this result fails to support the Common Mechanism Account, rather appearing consistent with the Independent Mechanisms Account.

CHAPTER 12

GENERAL DISCUSSION

The present research project aimed to determine whether individual differences in interpretation bias and individual differences in attention bias are simultaneous expressions of a single common underlying selective processing mechanism (the Common Mechanism Account), or instead result independently from quite different selective processing mechanisms (the Independent Mechanisms Account). To address the experimental question, participants reporting a range of different trait anxiety levels completed pairs of tasks taken from a battery of eight novel tasks, half of which measured attention bias and half of which measured interpretation bias. The strength of association between measures of attention bias and measures of interpretation bias (referred to as *Between Process* associations), was then compared with the strength of association between only measures of interpretation bias, or between only measures of attention bias (referred to as *Within Process* associations).

The Common Mechanism Account and the Independent Mechanisms Account generate different predictions regarding the patterns of associations between the bias measures. Both the Common Mechanism Account and the Independent Mechanisms Account predict strong *Within Process* associations. However, while the Common Mechanism Account predicts that the *Between Process* associations should generally be strong, and approximately equivalent in strength to the *Within Process* associations, the Independent Mechanisms Account predicts that the *Between Process* associations should generally be weak, and certainly substantially weaker than the *Within Process* associations.

The design of the project was such that the relationship between the internally reliable measures of trait anxiety-associated individual differences in interpretation bias and attention bias was the focus. Nevertheless, since the tasks that did not fulfil these criteria still had the potential to reveal information regarding the association between variability in interpretation bias and variability in attention bias, consideration was given to the association between these bias measures also.

This chapter summarises the results of the present research project and considers their implications for the experimental question. Firstly, the results of the eight individual experiments are reviewed in the context of their subsequent inclusion in the analysis of the patterns of association between the Threat Bias Indexes across the experimental tasks. Next, the results of the analysis of the patterns of association between the Threat Bias Indexes across the experimental tasks are summarised and their implications discussed. Within this part, the association between anxiety-linked individual differences in interpretation bias and anxiety-linked individual differences in attention bias is examined, after which consideration is given to the broader association between individual differences in interpretation bias and individual differences in attention bias, regardless of whether or not these are indeed linked to variations in anxiety. Limitations of the research are then recognised and addressed. Finally, directions for future research are suggested.

Task inclusion in the analysis of patterns of association between Threat Bias Indexes across the experimental tasks

As will be recalled from chapter 11, the patterns of association between the measures of attention bias and interpretation bias were appraised in a number of ways. Put simply, the patterns of association between the threat bias indexes of tasks that evidenced both trait anxiety sensitivity and significant internal reliability were examined, and the patterns of association between the threat bias indexes of the tasks regardless of their internal reliability and trait anxiety sensitivity were examined. To determine inclusion in the final analysis each task was assessed in one of the eight experiments. This revealed each tasks' sensitivity to trait anxiety and internal reliability. The results of the eight experiments are summarised in Table 32.

Table 32.

Summary of the results of the eight experiments.

Experiment	Experimental Task	Sensitivity to variability in trait anxiety	Internal reliability
1	Attention/Initial/Visual	×	×
2	Attention/Initial/Auditory	✓	✓
3	Interpretation/Initial/Visual	×	✓
4	Interpretation/Initial/Auditory	✓	✓
5	Attention/Revised/Visual	×	✓
6	Attention/Revised/Auditory	×	×
7	Interpretation/Revised/Visual	✓	×
8	Interpretation/Revised/Auditory	×	✓

Notes.

✓ denotes presence of statistically significant effect.

× denotes absence of statistically significant effect.

As can be seen from Table 32, the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task each evidenced significant internal reliability and trait anxiety sensitivity. Therefore, they were included in the analysis of critical importance to the experimental question, which was designed to examine the association between internally reliable measures anxiety-linked attention bias and interpretation bias. All the experimental tasks were included in the broader analysis of the association between individual differences in attention bias and interpretation bias.

The patterns of association between Threat Bias Indexes across the experimental tasks

Of critical interest to the experimental question was the pattern of associations between the measures of attention bias and measures of interpretation bias that demonstrated both significant internal reliability and sensitivity to variability in trait anxiety. Herein this pattern of associations is termed the *Primary Pattern of Associations*. Of secondary importance to the experimental question was the broader pattern of associations between the measures of attention bias and the measures of interpretation bias regardless of the measures' internal reliability and trait anxiety sensitivity. Herein this pattern of associations is termed the *Secondary Pattern of Associations.* The primary pattern of associations is reviewed first, after which the secondary pattern of associations is reviewed.

The Primary Pattern of Associations

Summary of results

The Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task fulfilled all the criteria necessary to address the critical experimental question. The experimental question was addressed by examining the strength of the correlation between the Threat Bias Indexes of these two tasks. While the Common Mechanism Account predicts large and significant *Between Process* associations, the Independent Mechanisms Account predicts small and non-significant *Between Process* associations. The correlation between the Threat Bias Indexes of the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task was small in magnitude and non-significant, a result that is consistent with the Independent Mechanisms Account, and not with the

Common Mechanism Account. The implications of this finding will be considered next.

Implications of the results

The results of the analysis of the Primary Pattern of Associations are consistent with the predictions of the Independent Mechanisms Account, that trait anxiety-associated individual differences in attention bias and trait anxiety-associated individual differences in interpretation bias are reflections of separate dissociable cognitive mechanisms. These results are particularly important in light of the tasks that were included in this analysis. The two tasks in the analysis, the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task evidenced acceptable split half reliability and sensitivity to individual differences in trait anxiety. Specifically, the Attention/Initial/Auditory Task evidenced significant weak internal reliability, while the Interpretation/Initial/Auditory Task evidenced significant moderate internal reliability. Further, there was a significant trait anxiety group difference in the performance of both the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task. Thus, on each task unlike the low trait anxiety groups, the high trait anxiety groups displayed disproportionately speeded response times for target words related to threatening relative to the non-threatening meanings. In addition, on the Attention/Initial/Auditory Task there was a significant linear correlation between trait anxiety and an index of threat biased attention, while on the Interpretation/Initial/Auditory Task there was a near-significant linear correlation between trait anxiety and an index of threat biased interpretation. As such, on both tasks greater trait anxiety levels tended to be associated with disproportionately faster response times for target words related to threatening relative to non-threatening meanings. Therefore we may be confident that the two tasks reliably measure anxiety-linked individual differences in threat-biased information processing.

Importantly, the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task were identical except for the information processing bias that each task was designed to measure, where the Attention/Initial/Auditory Task was designed to measure attention bias, while the Interpretation/Initial/Auditory Task was designed to measure interpretation bias. As such, trials in each task commenced with a Fixation Display, followed by a Prime Display that presented two meanings, and then a Target Display that presented two unambiguous words, one of which was related to one meaning in the Prime Display. In both tasks, participants were required to identify the location of the Target word that was related to one of the Prime Display meanings. Important parameters were identical for the two tasks, for example: each Prime Display of the Interpretation/Initial/Auditory Task was designed to activate the same meanings as the corresponding Prime Display of the Attention/Initial/Auditory Task; the stimuli in each task were presented in the auditory modality; the same temporal parameters were employed in each task; the same number of trials were contained in each task. The only difference between the tasks was that a homonym was presented in the Prime Display of the Interpretation/Initial/Auditory Task, while an unambiguous threat synonym and an unambiguous non-threat synonym was presented in the Prime Display of the Attention/Initial/Auditory Task. In light of the tasks' similarities, the absence of a correlation between their performance may arguably be attributed to the independence of anxiety-linked attention bias and interpretation bias.

The absence of an association between the performance of the Interpretation/Initial/Auditory Task and the Attention/Initial/Auditory Task is consistent with the findings of two studies reported after the commencement of this research project (e.g., Pury, 2002; Teachman, 2005). Pury (2002) asked undergraduate participants to complete a masked and unmasked emotional Stroop task and a homophone spelling task at a time when they were under low academic stress. Then, at a time of high academic stress, she asked the participants to rate their current symptoms of anxiety and depression. Pury found that the participants' performance on the homophone spelling task predicted their subsequent level of negative affect, while their performance on the emotional Stroop task did not. Conversely, participants' performance on the masked emotional Stroop task predicted their symptoms of anxiety, while their performance on the homophone spelling task did not. The difference between the predictive capacity of each of these measures suggests that each task taps a different underlying cognitive mechanism. Indeed, neither the masked, nor the unmasked attention bias index derived from the emotional Stroop task was significantly correlated with the interpretation bias index derived from the homophone spelling task. Therefore, like the results of the present research project, Pury's results suggests that the two information processing biases result from independent underlying mechanisms.

Similar results were also found by Teachman in 2005. In Teachman's (2005) study, individuals reporting high and low anxiety sensitivity completed the emotional Stroop task and were then asked to select unambiguous threatening or neutral explanations for ambiguous scenarios. There was no significant difference between performance of the high and low anxiety groups on the emotional Stroop task. However, when selecting explanations for the ambiguous scenarios, participants reporting high anxiety sensitivity tended to favour the threatening explanation whereas those reporting low anxiety sensitivity showed no such preference. Importantly, indexes of the two measures were not significantly correlated. The findings of Teachman's (2005) study lend further support to the finding of the present research that suggests that attention bias and interpretation bias rely upon independent mechanisms.

Theoretical Implications. The lack of associated between anxiety-linked individual differences in attention bias and anxiety-linked individual differences in interpretation bias in the present research has important implications in terms of the theoretical models that have been advanced to explain the relationship between cognition and emotion, and more specifically cognition and trait anxiety.

These results present a challenge for the Common Mechanism Models presented in the Introduction in chapter 1 (e.g., Beck, 1976; Beck & Clark, 1988, 1997; Bower, 1992; Bower & Forgas, 2000; Williams et al., 1988, 1997). For instance, Beck's Schema Theory proposes that in anxiety, activated Danger Schema initiate both biased attention and biased interpretation towards threatening information (Beck, 1976; Beck & Clark, 1988, 1997). Necessarily, this means that biased attention and biased interpretation will be activated equally and as a consequence be equally evident when measured. Therefore, while Beck's model can explain the occurrence of anxiety-associated variability in attention bias on the Attention/Initial/Auditory Task, and the occurrence of anxiety-associated variability in interpretation bias on the Interpretation/Initial/Auditory Task, it cannot easily explain the absence of a significant correlation between the trait anxiety-associated attention bias and trait anxiety-associated interpretation bias.

Bower's Network Model, proposes that concepts and emotions form nodes in a network. He proposes that activation of the anxiety emotion node by the experience of anxiety spreads to also activate an anxiety-associated concept node (Bower, 1992; Bower & Forgas, 2000). This anxiety-associated concept node causes individuals to selectively attend to threatening information and to selectively interpret ambiguous information as meaning threat (Bower, 1992; Bower & Forgas, 2000). Like Beck's model (Beck, 1976; Beck & Clark, 1988; 1997), since attention bias and interpretation bias each derive from the same mechanism (the anxiety-associated concept node), Bower's model implies that attention bias and interpretation bias will be activated to a similar extent. As such, the expression of both biases should be correlated. Thus once again, while Bower's Network Model can explain the evidence of trait anxiety-associated attention bias on the Attention/Initial/Auditory Task, and the evidence of trait anxiety-associated interpretation bias on the Interpretation/Initial/Auditory Task, it is unable to accommodate the lack of association between the Threat Bias Indexes on the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Tasks.

In their Integrative Model of cognition and emotion, Williams et al. (1988, 1997) propose that anxiety is associated with the increased *Integration*, or mutual activation of anxiety-relevant concepts and information. A consequence of this increased integration is the prioritised allocation of information processing resources towards possible sources of threat. In this way integration equally brings about both selective attention towards threat and the selective interpretation of ambiguous stimuli as threatening. As was the case for both Beck's model (Beck, 1976; Beck & Clark, 1988; 1997) and Bower's model (Bower, 1992; Bower & Forgas, 2000), Williams et al.'s (1988, 1997) Integrative Model can explain the occurrence of trait anxiety-associated attention bias evidenced on the Attention/Initial/Auditory Task, and trait anxiety-associated interpretation bias on the Interpretation/Initial/Auditory Task. However, like the two aforementioned Common Mechanism Models, Williams et al.'s model is unable to explain the lack of a significant correlation between the performance of the Interpretation/Initial/Auditory Task and the Attention/Initial/Auditory Task.

In summary, the Common Mechanism Models are unable to accommodate the findings concerning the lack of association between the performance of the

Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task. Therefore, the absence of an association between the Threat Bias Indexes of the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task calls in to question the validity of these models. In contrast, these findings are consistent with those theoretical models of cognition and emotion proposing that anxiety-linked individual differences in attention bias and interpretation bias each reflect the actions of independent cognitive mechanisms (e.g., Clark, 1986; Clark et al., 1997; Clark & Wells, 1998; Öhman, 1993; Whalen, 1998). These models do not predict that anxiety-linked attention bias towards threat will be correlated with anxiety-linked biased interpretation favouring the threatening resolution of ambiguous stimuli.

As will be recalled from the Introduction in chapter 1, the best examples of Independent Mechanism Models are those in which the theorists have endeavoured to differentiate anxiety disorders on the basis of the differential contributions of attention bias and interpretation bias (e.g., Clark, 1986; Clark et al., 1997; Clark & Wells, 1998). For instance, Clark's Cognitive Model of Panic Disorder specifically implicates interpretation bias, but not attention bias, as the key cognitive mechanism that underlies panic disorder (Clark, 1986; Clark et al., 1997). Conversely, Clark and Well's Cognitive Model of Social Anxiety specifically implicates attention bias rather than interpretation bias as the key cognitive mechanism that underlies social anxiety (Clark & Wells, 1995). The presently observed independence of anxiety-linked attention bias and anxiety-linked interpretation bias are consistent with these possibilities concerning the differential involvement of each type of anxiety-linked information processing bias in different manifestations of anxiety dysfunction.

According to Clark, panic disorder occurs due to the tendency to misinterpret physical sensations associated with anxiety such as heart palpitations and breathlessness in a catastrophic fashion (Clark, 1986, 2004; Clark et al., 1997). The absence of an association between attention bias as measured by the Attention/Initial/Auditory Task and interpretation bias as measured by the Interpretation/Initial/Auditory Task is consistent with Clark's model of panic disorder, suggesting that attention bias and interpretation bias are not necessarily equally evident within an individual.

Clark and Wells' (1995) Model of Social Anxiety Disorder is also consistent with the observation that performance of the Interpretation/Initial/Auditory Task and the Attention/Initial/Auditory Task are not associated. Clark and Wells' (1995) specify that attention bias, rather than interpretation bias, underlies the development and maintenance of social anxiety disorder. Clark and Wells (1995) posit that social anxiety occurs because individuals focus their attention towards evidence of their poor social performance.

When considered in light of the theoretical models which place weight on only one of these two information processing biases in the maintenance of a particular emotional condition, the present finding that indexes of the Attention/Initial/Auditory Task are not correlated with indexes of the Interpretation/Initial/Auditory Task, has considerable implications. In particular, it becomes important to identify the potentially differing association between differing anxiety disorders and attention bias and interpretation bias.

Applied Implications. Following on from these important theoretical implications, these results also have significant applied implications. A large proportion of current treatments for anxiety disorders are derived from Common Mechanism Models such as those of Beck (1976; Beck & Clark, 1988, 1997). As a consequence, treatments for a range of different anxiety conditions and indeed other emotional disorders, employ very similar methods and target very similar objectives

(Clark, 2004). To illustrate, consider Beck's cognitive treatment model (Beck et al., 1985). Beck et al. (1985) suggest that regardless of the particular anxiety condition, anxiety is associated with directing cognitive processing resources towards possible sources of threat and danger. Therefore, the key element of Beck's treatment for all anxiety disorders is the modification of the mechanism that supposedly underpins interpretation bias and attention bias, which according to this account is the Danger Schema (Beck & Clark, 1988, 1997; Beck & Emery, 1985; Brown et al., 2001). However, if attention bias and interpretation bias instead result from separate cognitive mechanisms, and if different anxiety conditions reflect the differential input of these cognitive mechanisms, then optimum treatment effectiveness may require the targeting of the particular cognitive bias underlying each particular anxiety condition.

In summary, the results of the present research suggest that anxiety-linked individual differences in interpretation bias and attention bias represent independent mechanisms. As discussed, this has important implications in terms of our theoretical understanding of anxiety conditions. Specifically, it does not support the validity of Common Mechanism Models, and is more consistent with Independent Mechanisms Models. The following section considers whether any additional insights can be gained from the analysis of the association between attention bias and interpretation bias as assessed by all the tasks in the test battery.

The Secondary Pattern of Associations

The Secondary Pattern of Associations was appraised by examining the pattern of correlations between the Threat Bias Indexes of all the experimental tasks, and then by examining the pattern of correlations between the Threat Bias Indexes of tasks that evidenced either internal reliability and/or trait anxiety sensitivity. Support for either the Common Mechanism Account or the Independent Mechanisms Account was determined by comparing the strength of association between measures of attention bias and measures of interpretation bias (referred to as *Between Process* correlations) with the strength of association between only measures of attention bias or between only measures of interpretation bias (referred to as *Within Process* correlations).

As will be recalled from chapter 11, strength of association was determined on the basis of three measures: the proportion of statistically significant associations, the proportion of medium or large sized associations, and the overall size of the associations. Specific testable predictions of the Independent Mechanisms Account and the Common Mechanism Account were generated on the basis of these three measures. Both the Independent Mechanisms Account and the Common Mechanism Account predicted significant and sizable *Within Process* correlations. However, the Independent Mechanisms Account predicted that: relative to *Between Process* correlations, a greater proportion of *Within Process* correlations would be statistically significant; likewise, relative to *Between Process* correlations, a greater proportion of *Within Process* correlations would be medium or large in size; and the overall *Within Process* correlations would be greater in size than the overall *Between Process* correlations. Conversely, the Common Mechanism Account predicted that: an equivalent proportion of *Between Process* correlations and Within *Process* correlations would be statistically significant; similarly, an equivalent proportion of *Between Process* correlations and Within *Process* correlations would be medium or large in magnitude; and the overall size of the *Within Process* correlations would be equivalent to the overall size of the *Between Process* correlations.

Summary of results

Table 33 summarises the results of the analysis of the Secondary Pattern of

Associations in terms of their consistency with either the Independent Mechanisms Account or the Common Mechanism Account.

Table 33.
The consistency of the Secondary Pattern of Associations with either the Common Mechanism Account, or the Independent Mechanisms Account on each of the three measures of strength of association.

	Comparison of proportion of significant correlations	Comparison of proportion of medium / large magnitude correlations	Comparison of overall magnitude of correlations
All tasks	IMA	IMA	Neither
Internally reliable and/or trait anxiety sensitive tasks	IMA	IMA	Neither

Notes:
CMA: denotes results consistent with the Common Mechanism Account,
IMA: denotes results consistent with the Independent Mechanisms Account,
Neither: denotes results consistent with neither the Common Mechanism Account nor the Independent Mechanisms Account.

As displayed in Table 33, of the results of the analysis of the Secondary Pattern of Associations, four were consistent with the predictions of the Independent Mechanisms Account, none were consistent with the predictions of the Common Mechanism Account, and interestingly two were not consistent with either the Independent Mechanisms Account or the Common Mechanism Account.

The findings consistent with the predictions of the Independent Mechanisms Account may be summarised as follows. As predicted by the Independent Mechanisms Account there was a greater proportion of statistically significant *Within Process* correlations than *Between Process* correlations regardless of whether the analysis included all tasks or only those tasks showing either trait anxiety sensitivity and/or acceptable internal reliability. Likewise as predicted by the Independent Mechanisms Account, when all tasks were analysed and when only those tasks showing either trait anxiety sensitivity and/or acceptable internal reliability were analysed, a greater proportion of *Within Process* correlations were medium or large sized relative to *Between Process* correlations.

The following summarises the results that were inconsistent with either the Common Mechanism Account or the Independent Mechanisms Account. For instance, regardless of whether the analysis included all tasks or only those tasks showing either trait anxiety sensitivity and/or acceptable internal reliability, neither the overall mean of the attention *Within Process* correlations nor the overall mean of the interpretation *Within Process* correlations differed significantly from zero. Since each Account predicts generally strong and statistically significant *Within Process* correlations, this finding is inconsistent with both.

Implications of the results

One possible interpretation of the Secondary Pattern of Associations is that individual differences in attention bias and individual differences in interpretation bias not only reflect independent mechanisms, but that attention bias and interpretation bias are each multidimensional themselves and as such, each reflect the operation of multiple cognitive mechanisms. Herein this account is termed the *Extreme Independent Mechanisms Account*. However, while we may be confident in the implications drawn from the Primary Pattern of Associations, which are based on measures that possess significant internal reliability and sensitivity to trait anxiety, since the analysis of the Secondary Pattern of Associations included tasks that did not all evidence either trait anxiety sensitivity or acceptable internal reliability, any implications of the Secondary Pattern of Associations must be considered with caution.

Those who promote the Extreme Independent Mechanisms Account would find support from recent research conducted by Dalgleish et al. (2003) and Salemink, van den Hout and Kindt (2007). Dalgleish et al. (2003) compared the dot probe and emotional Stroop task performance of a group of control participants and a group of anxious participants. While significant anxiety group differences were found on the dot probe task, they were not found on the emotional Stroop task. Furthermore, there was no evidence of a positive association between the two tasks as measured by Pearson correlational analysis. The authors interpreted this finding as suggesting that the performance of the two tasks may tap different underlying cognitive mechanisms. This result parallels the results of the analysis of the Secondary Pattern of Associations. Furthermore, if attention bias is multidimensional, Dalgleish et al.'s study could suggest that the performance of the emotional Stroop task requires a different dimension of attentional processing to the dimension of attentional processing required by the dot probe task. However, Dalgleish et al.'s study suffers from at least one important limitation. Unlike the present research program Dalgleish et al. (2003) did not assess the internal reliability of either the dot probe task or the emotional Stroop task that they employed. However, a task's internal reliability can affect the extent to which it correlates with another task (Humphreys & Drasgow, 1989). Therefore, the possibility that the absence of a correlation between the emotional Stroop task and the dot probe task is due to the poor internal reliability of the two tasks cannot be excluded.

The findings of a recent study by Salemink et al. (2007) could also provide support for the Extreme Independent Mechanisms Account. Salemink et al. (2007) trained participants to interpret ambiguous words as either threatening or neutral in emotional valence using a sentence completion task. After training, participant's interpretation of ambiguous words was tested using four alternative tasks, two of which were measures that were similar to the training task and two of which were measures that were different to the training task. While participants demonstrated interpretation bias on the tasks that were similar to the training tasks, there was no evidence of trained interpretation bias on the tasks that differed from the training tasks. Proponents of the Extreme Independent Mechanisms Account may argue that these results are reflections of the multidimensional nature of interpretation bias. That is, it is possible that while the tasks that were similar to the training task tapped the same dimension of interpretation bias as the dimension that was trained, the tasks that differed from the training task may have tapped an alternative untrained dimension of interpretation bias. If this alternative dimension of interpretation bias was unrelated to the trained dimension of interpretation bias, it would not have been affected by the training. However, as was the case for Dalgleish et al. (2003) Salemink et al. did not report the internal reliability of any of the experimental tasks employed in the study. Therefore, the results obtained by Salemink may reflect the low internal reliability of the tasks employed.

Theoretical Implications. The present research provides very limited support for the Extreme Independent Mechanisms Account. However, if future research using measures of attention bias and interpretation bias that are internally reliable and sensitive to anxiety, reveals results consistent with the Extreme Independent Mechanisms Account, this would imply that attention bias, interpretation bias, and their association, are considerably more complex than initially supposed. As such, certain dimensions of attention bias may correlate with some but not all other dimensions of attention bias and certain dimensions of interpretation bias may correlate with some but not all other dimensions of interpretation bias. It is further possible that certain dimensions of attention bias correlate with certain dimensions of interpretation bias. Such an account would imply that particular individuals may be characterised by the tendency to selectively attend towards threat under certain conditions, but not under other conditions. Accompanying this tendency, these same individuals may also tend to interpret ambiguous information as threatening under certain conditions, but not under others. Dependent upon the underlying cognitive mechanisms involved in these processes, such tendencies may be associated, although not necessarily, with one another.

If future research supported the entertainment of the Extreme Independent Mechanisms Account, it would be important to identify the different mechanisms that underlie attention bias and interpretation bias. One method by which these mechanisms could be determined is through examination of the dimensions on which the two information processes vary. Already researchers have identified a number of these dimensions (reviewed in: MacLeod, 1990; Mathews & MacLeod, 1994, 2005; Williams et al., 1988, 1997). For example, there is evidence of tasks being differentially sensitive to anxiety when stimuli are presented at speeds which either allow or prevent conscious awareness of the content of the stimuli (MacLeod & Rutherford, 1992, 1998). This could suggest that attention bias that involves automatic cognitive processing and attention bias that involves strategic cognitive processing, each rely on independent underlying mechanisms. Likewise, interpretation bias that involves automatic cognitive processing and interpretation bias that involves strategic cognitive processing, may rely on separate mechanisms (Richards & French, 1992). Other dimensions of variability that could point to mechanisms underlying attention bias and interpretation bias include: anxiety disorders versus other psychological disorders (e.g., depression; MacLeod & Rutherford, 1998); and focus of information processing resources towards verbal information versus pictorial information (Fox et al., 2001).

The Secondary Pattern of Associations could support the Extreme Independent Mechanisms Account which proposes that attention bias and interpretation bias not only rely on separate underlying mechanisms, but that attention bias and interpretation bias each rely on multiple different underlying mechanisms. However, in light of the fact that the Secondary Pattern of Associations is based on tasks that are not necessarily sensitive to anxiety or internally reliable, the Extreme Independent Mechanisms Account is not a position endorsed by the present research.

Limitations of the Research

A number criticisms commonly levelled at studies investigating cognition and emotion also pertain to the present research. For instance, the use of university students as participants limits the representativeness of the sample and may mean that the findings are less relevant to the broader population. By focussing on trait anxiety, the degree to which the present research findings can be generalised to clinical anxiety disorders is restricted. Likewise, since trait anxiety was the only personality trait variable measured, the extent to which the effects under investigation may be attributed to trait anxiety rather than some other unmeasured but confounding construct (e.g., depression) is not known. Furthermore, given that attention bias and interpretation bias were measured using computer tasks, the extent to which the findings of this project are applicable to the real world is questionable. While the present research project is not immune to such typical limitations, since there are a number of limitations that are more specific to this project these will be the focus of the present section.

Limitation 1: Employing equivalent, novel tasks

One positive feature of the present research is that regardless of the information processing bias that an experimental task was designed to measure, the manner in which the information processing bias was measured was equivalent across the eight experimental tasks. Specifically, regardless of the bias that a task measured, the same key trial displays were employed, namely the Prime Display and the Target Display. While the Prime Display stimuli differed depending on modality and the particular bias that the task was designed to measure, the pairs of meanings presented in the Prime Displays of all tasks were identical. Similarly, aside from modality, the stimuli presented in all tasks' Target Displays were identical. The temporal parameters governing the Prime and Target Displays were identical across all tasks, as were the trial number and trial duration. Finally, across all tasks participants received the same instructions: to indicate the location of the Target Display word that was related to one of the preceding Prime Display words, by pressing a computer key. The equivalence of the tasks was crucial to the research design because it reduced the possible influence of superficial task differences on the associations between the tasks. However, although the tasks were developed on the basis of both theoretical (e.g., MacLeod, 1990; Mathews & MacLeod, 1994, 2005; Williams et al., 1997) and past experimental evidence (e.g., Grey & Mathews, 2000; Richards & French, 1992; Wilson et al., 2006), by making the tasks equivalent they may have lost some of the features that made the traditional tasks sensitive to the anxiety-associated individual differences in the information processing biases. Indeed, the results of the present research did not provide evidence that all of the present experimental tasks were consistently sensitive to anxiety-linked differences in information processing biases.

Two examples of task factors which were affected by the need to develop equivalence across all the tasks in ways that could have impacted on the sensitivity of individual tasks to individual differences in biased information processing concern the manner of presentation of visual stimuli and the stimulus onset asynchrony between the Prime and Target Displays. In previous research that has assessed anxiety-linked differences in attention bias (e.g., MacLeod et al., 1986) and interpretation bias (e.g., Richards & French, 1992), the final target stimuli usually have remained present on the screen until participants make their response. However, in the present research, in order to ensure that exposure to the stimuli was not longer in the visual tasks than was the case in the auditory tasks, the visual stimuli were presented for the same duration as the auditory stimuli, that is, for 650 ms. In consequence, task performance may have relied upon cognitive resources (e.g., memory) in addition to either attentional or interpretative resources, thereby limiting the tasks' sensitivity to either attention bias or interpretation bias. Therefore, it is possible that the observed insensitivity of most of the visual tasks to anxiety-linked differences in biased information processing was due to the time-limited presentation of the target stimuli.

Across all the tasks, the stimulus onset asynchrony between Prime and Target Display stimuli was 750 ms. This was chosen since past literature had suggested that anxiety-associated interpretation bias was most reliable 750 ms after the presentation of ambiguous words (Richards & French, 1992). However, some researchers suggest that attention bias is more evident at intervals shorter than 750 ms following stimulus presentation (MacLeod, 1999). MacLeod (1999) proposed that attention bias can be moderated by strategic information processing which occurs at stimulus onset asynchronies that are greater than 500 ms (Richards & French, 1992). Therefore, it is possible that the duration of the stimulus onset asynchrony used in this study permitted the participants to rely on strategic information processing and that this limited the anxiety sensitivity of the tasks designed to pick up attention bias. However, since the tasks measuring attention bias were not less sensitive than the tasks measuring interpretation bias, the length of the stimulus onset asynchrony between the Prime and Target Displays cannot fully explain the insensitivity of many of the tasks to anxiety-linked bias.

Nevertheless, there is evidence to suggest that the tasks were indeed measuring individual differences in attention bias and individual differences in interpretation bias as intended. In particular, three of the tasks, the Attention/Initial/Auditory Task, the Interpretation/Initial/Auditory Task and the Interpretation/Revised/Visual Task each evidenced trait anxiety-associated biases in information processing. This suggests that even though the tasks were novel, their design was such that a subset were sensitive to trait anxiety-associated biased information processing as required. Further, since the Interpretation/Revised/Visual Task (which involved the presentation of visual stimuli) was sensitive to trait anxiety-associated variability in threat-biased interpretation, suggests that the limited presentation time of the visual stimuli did not affect the tasks' sensitivity. Similarly, the fact that anxiety-linked processing was evidenced in a task that measured attention bias (the Attention/Initial/Auditory Task) and in two tasks that measured interpretation bias (the Interpretation/Initial/Auditory Task and the Interpretation/Revised/Visual Task) suggests that the temporal parameters cannot fully explain the other tasks' insensitivity to the different information processing biases.

Limitation 2: Parallel testing of novel tasks

In order to examine the correlations between pairs of tasks, all of the novel experimental tasks were developed at the beginning of the research program and then tested in parallel. The benefits of this approach were that it provided a clear structure to the program of research, and enabled the assessment of the key experimental question, regarding the association between the different experimental tasks. However, despite these benefits, a problem inherent in this design was that it was not possible to modify components of the experimental tasks on the basis of earlier designs that were unsuccessful. This problem was of particular concern since all tasks employed in this research program were novel and their sensitivity to anxiety-linked information processing bias had not previously been demonstrated.

An example of where the present research program may have benefited from modifying one experimental task on the basis of the sensitivity of another experimental task to anxiety-associated threat-biased information processing is apparent when considering the results of Experiments 5 and 6. In Experiment 5, one explanation posited for the insensitivity of the Attention/Revised/Visual Task to anxiety-associated differences in revised attention from threat, was that participants had an insufficient number of locations from which to search for the target. However, it was not possible to modify the Attention/Revised/Auditory Task in Experiment 6 on this basis since testing of the Attention/Revised/Auditory Task was already underway. Possibly as a result of this, the Attention/Revised/Auditory Task was also found to be insensitive to anxiety-associated differences in revised attention from threat.

To improve experimental tasks' sensitivity to the anxiety-linked information processing biases, it is necessary to modify their designs on the basis of earlier unsuccessful designs. However, examination of the patterns of associations between the different experimental tasks requires that the tasks are tested in parallel with one another. Therefore, in future before testing the battery of tasks in parallel, it would be helpful to pilot test the tasks. Then, any modifications designed to improve the tasks' sensitivity to the anxiety-linked information processing biases could be made. This would enable a battery of experimental tasks sensitive to anxiety-linked information processing biases to be tested in parallel.

Limitation 3: Task order

To measure the association between the different experimental tasks, each participant completed two tasks, one after the other. As such it was not possible for each task to be completed first all of the time. Nevertheless, it must be acknowledged that the order in which the tasks were completed may have impacted on the tasks' correlations with one another. That is, the performance of the first task may have affected performance of the second task, and as a consequence impacted on the correlation between the two different tasks. The possibility that the completion of one task affected the performance of another task seems particularly likely in light of the strong similarities between the eight experimental tasks (reviewed in the earlier section: *Limitation 1: Employing equivalent novel tasks*), and since most stimuli were common to all experimental tasks. As a result of these task similarities and the need to complete one task before the other, tasks that were completed second could have suffered from effects associated with participant-fatigue, learning, or stimulus repetition. To ensure that testing order was not a confound, across all the tasks testing order was counterbalanced, so that half of the participants in each trait anxiety band completed each task first half of the time. Nevertheless, the performance of the first task may have affected performance of the second task, and as a consequence impacted on the correlation between the different tasks. However, since a correlational analysis of tasks that are each completed first or that are each completed second cannot be conducted, there is no way to discount the effect of task order on the correlations between the present experimental tasks.

Given the potential impact of order effects on the correlations, future research into the association between measures of information processing bias would benefit from steps taken to further limit the impact of order effects. For instance in the future, the trials of two different tasks could be combined to form a single composite task in which the trials of each individual task alternate with one another. This design has the potential to substantially reduce the impact of order effects. Furthermore, it would enable the examination of order effects, since it would be possible to compare the correlation between the first half of the trials of each task type with the correlation between the second half of the trials of each task type.

Limitation 4: Task internal reliability

It may be argued that one limitation of the present research was the low levels of internal reliability evidenced by the experimental tasks. This could suggest that in general the tasks were not capable of consistently measuring individual differences in information processing bias. However, a major strength of the present research program was the fact that steps were taken to determine the tasks' internal reliability. To date, very few studies of anxiety and information processing bias have reported the reliability of the measures employed to assess biased information processing (Mauer & Borkenau, 2007). Largely, this has been because most tasks are not very amenable to internal reliability assessment. Therefore, it is a credit to the present research program that the experimental tasks were designed in a way that allowed the measurement of the internal reliability of the effect of key interest.

For the purpose of the present research, a task's internal reliability was considered acceptable if it attained statistical significance at an α level of .05. Consequently, five of the experimental tasks were deemed to possess acceptable internal reliability. However, while statistical significance is necessary, it is not sufficient to provide confidence in an internal reliability coefficient (Furr & Bacharach, 2008; John & Soto, 2007). In addition to statistical significance, some statisticians argue that it is also necessary to take into account the size of the internal reliability coefficient itself (John & Soto, 2007; Pedhazur & Scmelkin, 1991). Conventionally, researchers have considered that an internal reliability coefficient of .70 represents sufficient internal reliability (John & Soto, 2007; Pedhazur & Scmelkin, 1991). However, none of the present experimental tasks' internal reliability coefficients were close to this size. Indeed, in the present research program statistical significance occurred when internal reliability coefficients approximated .30. Consequently, what was considered an acceptable level of internal reliability in the present research program, may otherwise be considered a low level of internal reliability.

Although few published studies report the internal reliability of individual difference measures such as the dot probe task and the emotional Stroop task (Mauer & Borkenau, 2007), those that are available tend to reveal levels of internal reliability which approximate the levels of internal reliability evidenced by the present experimental tasks (e.g., Mauer & Borkenau, 2007; Schmukle, 2005). For example, Schmukle (2005) measured the split half reliability of the dot probe task when completed by a non-clinical sample of participants reporting varying levels of trait anxiety. While Schmukle (2005) found evidence of a positive association between trait anxiety level and a measure of the tendency to selectively attend towards threat, the task's split half reliability coefficient was less than .30. Similarly, Mauer & Borkenau (2007) showed that the internal reliability of an emotional Stroop task with word stimuli, and an emotional Stroop task with visual face stimuli did not exceed .33. As such, the internal reliability of these two widely employed measures of information processing bias is comparable to the level of internal reliability evidenced by the

Attention/Initial/Auditory Task ($r = .31, p < .01$), the Attention/Revised/Visual Task ($r = .31, p < .01$), and the Interpretation/Revised/Auditory Task ($r = .34, p < .001$). Furthermore, the internal reliability of the Interpretation/Initial/Visual Task ($r = .50, p < .001$) and the Interpretation/Initial/Auditory Task substantially exceed this level ($r = .49, p < .001$). Therefore, in light of the internal reliability of the emotional Stroop task and the dot probe task, it does not seem unreasonable that an internal reliability coefficient that exceeded .30, was considered acceptable for the purpose of the present research.

One possible explanation for the tasks' low levels of internal reliability is that some of the trials in each task were sensitive to differences in information processing bias and some were not. This may have been because of variability in the capacity of stimuli to tap the particular information processing bias, with some items working best for some participants. At this stage the particular aspects of the trials that are insensitive to individual differences in the information processing biases are not clear. Further detailed analysis would be necessary to identify these aspects. However, future variants of the present tasks may benefit from identifying and then eliminating these items.

Alternatively, the low internal reliability of the tasks could be attributed to the effects of testing order. As discussed earlier, although testing order was counterbalanced, the performance of the first task may have affected the performance of the second task. Indeed, fatigue, learning and repetition can each affect internal reliability (Furr & Bacharach, 2008; John & Soto, 2007). To examine whether this was the case in the present research, the internal reliability of each task was computed separately for those participants who had completed the task first and for those participants who had completed the task second. Internal reliability was determined using the Spearman-Brown split-half formula with the same participant exclusion criteria as employed in the eight experiments. The tasks' internal reliability coefficients yielded: when all participants were included in the analysis regardless of task order (as was the case in each of the experiments); when the task was completed first; and when the task was completed second are displayed in Table 34.

Table 34.

The effect of testing order on the Spearman-Brown split-half reliability of each of the experimental tasks.

Experiment	Experimental Task	Split-half reliability regardless of task order	Split-half reliability when task completed first	Split-half reliability when task completed second
1	Attention/Initial/Visual	$r = .007$, $p = ns$	$r = .03$, $p = ns$	$r = -.02$, $p = ns$
2	Attention/Initial/Auditory	$r = .31$, $p < .01$	$r = .21$, $p < .05$	$r = .34$, $p < .001$
3	Interpretation/Initial/Visual	$r = .50$, $p < .001$	$r = .43$, $p < .001$	$r = .65$, $p < .001$
4	Interpretation/Initial/Auditory	$r = .49$, $p < .001$	$r = .54$, $p < .001$	$r = .44$, $p < .001$
5	Attention/Revised/Visual	$r = .31$ $p < .01$	$r = .24$, $p < .05$	$r = .42$, $p < .001$
6	Attention/Revised/Auditory	$r = .13$, $p = ns$	$r = .11$, $p = ns$	$r = .15$, $p = ns$
7	Interpretation/Revised/Visual	$r = .03$, $p = ns$	$r = .55$, $p < .001$	$r = -.71$, $p < .001$
8	Interpretation/Revised/Auditory	$r = .34$, $p < .001$	$r = .45$, $p < .001$	$r = .06$, $p = ns$

Visual inspection reveals that the internal reliability coefficients yielded when task order was not considered in the split-half reliability analyses tend to be smaller in magnitude than those yielded when the order in which a task was completed was taken into account in the calculation of internal reliability. This could suggest that the low internal reliability evidenced by the present tasks resulted from the requirement that participants complete more than one task. However, intriguingly five of the eight tasks evidenced larger sized internal reliability coefficients when the task was completed second. This is surprising since fatigue and repetition are typically thought to reduce a task's internal reliability (John & Soto, 2007; Furr & Bacharach, 2008). Nevertheless, it could suggest that the tasks' generally low levels internal reliability are at least partly attributable to task order effects. It should be noted however, that when the association between anxiety and threat-biased information processing was re-analysed taking task order into account, there was no additional evidence of anxiety-linked variability in biased information processing to that which had been revealed in the original analyses which did not consider task order. Therefore, while the tasks' internal reliability tended to improve when order was taken into account, the conclusions regarding the association between anxiety and threat-biased information processing were not compromised by disregarding task order in the analyses.

As just described, the internal reliability of the present tasks tended to be low. This could be due to order effects or variability in the sensitivity of the items to individual differences in information processing bias. Since task internal reliability may increase our confidence in the sensitivity of tasks to the effect of interest, it would be desirable if future variants of these tasks had higher levels of internal reliability. This might be achieved by designing tasks which minimise the impact of order effects.

Limitation 5: Reliance on null results

The Common Mechanism Account and the Independent Mechanisms Account differ in the predictions that they generate with regards to the patterns of associations across the eight experimental tasks. As will be recalled from the Introduction in chapter 1, the Common Mechanism Account predicts strong *Within Process* associations and equally strong *Between Process* associations. Conversely, the Independent Mechanisms Account predicts strong *Within Process* associations and relatively weaker *Between Process* associations. As such, the Independent Mechanisms Account predicts null results. Therefore, the confidence with which one could conclude in favour of these two accounts is not equivalent. A pattern of results consistent with the predictions of the Common Mechanism Account would provide firm support for the Common Mechanism Account. In contrast, while a failure to attain the results that support the Common Mechanism Account would be consistent with the pattern of effects predicted by the Independent Mechanisms Account, drawing the confident conclusion that this account is valid would be precluded since they are based on null results.

The capacity to extrapolate from the null correlations between tasks measuring attention bias and tasks measuring interpretation bias would be substantially greater if they were accompanied by high correlations amongst task pairs that each measured the same information processing bias. That is, if there were high correlations amongst pairs of tasks that each measured interpretation bias and high correlations amongst pairs of tasks that each measured attention bias, but low correlations amongst pairs of tasks one of which measured attention bias and one of which measured interpretation bias, then it would be possible to be confident that these results are strongly consistent with the predictions of the Independent Mechanisms Account. However, since the present results do not provide evidence of strong associations either within pairs of tasks that each measure the same information processing bias, or between pairs of tasks that each measure the alternative information processing bias, it is necessary to be cautious about the confidence that can be placed in the Independent Mechanisms Account because the results could simply reflect the insensitivity of the tasks.

There is some evidence that the present results are not simply due to the insensitivity of the tasks. In particular, the difference between the overall correlation amongst the attention *Within Process* associations relative to the overall correlation amongst the *Between Process* associations was near-significant. Although non-significant, this result provides some limited reassurance that task pairs that each measure the same information processing bias as one another tended towards being more highly associated than tasks that each measured the alternative information processing bias.

Ideally assessment of the Independent Mechanisms Account by future research would involve predictions that require the presence rather than the absence of particular effects. However, the nature of the Independent Mechanisms Account is such that it lends itself to predictions regarding the absence of an association between attention bias and interpretation bias. Therefore, cumulatively the repeated failure of future research that uses experimental methods which overcome the limitations of the present research, to find an association between attention bias and interpretation bias would increasingly shake our faith in the Common Mechanism Account.

Limitation 6: Limited power

Despite the large scale of the present research program, which involved testing a total of 560 participants, only twenty participants completed each pair of experimental tasks. While it was not practical to test more participants, the small number of participants who completed each pair of tasks may not have allowed rejection of the null hypothesis, even if there was a real effect. This issue is of particular importance given the implications drawn on the basis of the absence of a significant correlation between the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task. As will be recalled from chapter 11, using an alpha level of .05, the correlation between the Threat Bias Index of the Attention/Initial/Auditory Task and the Threat Bias Index of the Interpretation/Initial/Auditory Task was $r = .24$, $p = .30$. However, the power of this correlation, or the probability of discovering that this correlation is statistically different from there being no correlation is only .18. That is, with an alpha level of .05 and a sample size of twenty, it is only possible to reject the null hypothesis and be confident that the correlation of .24 is significantly different from zero 18% of the time. Conversely, the probability of a Type II error (that is, incorrectly accepting the null hypothesis when it is false) is .82. Therefore, the capacity of the present research to detect a real effect is limited and there is a real possibility that the absence of a correlation between the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task is due to error.

The limited power of this research program is a problem that cannot be ignored. However, the significant internal reliability and anxiety sensitivity of the both the Attention/Initial/Auditory Task and Interpretation/Initial/Auditory Task and the apparent lack of association between the two tasks, provides clear direction for future research. Specifically, it would be profitable to examine the correlation between the performance of the two tasks using a sample size large enough to ensure that any real effects would be picked up. If we assume that the correlation between the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task in this future study would approximate the correlation yielded by the present study, a sample size of 135 participants would be sufficient to ensure that with an alpha level of .05, it would be possible to reject the null hypothesis 80% of the time. Given the theoretical and applied importance of this finding, this research would be of great benefit.

When considering the implications of the present research, it is important to be aware of its limitations, which include: the use of novel tasks designed to be equivalent with one another; testing the novel tasks in parallel; testing order effects; the low internal reliability of some of the tasks; the reliance on null results; and the low power of the correlational analyses of the task pairs. These limitations could be reduced in future research: by including only tasks with significant internal reliability and sensitivity to trait anxiety; by ensuring that evidence for the predictions of the Independent Mechanisms Account can be demonstrated by the presence rather than the absence of effects; and by employing a sample size that would provide sufficient power to allow rejection of the null hypothesis if a real effect is present.

Conclusions and Future Research Directions

Arguably, the results of the present research program have contributed to knowledge of the association between anxiety-linked attention bias and interpretation bias. However, this investigation is really only the beginning of the journey towards a complete understanding of anxiety-linked attention bias and interpretation bias, their association, and the mechanisms that underlie each bias. Given the important theoretical and applied implications of understanding the association between attention bias and interpretation bias, it is essential that future research continues to work towards developing this understanding. In particular, in light of the consistency of the present results with the Independent Mechanisms Account, Independent Mechanisms Models should be the focus of future research.

One method by which future researchers could investigate the relationship between attention bias and interpretation bias would be to examine the differential involvement of attention bias and interpretation bias in particular clinical anxiety conditions. In conjunction with Independent Mechanisms Models, the results of the primary pattern of associations suggest that attention bias and interpretation bias would be differentially involved in specific clinical anxiety disorders (Clark, 1986; Clark et al., 1997; Clark & Wells, 1995). If particular clinical anxiety disorders rely on attention bias and interpretation bias to differing degrees, we would expect that the two information processing biases would not be equally evident within individuals suffering from these anxiety disorders. To clarify one way in which future research could examine the differential role of attention bias and interpretation bias in particular clinical anxiety disorders, panic disorder is considered. In his model of panic disorder, Clark (1986) specifically implicates interpretation bias rather than attention bias as key to the development and maintenance of panic disorder. On the basis of the present research findings and Clark's (1986) theoretical model, it would be expected that individuals with panic disorder would evidence threat-biased interpretation to a greater extent than threat-biased attention. To test this, individuals with panic disorder and non-anxious control participants could complete variants of the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task designed to overcome the methodological limitations identified earlier and to present representations of threat that are specifically relevant to panic disorder. Since the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task are identical except for their Prime Display stimuli, their results could be examined together using a Repeated Measures ANOVA with Task Type (Attention/Initial/Auditory Task vs. Interpretation/Initial/Auditory Task) included as a factor. This analysis would reveal whether relative to the non-anxious participants, participants with panic disorder evidence greater threat-biased interpretation than threat-biased attention. This methodology could also be used to investigate the differing role of attention bias and interpretation bias in other clinical anxiety disorders such as social anxiety disorder.

Another way to investigate the association between attention bias and interpretation bias is through the use of training. Recent research has shown that individuals can be trained to selectively attend towards threatening information and to selectively interpret ambiguous information as being threatening in meaning (reviewed by Mathews & MacLeod, 2002, 2005). If, as the present research predicts, attention bias and interpretation bias rely on separate underlying mechanisms, then training to attend towards threat would lead to threat-biased attention but not threat-biased interpretation, and similarly training to interpret ambiguous stimuli as threatening would lead to threat-biased interpretation but not threat-biased attention. To test this training variants of the Attention/Initial/Auditory Task and the Interpretation/Initial/Auditory Task could be developed. Such training variants would be identical to the original measures, however in each the target words would be repeatedly related to one particular meaning of the Prime Display. That is, training to preferentially process threat would involve the repeated presentation of target words related to the Prime Display's threatening meaning, while training to preferentially process non-threat would involve the repeated presentation of target words related to the Prime Display's non-threatening meaning. Participants with medium levels of trait anxiety could be trained to preferentially process threat on either the training variant of the Attention/Initial/Auditory Task or on the training variant of the Interpretation/Initial/Auditory Task. After training, participants would complete both the standard Attention/Initial/Auditory Task and the standard

Interpretation/Initial/Auditory Task. The performance of participants on the tasks that measured the trained information processing bias compared with the untrained information processing bias would reveal whether or not training threat-biased attention leads to threat-biased interpretation, and whether or not training threat-biased interpretation leads to threat-biased attention.

As outlined earlier in this chapter, when considered in conjunction with the Independent Mechanisms Models (e.g., Clark, 1986; Clark et al., 1997; Clark & Wells, 1995), the present research suggests that treatment of specific clinical anxiety disorders could be improved by targeting the particular information processing bias that has been identified as underlying that disorder. Clearly, given the potential clinical benefits of this knowledge, this is an important avenue for future investigation. Recent research has shown that training individuals to either selectively attend to threat, or selectively interpret ambiguous stimuli as threatening predicts their subsequent emotional response to stress (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). Therefore, in the future a training paradigm could be employed to examine the effect of modifying different information processing biases on the symptoms of individuals with particular anxiety disorders. If the Independent Mechanisms Models hold, it would be expected that targeting the information processing bias identified as underlying a particular anxiety disorder would alleviate the symptoms of that disorder to a greater extent than targeting another information processing bias. By way of example, social anxiety disorder is considered. Clark and Wells (1995) theorise that social anxiety disorder is maintained by attention bias towards evidence of one's poor social performance. If as the present research and Clark and Wells' (1995) predict, social anxiety disorder is primarily maintained by mechanism/s underlying attention bias, it is expected that in a socially threatening situation, an individual's symptoms of social anxiety would be more greatly reduced by training to direct attentional processing towards non-threatening information about his/her social performance than by training to interpret ambiguous information about his/social performance as being non-threatening. To test this training variants of the Interpretation/Initial/Auditory Task and the Attention/Initial/Auditory Task like those described earlier in this section could be employed, but with the qualification that the threatening meanings presented would relate to social threat. Participants diagnosed with social anxiety disorder could be trained either to attend towards non-threatening social information on the Attention/Initial/Auditory Training Task or to interpret ambiguous social information as non-threatening on the Interpretation/Initial/Auditory Training Task. The effectiveness of the training would then be assessed, such that individuals who completed the Attention/Initial/Auditory Training Task would complete a version of the Attention/Initial/Auditory Task whose threatening representations were related to social threat, while individuals who completed the Interpretation/Initial/Auditory Training Task would complete a version of the Interpretation/Initial/Auditory Task whose threatening representations were related to social threat. At the same time, participants would be exposed to a social anxiety provoking stressor such as being video taped, and their symptoms of social anxiety would be assessed. This type of experimental methodology would enable the assessment of the impact of modifying one information processing bias on the symptoms of particular clinical anxiety disorders.

As discussed, the present thesis has contributed to the advancement of knowledge about the association between individual differences in attention bias and interpretation bias. The results of the thesis are consistent with theoretical accounts that attribute anxiety-linked differences in attention bias and anxiety-linked differences in interpretation bias to separate and dissociable underlying mechanisms governing information processing selectivity. This has implications for theoretical models of anxiety and cognition and not only advances our understanding of attention bias and interpretation bias, but also may impact on the best approach to therapeutically remediating anxiety disorders through the manipulation of selective information processing.

REFERENCES

Amir, N., Beard, C., Przeworski, A. (2005). Resolving ambiguity: The effect of experience on interpretation of ambiguous events in social phobia. *Journal of Abnormal Psychology, 114,* 402-408.

Anderson, J., & Holcomb, P. (1995). Auditory and visual semantic priming using different stimulus onset asynchronies: An event related brain potential study. *Psychophysiology, 32,* 177-190.

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M., & van Ijzndoorn, M. (2007). Threat-related attentional bias in anxious and non-anxious individuals: A meta-analytic study. *Psychological Bulletin, 133,* 1-24.

Barnes, L., Harp, D., & Jung, W. (2002). Reliability generalization of scores on the Spielberger State-Trait Anxiety Inventory. *Educational and Psychological Measurement, 62,* 603-618.

Barnhart, C.L. (1962). *The American College Dictionary.* New York: Random House Inc.

Beck, A.T. (1976). *Cognitive Therapy and the Emotional Disorders.* New York: International Universities Press.

Beck, A.T. & Clark, D.M. (1988). Anxiety and depression: An information processing perspective. *Anxiety Research, 1*, 23-36.

Beck, A.T., & Clark, D.M. (1997). An information processing model of anxiety: Automatic and strategic processes. *Behaviour, Research and Therapy, 35,* 49-58.

Beck, A.T., Emery, G., & Greenberg, R.C. (1985). *Anxiety Disorders and Phobias: A Cognitive Perspective.* New York: Basic Books.

Blanchette, I., & Richards, A. (2003). Anxiety and the interpretation of ambiguous information: Beyond the emotion-congruent effect. *Journal of Experimental Psychology, General, 132*, 294-309.

Blanchette, I., Richards, A., & Cross, A. (2007). Anxiety and the interpretation of ambiguous facial expressions: The influence of contextual cues. *The Quarterly Journal of Experimental Psychology, 60,* 1101-1115.

Boothroyd, A., Mulhearn, B., Gong, J., & Ostroff, J. (1996). Effects of spectral smearing on phoneme and word recognition. *Journal of the Acoustical Society of America, 100,* 1807-1818.

Bower, G.H. (1992). How might emotions affect learning? In S.A. Christianson (Ed.), *The Handbook of Emotion and Memory.* Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Bower, G.H., & Forgas, J.P. (2000). Affect, memory, and social cognition. In E. Eich, J.F. Kihlstrom, G.H. Bower, J.P. Forgas & P.M. Niedenthal (Eds.), *Cognition and Emotion.* (pp.87-168). Oxford: Oxford University Press.

Bradley, B., Mogg, K., Falla, S., & Hamilton, L. (1998). Attentional bias for threatening facial expressions in anxiety: Manipulation of stimulus duration. *Cognition and Emotion, 12,* 737-753.

Bradley, B., Mogg, K., & Millar, N. (2000). Covert and overt orienting of attention to emotional faces in anxiety. *Cognition and Emotion, 14,* 789-808.

Broadbent, D., & Broadbent, M. (1988). Anxiety and attentional bias: State anxiety and trait. *Cognition and Emotion, 2,* 165-183.

Broomfield, N., & Turpin, G. (2005). Covert and overt attention in trait anxiety: A cognitive psychophysiological analysis. *Biological Psychology, 68,* 179-200.

Brown, T., O'Leary, T., & Barlow, D. (2001). Generalised anxiety disorder. In D.H. Barlow (Ed.), *Clinical Handbook of Psychological Disorders,* (pp. 155-208).

New York: Guilford.

Bryant, R., & Harvey, A. (1997). Attentional bias in posttraumatic stress disorder. *Journal of Traumatic Stress, 10,* 635-644.

Burgess, I., Jones, L., Robertson, S., Radcliffe, W., & Emerson, E. (1981). The degree of control exerted by phobic and non-phobic verbal stimuli over the recognition behaviour of phobic and non-phobic subjects. *Behaviour, Research and Therapy, 19*, 233-243.

Butler, G., & Mathews, A. (1983). Cognitive processes in anxiety. *Advances in Behaviour, Research and Therapy, 5,* 51-62.

Calvo, M., & Castillo, M. (1997). Mood-congruent bias in interpretation of ambiguity: Strategic processes and temporary activation. *The Quarterly Journal of Experimental Psychology, 50,* 163-182.

Calvo, M., & Castillo, M. (2001). Selective interpretation in anxiety: Uncertainty for threatening events. *Cognition and Emotion,* 15, 299-320.

Calvo, M., Eysenck, M., & Castillo, M. (1997). Interpretation bias in test anxiety: The time course of predictive inferences. *Cognition and Emotion, 11,* 43-63.

Calvo, M., & Eysenck, M. (2000). Early vigilance and late avoidance of threat processing: Repressive coping versus low/high anxiety. *Cognition and Emotion, 14,* 763-787.

Calvo, M., Eysenck, M., & Estevez, A. (1994). Ego-threat interpretive bias test anxiety: On-line inferences. *Cognition and Emotion, 8,* 127-146.

Clark, D. (1986). A cognitive approach to panic. *Behaviour, Research and Therapy, 24,* 461-470.

Clark, D. (2004). Developing new treatments: On the interplay between theories, experimental science and clinical innovation. *Behaviour, Research and*

Therapy, 42, 1089-1104.

Clark, D., Salkovskis, P., Breitholtz, E., Westling, B., Ost, L., Koehler, K., Jeavons, A., & Gelder, M. (1997). Misinterpretation of body sensations in panic disorder. *Journal of Consulting and Clinical Psychology, 65,* 203-213.

Clark, D., & Wells, A. (1995). A cognitive model of social phobia. In R.G. Heimberg, M.R. Liebowitz, D.A. Hope & F.R. Schneider (Ed.'s), *Social Phobia: Diagnosis, Assessment and Treatment*, NY: Guilford.

Cohen, Y., Rasic-Lachenmeyer, J., & Springer, C. (2003). Anxiety and selective attention in obsessive-compulsive disorder. *Behaviour, Research and Therapy, 41,* 1311-1323.

Cox, W., Fadardi, J., Pothos, E. (2006). The Addiction-Stroop Test: Theoretical considerations and procedural recommendations. *Psychological Bulletin, 132,* 443-476.

Dalgleish, T., & Watts, F. (1990). Biases of attention and memory in disorders of anxiety and depression. *Clinical Psychology Review, 10,* 589-604.

Deghani, M., Sharpe, L., Nicholas, M. (2003). Selective attention to pain-related information in chronic musculoskeletal pain patients. *Pain, 105,* 37-46.

Dutch, R. (1966). *Roget's Thesaurus of English Words and Phrases*. Middlesex: Penguin Books Ltd.

Earleywine, M. (1994). Cognitive bias covaries with alcohol consumption. *Addictive Behaviors, 19,* 539-544.

Echardt, C., & Cohen, D. (1997). Attention to anger-relevant and irrelevant stimuli following naturalistic insult. *Personality and Individual Differences, 23,* 619-629.

Edwards, M., Burt, J., & Lipp, O. (2006). Selective processing of masked and unmasked verbal threat material in anxiety: Influence of an immediate acute stressor. *Cognition and Emotion, 20,* 812-835.

Egloff, B., & Hock, M. (2001). Interactive effects of state anxiety and trait anxiety on emotional Stroop interference. *Personality and Individual Differences, 31*, 875-882.

Eysenck, M. (1992). Anxiety: The Cognitive Perspective. Hove: Lawrence Erlbaum and Associates Publishers.

Eysenck, M. (2004). Trait anxiety, repressors and cognitive biases. In J. Yiend. (Ed.). *Cognition, Emotion and Psychopathology: Theoretical, Empirical and Clinical Directions.* (pp. 49-67). Cambridge: Cambridge University Press.

Eysenck, M., & Calvo, M. (1992). Anxiety and performance: The processing efficiency theory. *Cognition and Emotion, 6,* 409-434.

Eysenck, M., Derakshan, N., Santos, R., & Calvo, M. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion, 7,* 336-353.

Eysenck, M., MacLeod, C., & Mathews, A. (1987). Cognitive functioning in anxiety. *Psychological Research, 49,* 189-195.

Eysenck, M., Mogg, K., May, J., Richards, A., & Mathews, A. (1991). Biases in interpretation of ambiguous sentences related to threat in anxiety. *Journal of Abnormal Psychology, 100,* 144-150.

Faunce, G. (2002). Eating disorders and attentional bias: A review. *Eating Disorders, 10,* 125-139.

Feldt, L., & Charter, R. (2003). Estimating the reliability of a test split into two parts of equal or unequal length. *Psychological Methods, 8*, 102-109.

Foa, E., & McNally, R. (1986). Sensitivity to feared stimuli in obsessive-compulsives: A dichotic listening analysis. *Cognitive Therapy and Research, 10,* 477-485.

Fox, E. (1993a). Attentional bias in anxiety: Selective or not? *Behaviour, Research and Therapy, 31,* 487-493.

Fox, E. (1993b). Allocation of visual attention and anxiety. *Cognition and Emotion, 7,* 207-215.

Fox, E. (1994). Attentional bias in anxiety: A defective inhibition hypothesis. *Cognition and Emotion, 8*, 165-195.

Fox, E. (2002). Covert and overt orienting of attention to emotional faces in anxiety. *Cognition and Emotion, 14,* 789-808.

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General,* 681-700.

Fox, E., Russo, R., & Dutton, K. (2002). Attentional bias for threat: Evidence for a delayed disengagement from emotional faces. *Cognition and Emotion, 16,* 355-379.

Furr, R. M., Bacharach, V. (2008). *Psychometrics: An Introduction*. London: Sage Publications Ltd.

Gotlib, I., Yue, D., & Joormann, J. (2005). Selective attention in dysphoric individuals: The role of affective interferences and inhibition. *Cognitive Therapy and Research, 29,* 417-432.

Graf, P., & Mandler, G. (1984). Activation makes words more accessible, but not necessarily more retrievable. *Journal of Verbal Learning and Verbal Behaviour, 23,* 553-568.

Grey, S., & Mathews, A. (2000). Effects of training on interpretation of emotional ambiguity. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology, 53,* 1143-1162.

Hester, R., Dixon, V., & Garavan, H. (2006). A consistent attentional bias for drug-related material in active cocaine users across word and picture versions of the emotional Stroop task. *Drug and Alcohol Dependence, 81,* 251-257.

Hirsch, C., & Mathews, A. (1997). Interpretative inferences when reading about emotional events. *Behaviour, Research & Therapy,* 35, 1123-1132.

Hirsch, C., & Mathews, A. (2000). Impaired positive inferential bias in social phobia. *Journal of Abnormal Psychology, 109*, 705-712.

Holcomb, P., & Neville, H. (1990). Auditory and visual semantic priming in lexical decision: A comparison using event-related brain potentials. *Language and Cognitive Processes, 5,* 281-312.

Hope, D., Rapee, R., Heimberg, R., & Dombeck, M. (1990). Representations of the self in social phobia: Vulnerability to Social Threat. *Cognitive Therapy and Research, 14,* 177-189.

Humphreys, L., & Drasgow, F. (1989). Some comments on the relation between reliability and statistical power. *Applied Psychological Measurement, 13,* 419-425.

Huppert, J., Pasupeleti, R., Foa, E., & Mathews, A. (2007). Interpretation biases in social anxiety: Response generation, response selection, and self-appraisals. *Behaviour, Research and Therapy, 45,* 1505-1515.

Jerger, S., Stout, G., Kent., M., Albritton, E., Loiselle, L., Blondeau, R., & Jorgenson, S. (1993). Auditory Stroop effects in children with hearing impairment. *Journal of Speech and Hearing Research, 36,* 1083-1096.

John, O., & Benet-Martinez, V. (2000). Measurement: Reliability, construct validation and scale construction. In H. Reis & C., Judd (Ed's.). *Handbook of Research Methods in Social and Personality Psychology*. (pp. 340-369).

Cambridge: Cambridge University Press.

John, O., & Soto, C. (2007). The importance of being valid: Reliability and the process of construct validation. In R. Robins, R. Fraley & R. Krueger (Ed's.). *Handbook of Research Methods in Personality Psychology*. (pp. 461-494). NY: The Guilford Press.

Koster, E., De Raedt, R., Goeleven, E., Franck, E., & Crombez, G. (2005). Mood-congruent attentional bias in dysphoria: Maintained attention to and impaired disengagement from negative information. *Emotion, 5,* 446-455.

Koster, E., Cromez, G., Verschuere, B., & de Houwer, J. (2006). Attention to threat in anxiety-prone individuals: Mechanisms underlying attentional bias. *Cognitive Therapy and Research, 30,* 635-643.

Koster, E., Cromez, G., Verschuere, B., van Damme, S., & Wiersema, J. (2006). Components of attentional bias to threat in high trait anxiety: facilitated engagement, impaired disengagement, and attentional avoidance. *Behaviour, Research and Therapy, 44,* 1757-1771.

Kucera, H., & Francis, W. (1967). *Computational analysis of present-day American English.* Providence: Brown University Press.

Lavy, E., & van den Hout, M. (1994). Cognitive avoidance and attentional bias: Causal relationships. *Cognitive Therapy and Research, 18,* 179-191.

Lawson, C., MacLeod, C., & Hammond., G. (2002). Interpretation revealed in the blink of the eye: Depressive bias in the resolution of ambiguity. *Journal of Abnormal Psychology, 111,* 321-328.

Lilley, R., & Cobham, V. (2005). Interaction of anxiety sensitivity and induced physiological state: Effect on behaviour and interpretation of ambiguous scenarios. *Australian Journal of Psychology, 57,* 77-86.

Leyman, L., de Raedt, R., Schacht, R., & Koster, E. (2007). Attentional biases for angry faces in unipolar depression. *Psychological Medicine, 37,* 393-402.

MacLeod, C. (1990). Mood disorders and cognition. In M.W. Eysenck (Ed.). *Cognitive Psychology: An International Review* (pp.9-56). Chichester: John Wiley & Son's Ltd.

MacLeod, C. (1999). Anxiety and anxiety disorders. In T. Dalgleish & M. Power (Ed.'s). *Handbook of Cognition and Emotion* (pp.447-477). Chichester: John Wiley & Son's Ltd.

MacLeod, C., & Hagan, (1992). Individual differences in the selective processing of threatening information, and emotional responses to a stressful life event. *Behaviour, Research and Therapy, 30,* 151-161.

MacLeod, C., & Mathews, A. (1988). Anxiety and the allocation of attention to threat. *The Quarterly Journal of Experimental Psychology, 40*, 653-670.

MacLeod, C., & Mathews, A. (1991). Biased cognitive operations in anxiety: Accessibility of information or assignment of processing priorities? *Behaviour, Research and Therapy, 29,* 599-610.

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95*, 15-20.

MacLeod, C., & Rutherford, E. (1992). Anxiety and the selective processing of emotional information: Mediating roles of awareness, trait and state anxiety variables and personal relevance of stimulus materials. *Behaviour, Research and Therapy, 30*, 479-491.

MacLeod, C., & Rutherford, E. (1998). Automatic & strategic cognitive biases in anxiety and depression. In K. Kirsner (Ed.) *Implicit and explicit mental processes* (pp. 233-254). Mahwah, NJ: Erlbaum.

MacLeod, C., & Rutherford, E. (2004). Information processing approaches: Assessing the selective functioning of attention, interpretation and retrieval. In R.G. Heimberg, C.L. Turk, & D.S. Mennin (Ed.'s). *Generalized Anxiety Disorder: Advances in research and practice* (pp.109-142). London: The Guilford Press.

MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, G., & Holker, L. (2002). Selective attention and emotional vulnerability: Assessing the causal basis of their association through the experimental manipulation of attentional bias. *Journal of Abnormal Psychology, 111,* 107-123.

Martin, M., & Jones, G. (1995). Integral bias in the cognitive processing of emotionally linked pictures. *British Journal of Psychology, 86,* 419-433.

Mathews, A., & Mackintosh, B. (1998). A cognitive model of selective processing in anxiety. *Cognitive Therapy and Research, 22,* 539-560.

Mathews, A., & Mackintosh, B. (2000). Induced emotional interpretation bias and anxiety. *Journal of Abnormal Psychology, 109,* 602-615.

Mathews, A. & MacLeod, C. (1985). Selective processing of threat cues in anxiety states. *Behaviour Research and Therapy, 23*, 563-569.

Mathews, A., & MacLeod, C. (1986). Discrimination of threat cues without awareness in anxiety states. *Journal of Abnormal Psychology, 95*, 131-138.

Mathews, A., & MacLeod, C. (1994). Cognitive approaches to emotion and emotional disorders. *Annual Review of Psychology, 45*, 25-50.

Mathews, A., & MacLeod, C. (2002). Induced processing biases have causal effects on anxiety. *Cognition and Emotion, 16,* 331-354.

Mathews, A., & MacLeod, C. (2005). Cognitive vulnerability to emotional disorders. *Annual Review of Clinical Psychology, 1,* 167-195.

Mathews, A., May, J., Mogg, K., & Eysenck, M. (1990). Attentional bias in anxiety:

Selective search or defective filtering? *Journal of Abnormal Psychology, 99,* 166-173.

Mathews, A., & Milroy, R. (1994). Processing of emotional meaning in anxiety. *Cognition and Emotion, 8*, 535-553.

Mathews, A., Richards, A., & Eysenck, M. (1989). Interpretation of homophones related to threat in anxiety states. *Journal of Abnormal Psychology, 98,* 31-34.

Matlin, M. (1994). *Cognition, Third Edition.* Fort Worth: Harcourt Brace Publishers.

Mattia, J., Heimberg, R., Hope, D. (1993). The revised Stroop color-naming task in social phobics. *Behaviour, Research and Therapy, 31,* 305-313.

Mauer N., & Borkenau, P. (2007). Temperament and early information processing: Temperament-related attentional bias in emotional Stroop tasks. *Personality and Individual Differences, 43,* 1063-1073.

McCabe, S., & Gotlib, I. (1993). Attentional processing in clinically depressed subjects: A longitudinal investigation. *Cognitive Therapy and Research, 17*, 359-377.

McNally, R., Hornig, C., Hoffman, E., & Han, E. (1999). Anxiety sensitivity and cognitive biases for threat. *Behavior Therapy, 30,* 51-61.

McNally, R., Riemann, B., & Kim, E. (1990). Selective processing of threat cues in panic disorder. *Behaviour, Research and Therapy, 28,* 407-412.

Milberg, W., Blumstein, S., Dworetzky, B. (1988). Phonological factors in lexical access: Evidence from an auditory lexical decision task. *Bulletin of the Psychonomic Society, 26,* 305-308.

Mineka, S., & Sutton, S. (1992). Cognitive biases and the emotional disorders. *Psychological Science, 3,* 65-69.

Mogg, K., & Bradley, B. (1998). A cognitive-motivational analysis of anxiety.

Behaviour, Research and Therapy, 36, 809-848.

Mogg, K., & Bradley, B. (2004). A cognitive-motivational perspective on processing of threat information in anxiety. In J. Yiend (Ed.). *Cognition, Emotion and Psychopathology: Theoretical, empirical and clinical directions.* (pp. 68-85). Cambridge: Cambridge University Press.

Mogg, K., Bradley, B., De Bono, J., & Painter, M. (1997). Time course of attentional bias for threat information in non-clinical anxiety. *Behaviour, Research & and Therapy, 35*, 297-303.

Mogg, K., Bradley, B., Dixon, C., Fisher, S., Twelftree, H., & McWilliams, A. (2000). Trait anxiety, defensiveness and selective processing of threat: an investigation using two measures of attentional bias. *Personality and Individual Differences, 28,* 1063-1077.

Mogg, K., Bradley, B., & Hallowell, N. (1994). Attentional bias to threat: Roles of trait anxiety, stressful events, and awareness. *The Quarterly Journal of Experimental Psychology, 47*, 841-864.

Mogg, K., Bradley, B., Miller, T., Potts, H., Glenwright, J., & Kentish, J. (1994). Interpretation of homophones related to threat: Anxiety or response bias effects? *Cognitive Therapy and Research, 18,* 461-477.

Mogg, K., Bradley, B., & Williams, R. (1995). Attentional bias in anxiety and depression: The role of awareness. *British Journal of Clinical Psychology, 34,* 17-36.

Mogg, K., Bradley, B., Williams, R., & Mathews, A. (1993). Subliminal processing of emotional information in anxiety and depression. *Journal of Abnormal Psychology, 102,* 304-311.

Mogg, K., Kentish, J. & Bradley, B. (1993). Effects of anxiety and awareness on colour-identification latencies for emotional words. *Behaviour, Research and Therapy, 31,* 559-567.

Mogg, K., Mathews, A., & Eysenck, M. (1992). Attentional bias to threat in clinical anxiety states. *Cognition and Emotion, 6,* 149-159.

Mogg, K., Mathews, A., Eysenck, M., & May, J. (1991). Biased cognitive operations in anxiety: Artefact, processing priorities or attentional search. *Behaviour, Research & Therapy, 29*, 459-467.

Mogg, K., Mathews, A., & Weinman, J. (1989). Selective processing of threat cues in anxiety states: A replication. *Behaviour Research and Therapy, 27*, 317-323.

Mogg, K., Millar, N., & Bradley, B. (2000). Biases in eye movements to threatening facial expressions in Generalised Anxiety Disorder and Depressive Disorder. *Journal of Abnormal Psychology, 109,* 695-704.

Mohlman, J., Carmin, C., & Price, R. (2007). Jumping to interpretations: Social anxiety disorder and the identification of emotional facial expressions. *Behaviour, Research and Therapy, 45,* 591-599.

Morgan, A., & Brandt., J. (1989). An auditory Stroop effect for pitch, loudness and time. *Brain and Language, 36,* 592-603.

Neely, J. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited capacity attention. *Journal of Experimental Psychology: General, 106,* 226-254.

Öhman, A. (1993). Fear and anxiety as an emotional phenomena. In M. Lewis & J. Haviland (Eds.) *Handbook of emotions* (pp. 511-536). NY: Guilford Press.

Pagano, R. (1994). *Understanding Statistics in the Behavioural Sciences, Fourth Edition*. Minneapolis: West Publishing Company.

Pedhazur, E., & Pedhazur-Schmelkin, L. (1991). *Measurement, Design and Analysis:*

An Integrated Approach. London: Lawrence Erlbaum Associates, Publishers.

Pincus, T., Pearce, S., McClelland, A., Farley, S., & Vogel, S. (1994). Interpretation bias in responses to ambiguous cues in pain patients. *Journal of Psychosomatic Research, 38,* 347-353.

Pratto, F., & John, O. (1991). Automatic vigilance: The attention grabbing power of social information. *Journal of Personality and Social Psychology, 61*, 380-391.

Posner, M. (1980). Orientation of attention. *Quarterly Journal of Experimental Psychology, 32,* 3-25.

Power, M., & Dalgleish, T. (2008). *Cognition and Emotion: From Order to Disorder, 2nd Edition*. NY: Psychology Press.

Pury, C. (2002). Information-processing predictors of emotional response to stress. *Cognition and Emotion, 16,* 667-683.

Putman, P., Hermans, E., & van Honk, J. (2004). Emotional Stroop performance for masked angry faces: It's BAS, not BIS. *Emotion, 4,* 305-311.

Putman, P., Hermans, E., & van Honk, J. (2006). Anxiety meets fear in perception of dynamic expressive gaze. *Emotion, 6,* 94-102.

Raykos, B. (2006). Attentional and interpretive biases: Independent dimensions of individual difference or expressions of a common selective processing mechanism? Unpublished doctoral dissertation, University of Western Australia, Perth, Western Australia, Australia.

Ree, M., & Harvey, A. (2006). An investigation of interpretive bias in insomnia: An analogue study comparing normal and poor sleepers. *Sleep: Journal of Sleep and Sleep Disorders Research, 29,* 1359-1362.

Richards, A. (2004). Anxiety and the resolution of ambiguity. In J. Yiend (Ed.). *Cognition, Emotion and Psychopathology: Theoretical, Empirical and Clinical*

Directions (pp. 130-148). Cambridge: Cambridge University Press.

Richards, A., & French C. (1992). An anxiety-related bias in semantic activation when processing threat/neutral homographs. *Quarterly Journal of Experimental Psychology, 36,* 489-503.

Richards, A., Reynolds, A., & French, C. (1993). Anxiety and the spelling and use in sentences of threat/neutral homophones. *Current Psychology: Research & Reviews, 12,* 18-25.

Rodd, J. (2004). When do leotards get their spots? Semantic activation of lexical neighbours in visual word recognition. *Psychonomic Bulletin & Review, 11,* 434-439.

Roelofs, J., Peters, M., Zeegers, M., & Vlaeyen, J. (2002). The modified Stroop paradigm as a measure of selective attention towards pain-related stimuli among chronic pain patients: a meta-analysis. *European Journal of Pain, 6*, 273-281.

Rosenthal, R. (1991). *Meta-Analytic Procedures for Social Research, Revised Edition.* California: Sage Publications Ltd.

Rosenthal, R., & DiMatteo, M. (2001). Meta-analysis: Recent developments in quantitative methods for literature reviews. *Annual Review of Psychology, 52,* 59-82.

Rosenthal, R., Rosnow, R., Rubin, D. (2000). *Contrasts and Effect Sizes in Behavioral Research: A correlational approach.* Cambridge: Cambridge University Press.

Salemink, E., van den Hout, M., & Kindt, M. (2007). Trained interpretive bias: Validity and effects on anxiety. *Journal of Behavior Therapy, 38,* 212-224.

Schmukle, S. (2005). Unreliability of the dot probe task. *European Journal of Personality, 19*, 595-605.

Schmitt, N. (1996). Uses and abuses of coefficient alpha. *Psychological Assessment,* *8,* 350-353.

Spielberger, C.D., Gorusch, R.L., Lushene, R., Vagg, P.R., & Jacobs, G.A. (1983). Manual for the State-Trait Anxiety Inventory (Form Y). Palo Alto, CA: Consulting Psychologists Press.

Stetter, F., Ackermann, K., Bizer., Straube, E., & Mann, K. (1995). Effects of disease-related cues in alcoholic inpatients: Results of a controlled “Alcohol Stroop” study. *Alcoholism: Clinical and Experimental Research, 19,* 593-599.

Teachman, B. (2005). Information processing and anxiety sensitivity: Cognitive vulnerability to panic reflected in interpretation and memory biases. *Cognitive Therapy and Research, 29,* 479-499.

Twilley, L., Dixon, P., Taylor, D., & Clark, K. (1994). University of Alberta norms of relative meaning frequency for 566 homographs. *Memory & Cognition, 22*, 111-126.

van den Hout, M., Tenney, N., Huygens, K., Merckelbach, H., & Kindt, M. (1995). Responding to subliminal threat cues is related to trait anxiety and emotional vulnerability: A successful replication of MacLeod & Hagan (1992). *Behaviour, Research and Therapy, 33*, 451-454.

van Honk, J., Tuiten, A., van den Hout, M., de Haan, R., van den Hout, M., & Stam, H. (2001). Attention biases for angry faces: Relationships to trait anger and anxiety. *Cognition and Emotion, 15,* 279-297.

van Honk, J., Tuiten, A., van den Hout, M., Putman, P., de Haan, R., & Stam, H. (2001). Selective attention to unmasked and masked threatening words: Relationships to trait anger and anxiety. *Personality and Individual Differences, 30,* 711-720.

Whalen, P. (1998). Fear, vigilance and ambiguity: Initial neuro-imaging studies of the human amygdala. *Current Directions in Psychological Science, 7*, 177-188.

Williams, J., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology, *Psychological Bulletin, 120,* 3-24.

Williams, J., Watts, F., MacLeod C., & Mathews, A. (1988). *Cognitive Psychology and Emotional Disorders*. NY: John Wiley & Sons Inc.

Williams, J., Watts, F., MacLeod C., & Mathews, A. (1997). *Cognitive Psychology and Emotional Disorders, 2nd Edition*. NY: John Wiley & Sons Inc.

Wilson, E., MacLeod, C., Mathews, A., & Rutherford, E. (2006). The causal role of interpretive bias in anxiety reactivity. *Journal of Abnormal Psychology, 115*, 103-111.

Wurm, L., Labouvie-Vief, G., Aycock, J., Rebucal, K., & Koch, H. (2004). Performance in auditory and visual emotional Stroop tasks: A comparison of older and younger adults. *Psychology and Aging, 19,* 523-535.

Yiend, J., & Mathews, A. (2001). Anxiety and attention to threatening pictures. *The Quarterly Journal of Experimental Psychology, 54*, 665-681.

Yoon, K., & Zinbarg, R. (2007). Threat is in the eye of the beholder: Social anxiety and the interpretation of ambiguous facial expressions. *Behaviour, Research and Therapy, 45,* 591-599.

Young, J., Weinberger, A., & Beck, A.T. (2001). Cognitive therapy for depression. In D.H. Barlow (Ed.), *Clinical Handbook of Psychological Disorders,* (pp. 276-287). New York: Guilford.

APPENDIX A

STIMULUS SELECTION

Experimental Stimuli

As was described in the Methodological Overview in chapter 2, the stimuli used in each experimental task were selected from quintets of words. As will be recalled, each quintet included: a *homonym*, that possessed a threatening and a non-threatening definition; a *threat synonym*, that was synonymous with its corresponding homonym's threatening meaning; a *non-threat synonym*, that was synonymous with its corresponding homonym's non-threatening meaning; a *threat associate*, that was semantically related to both its corresponding homonym's threatening definition and its corresponding threat synonym; and a *non-threat associate*, that was semantically related to both its corresponding homonym's non-threatening definition and its corresponding non-threat synonym. As will be recalled from Table 1 in chapter 2: a *threat associate* and a *non-threat associate* were contained in the Target Display of all tasks; a *threat synonym* and a *non-threat synonym* were displayed in the Prime Display of the attention tasks; and a *homonym* was displayed in the Prime Display of the interpretation tasks.

A total of 64 quintets was required for the present research to ensure that each task could present the quintets with equal frequency across the experimental conditions. The 64 quintets were chosen from a pool of 80 candidate quintets developed by Raykos (2006). Prior to selection, 21 candidate quintets were identified as containing one or more words that were not suitable for the present research. Words were deemed unsuitable if they: were intended to be unambiguous (i.e., *threat synonyms*, *non-threat synonyms*, *threat associates* or *non-threat associates*), but were ambiguous in the auditory modality (e.g., *FLOWER*); or if they were the alternative form of a word that was already present in the word pool (e.g., *SMACK* and *SMACKING*). The unsuitable words were replaced with alternatives selected from *Roget's Thesaurus* (Dutch, 1966).

As outlined in the Methodological Overview in chapter 2, the selection of the quintets was intended to achieve three goals: First, each Prime Display would present two meanings that differed in emotional valence; Second, within each pair of Prime Display meanings, one meaning would be semantically related to a corresponding *threat associate*, while the other meaning would be semantically related to a corresponding *non-threat associate*; Third, each Prime Display of an attention task would semantically correspond with a Prime Display of an interpretation task, such that each meaning in the Prime Display of an attention task, would be synonymous with one of the meanings in the corresponding Prime Display of an interpretation task. The 80 quintets were rated on the basis of these goals, so that the 64 quintets that best achieved these goals could then be selected.

Stimulus Ratings [32]

Emotional valence of Prime Display stimuli

For each of the 80 candidate quintets, emotional valence ratings of the *threat synonym*, the *non-threat synonym* and the *homonym* were obtained. 10 university student judges rated the emotional valence of the word stimuli using an 11 point scale ranging from -5, representing *threatening* to 0, representing *neutral* to +5, representing *favourable*. The word stimuli were counterbalanced across judges, so that each judge rated half of the *homonyms* defined by their threatening meaning and half of the *homonyms* defined by their non-threatening meaning. Likewise, each judge rated half of the *threat synonyms* and half of the *non-threat synonyms*.

---

[32] Rating scales were based on those used by Raykos (2006).

Semantic-relatedness of corresponding Prime and Target Display stimuli

For each of the 80 candidate quintets, ratings of the semantic relatedness of: the *homonym* and its corresponding *threat associate*; the *homonym* and its corresponding *non-threat associate*; the *threat synonym* and its corresponding *threat associate*, and the *non-threat synonym* and its corresponding *non-threat associate* were obtained. Semantic-relatedness was judged using an 11 point scale, ranging from –5, representing *not related*, to 0, representing *slightly related*, to +5, representing *highly related*. The judges were instructed that two words were considered related if either: they had semantically similar meanings (e.g.: *QUICK*, *FAST*) or, they had meanings associated with one another (e.g.: *CAT*, *DOG*). 10 new university student judges rated the semantic relatedness of the *homonyms* and their corresponding *threat associates* and *non-threat associates*. The word stimuli were counterbalanced across judges, so that each judge rated the semantic-relatedness of half the *homonyms* and their corresponding *threat associate* and half the *homonyms* and their corresponding *non-threat associates*. Another 10 student judges rated the semantic relatedness of the *threat synonyms* and their corresponding *threat associates*, and the semantic relatedness of the *non-threat synonyms* and their corresponding *non-threat associates*. These word stimuli were also counterbalanced across judges, so that each judge rated half the *threat synonyms* and their corresponding *threat associates* and half the *non-threat synonyms* and their corresponding *non-threat associates.*

Synonymity of the attention Prime Display meanings and the interpretation Prime Display meanings

For each of the 80 candidate quintets, ratings of the synonymity of the *homonyms* and their corresponding *threat synonyms* and *non-threat synonyms* were obtained. A further 10 university student judges made synonymity ratings on an 11 point scale, ranging from –5 representing not a synonym, to 0 representing slightly related, to +5 representing an excellent synonym. The word stimuli were counterbalanced across judges, so that each judge rated the synonymity of half of the *homonyms* and their corresponding *threat synonyms*, and half of the *homonyms* and their corresponding *non-threat synonyms*.

Quintet Selection

The final 64 quintets were selected from among the 80 candidate quintets on the basis of their ratings on the aforementioned scales.

In terms of the emotional valence ratings of the Prime Display stimuli, to be retained for the final set of experimental stimuli, a quintet was required to possess: a *threat synonym* with a mean emotional valence rating that was more negative (i.e., rated more threatening) than that of its corresponding *non-threat synonym*; and a *homonym* whose threatening meaning possessed a mean emotional valence rating that was more negative than that of its non-threatening meaning. One candidate quintet that did not meet this criterion was excluded from the final set.

In terms of the semantic-relatedness ratings of the corresponding Prime and Target Display stimuli, to be retained for the final experimental stimulus set, for each quintet, the mean semantic-relatedness rating of: the *homonym* and its corresponding *threat associate*; the *homonym* and its corresponding *non-threat associate*; the *threat synonym* and its corresponding *threat associate*; and the *non-threat synonym* and its corresponding *non-threat associate*; was required to be greater than +1. Nine candidate quintets that did not meet this criterion were excluded from the final set.

In terms of the synonymity of the attention Prime Display meanings and the interpretation Prime Display meanings, to be retained for the final experimental stimulus set, for each quintet, the mean synonymity rating of the *homonym* and its corresponding *threat synonym* and the mean synonymity rating of the *homonym* and its corresponding *non-threat synonym*, was required to be greater than +2. Six candidate quintets that did not meet this criterion were excluded from the final set.

Following these exclusions 64 quintets remained. These final 64 quintets are presented in Table 35.

Table 35
The Experimental Quintets

Homonym	Threat Synonym	Non-threat Synonym	Threat Associate	Non-threat Associate
TRAMP	BEGGAR	TRUDGE	VAGRANT	WALK
BUG	BOTHER	BEETLE	HASSLE	INSECT
FIDDLE	CHEAT	VIOLIN	DEFRAUD	VIOLA
YIELD	CONCEDE	PRODUCE	SURRENDER	HARVEST
PLOT	CONSPIRE	MUD	CONNIVE	GROUND
CHICKEN	COWARD	HEN	SCARED	CHOOK
DIE	DECEASE	CUBE	EXPIRE	DICE
STALL	DELAY	BOOTH	OBSTRUCT	CUBICLE
ARRESTING	DETAINING	ATTRACTIVE	SEIZING	BEAUTIFUL
FAINT	DIZZY	QUIET	WEARY	SUBTLE
SINK	DROWN	BASIN	SUBMERGE	TROUGH
WICKED	EVIL	EXCELLENT	SINFUL	FIRST-RATE
HANG	LYNCH	LINGER	CRIMINAL	HOVER
STATE	FLUSTER	SAY	ANXIOUS	SPEAK
SIMPLE	FOOLISH	EASY	IGNORANT	BASIC
WAKE	FUNERAL	AWAKEN	BURIAL	AROUSE
SPIRITS	GHOSTS	MORALE	DEMONS	CONFIDENT
SHARP	HARSH	QUICK	HOSTILE	ACUTE
PELT	HURL	SKIN	BARRAGE	FUR
JERK	IDIOT	TUG	IMBECILE	SHRUG
HAMPER	IMPEDE	BASKET	HINDER	PICNIC
POACH	KILL	SIMMER	MURDER	COOK
LIMP	LAME	SOFT	DISABLED	FLOPPY
PART	LEAVE	COMPONENT	ABANDON	ELEMENT
MEAN	NASTY	AVERAGE	CRUEL	MEDIAN

FALL	PLUMMET	AUTUMN	GRAVITY	WINTER
STALK	PURSUE	STEM	HARASS	PLANT
SCRAP	QUARREL	FRAGMENT	FIGHT	REMNANT
DUMP	REJECT	JUNK-HEAP	EXPEL	TIP
BLUE	SAD	AZURE	MOROSE	SAPPHIRE
NOTE	SCRUTINISE	MEMO	LOOK	E-MAIL
SMASHING	SHATTERING	FANTASTIC	DEMOLISH	WONDERFUL
JAR	SHOCK	VASE	JOLT	CARAFE
PATIENT	SICK	CALM	ILL	TOLERANT
HIT	SLAP	SUCCESS	WALLOP	TRIUMPH
HACK	SLASH	CARRIAGE	SLIT	TAXI-CAB
SMART	STINGING	INTELLIGENT	PAINFUL	CLEVER
LABOUR	CHILDBIRTH	WORK	CONTRACTIONS	JOB
STERN	STRICT	REAR	SEVERE	BACK
TRIP	STUMBLE	JOURNEY	STAGGER	EXCURSION
DENSE	STUPID	SOLID	OBTUSE	HEAVY
WILL	TESTAMENT	INTENTION	BEQUEST	DESIRE
BOUND	TIED-UP	LEAP	CONFINED	HOP
GRAVE	TOMB	THOUGHTFUL	TRENCH	SERIOUS
CATCH	TRAP	HOOK	SNARE	LATCH
GROWTH	TUMOUR	EXPANSION	CYST	INCREASE
SENTENCE	VERDICT	WORDS	PUNISHMENT	IDEA
ROUGH	VIOLENT	BUMPY	ABUSIVE	UNEVEN
PUNCH	WHACK	DRINK	THUMP	BEVERAGE
STRAP	WHIP	RIBBON	LASH	FASTENER
RETREAT	WITHDRAW	SANCTUARY	RELINQUISH	HAVEN
STRAIN	WORRY	FILTER	STRESS	SIEVE
GAG	SUPPRESS	WISE-CRACK	CHOKE	JOKE
JAM	PREDICAMENT	JELLY	DILEMMA	STRAWBERRY
SHOT	INJURED	TRY	WOUNDED	ATTEMPT
RANK	PUTRID	GRADE	OFFENSIVE	POSITION
CELL	JAIL	AMOEBA	PRISON	ORGANISM
DROP	EXCLUDE	TRICKLE	NEGLECT	DRIP
GLARE	FROWN	DAZZLE	SCOWL	SHINE
SLIP	SLIDE	PETTICOAT	COLLAPSE	SKIRT
MUG	ASSAULT	TUMBLER	ATTACK	TEA-CUP
FINE	PENALTY	HEALTHY	WRONG	GOOD
GROSS	DISGUSTING	TOTAL	VULGAR	QUANTITY
BUST	BROKEN	BREAST	RUIN	TORSO

Characteristics of the Final 64 Quintets

Emotional valence of Prime Display stimuli

The mean emotional valence ratings of the Prime Display stimuli in the final 64 quintets are presented in Table 36.

Table 36

Mean Emotional Valence Ratings of Prime Display Word Stimuli (Standard Deviations in Parentheses).

	Homonym Threat meaning	Homonym Non-threat meaning	Threat Synonym	Non-threat Synonym
Emotional Valence *	-2.05 (.95)	.87 (1.14)	-1.96 (1.13)	.95 (1.14)

Notes.

* The more negative the rating, the more threatening the word is considered.

To confirm that the stimuli included in the Prime Display presented two meanings that differed in emotional valence, an ANOVA was conducted. As desired, the *homonym's* threatening meanings were rated significantly more threatening than their non-threatening meanings, $F(1, 124) = 249.16$, $p < .001$. Similarly, an ANOVA confirmed that the *threat synonyms* were rated significantly more threatening in meaning than their corresponding *non-threat synonyms* $F(1, 124) = 216.29$, $p < .001$. Two ANOVA's were also conducted to ensure that the emotional valence of the meanings presented in the Prime Displays of interpretation tasks was comparable to the emotional valence of the meanings presented in the Prime Displays of the attention tasks. As desired, the emotional valence ratings of the *homonyms'* threatening meanings did not significantly differ from the emotional valence ratings of the *threat synonyms*, $F(1, 124) = .21$, $p = .64$. Likewise, the emotional valence ratings of the *homonyms'* non-threatening meanings did not significantly differ from the emotional valence ratings of the *non-threat synonyms*, $F(1, 124) = .14$, $p = .70$.

Semantic-relatedness of corresponding Prime and Target Display stimuli

The semantic relatedness ratings of the corresponding Prime and Target Display stimuli were as follows. The mean semantic relatedness rating of the *homonyms* and their corresponding *threat associates* was 2.90 ($SD = .76$). The mean semantic relatedness rating of the *homonyms* and their corresponding *non-threat associates* was 3.09 ($SD = .76$). The mean semantic relatedness rating of the *threat synonyms* and their corresponding *threat associates* was 3.04 ($SD = .99$). Finally, the mean semantic relatedness rating of the *threat synonyms* and their corresponding *threat associates* was 3.25 ($SD = .91$).

ANOVA's were conducted to confirm that the semantic relatedness of the threatening Prime Display stimuli and their corresponding *threat associates* did not differ to the semantic relatedness of the non-threatening Prime Display stimuli and their corresponding *non-threat associates*. It was confirmed that the semantic relatedness of the *threat synonyms* and their corresponding *threat associates* did not significantly differ from the semantic relatedness of the *non-threat synonyms* and their corresponding *non-threat associates*, $F(1, 124) = 1.55$, $p = .21$. Likewise, the semantic relatedness of the *homonyms* and their corresponding *threat associates* did not significantly differ from the semantic relatedness of the *homonyms* and their corresponding *non-threat associates*, $F(1, 124) = 1.92$, $p = .16$.

Synonymity of the attention Prime Display meanings and the interpretation Prime Display meanings

The synonymity ratings of the attention Prime Display stimuli and the interpretation Prime Display stimuli were as follows. The mean synonymity rating of the *homonyms* and their corresponding *threat synonyms* was 3.72, (*SD* = .60). The mean synonymity rating of the *homonyms* and their corresponding *non-threat synonyms* was 3.88 (*SD* = .68).

To ensure that the synonymity between the *homonyms* and their corresponding *threat synonyms*, did not differ from the synonymity between the *homonyms* and their corresponding *non-threat synonyms*, another ANOVA was conducted. This confirmed that the synonymity of the *homonyms* and their corresponding *threat synonyms* did not significantly differ from the synonymity of the *homonyms* and their corresponding *non-threat synonyms*, $F(1, 124) = 2.00$, $p = .15$.

Frequency of Use and Length of Word Stimuli

To ensure that any effect of familiarity, or word length, was consistent across the different classes of word stimuli, the frequency of usage of the words and their word length was determined. These are shown in Table 37. Frequency of usage was based on the norms of Kucera and Francis (1967).[33] Word length was based on the number of letters.

Table 37

Mean Word Frequency and Word Length of the Word Stimuli (Standard Deviations in parentheses).

	Homonym	Threat Synonym	Non-threat Synonym	Threat Associate	Non-threat Associate
Word Frequency*	94.43 (298.66)	29.21 (87.90)	51.40 (116.77)	37.20 (122.05)	59.96 (119.38)
Word Length	4.79 (1.29)	6.15 (1.71)	6.07 (2.05)	6.29 (1.67)	5.98 (1.71)

Notes.

* Based on Kucera-Francis' (1967) norms.

[33] Kucera-Francis (1967) norms were not available for three *threat synonyms*, two *non-threat synonyms* and six *non-threat associates*. Therefore, these words were not included in the descriptive statistics or analysis.

Paired samples t tests revealed no significant difference between the frequency of use of the: *threat synonyms* and the *non-threat synonyms*, $t(58) = -1.01$, $p = .31$; the *threat associates* and the *non-threat associates*, $t(57) = -1.32$, $p = .19$; the *homonyms* and *threat synonyms*, $t(60) = -1.68$, $p = .09$; or the *homonyms* and *non-threat synonyms*, $t(61) =$.-1.16, $p = .25$.

To ensure that any effect of word length was equivalent across the different classes of words, word length was also analysed. Paired samples t tests confirmed that there was no significant difference between the length of the *threat synonyms* and the *non-threat synonyms,* $t(63) = .24$, $p = .80$. Similarly, there was no significant difference between the length of the *threat associates* and *non-threat associates*, $t(63) = 1.07$, $p = .28$. There was a significant difference between the length of *homonyms* and *threat synonyms*, $t(63) = -5.04$, $p < .01$ and between the length of *homonyms* and *non-threat synonyms*, $t(63) = -4.57$, $p < .01$. But, this was not considered problematic as the speed with which participants cognitively process the Prime Display stimuli was not directly measured. Rather, what was measured was the relative speed with which participants identified the target word that was semantically related to one of the Prime Display meanings.

Practice Stimuli

A set of 16 quintets were developed for use in the practice trials. The practice quintets were intended to present stimuli with only non-threatening meanings. Therefore, the practice quintets consisted of a *homonym*, that possessed two non-threatening definitions; two *synonyms*, one which was synonymous with one meaning of the corresponding homonym meanings, the other which was synonymous with the alternative meaning of the homonym; and two *associates*, one which was semantically related to one meaning of the corresponding homonym, the other which was semantically related to the alternative meaning of the homonym. The *homonyms* and their corresponding *associates* were selected from Twilley, Dixon, Taylor and Clark (1994). The *synonyms* were selected from *Roget's Thesaurus* (Dutch, 1966). Table 38 displays the final set of practice quintets.

Table 38
The Practice Quintets

Homonym	Synonym A	Synonym B	Associate A	Associate B
LOAF	BREAD	LAZY	BAKER	IDLE
PUPIL	STUDENT	EYE	SCHOOL	RETINA
PITCH	TONE	THROW	HARMONY	TOSS
ROCK	POP	STONE	BAND	PEBBLE
RULER	KING	MEASURE	EMPEROR	CENTIMETRE
BOLT	SCREW	LIGHTENING	NUT	THUNDER
CALF	COW	LEG	FARM	THIGH
DIGIT	NUMERAL	FINGER	CALCULATOR	THUMB
INTEREST	HOBBY	CREDIT	ACTIVITY	LOAN
IRON	PRESS	ORE	STEAM	BRONZE
PORT	HARBOUR	WINE	MOORING	BRANDY
CHARM	WIT	TRINKET	GRACE	BRACELET
SCRUB	CLEAN	BUSH	SCOUR	VEGATATION
TRAIN	LOCOMOTIVE	TEACH	RAILROAD	INSTRUCT
SIGN	SIGNATURE	BILLBOARD	AUTOGRAPH	NEON
BOND	ADHERE	INSURANCE	GLUE	TENANT

APPENDIX B

FIGURES

Figure 11

Scatterplot showing the association between the Trait Anxiety Index and the Threat Bias Index of the Attention/Initial/Auditory Task, Experiment 2.

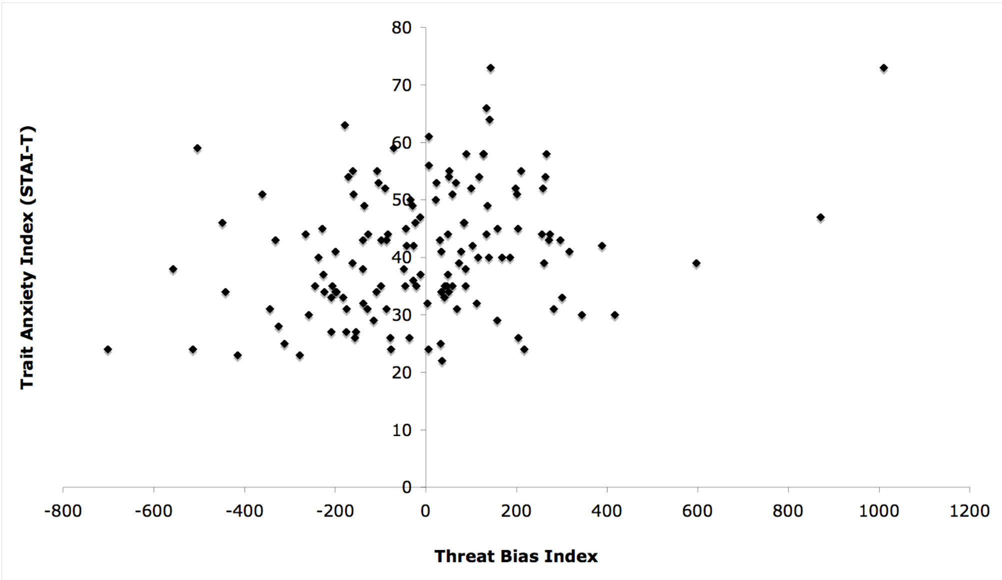


Figure 12

Scatterplot showing the association between the Trait Anxiety Index and the Threat Bias Index of the Interpretation/Revised/Visual Task, Experiment 7.

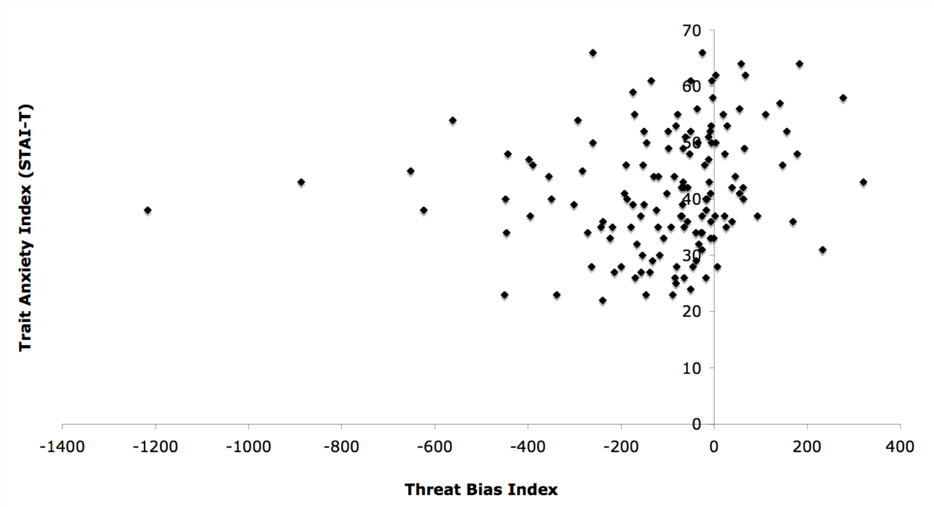


Figure 13

Scatterplot showing the association between the Trait Anxiety Index and the Accuracy Threat Bias Index of the Interpretation/Revised/Auditory Task, Experiment 8.