An examination of mediational relationships involving selective attention to negative information, attentional control, and anxiety vulnerability.

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Abstract

A number of distinct research literatures have sought to examine the attentional mechanisms that underpin heightened vulnerability to anxious mood. One literature has found consistent evidence that individuals with heightened anxiety vulnerability display heightened selective attention to negative information, as compared to individuals with low anxiety vulnerability. An alternate literature has found consistent evidence that individuals with heightened anxiety vulnerability display impairment in attentional control, that is, an impaired ability to control the movement of attention in correspondence with attentional objectives. Interestingly, these literatures propose two anxiety-linked effects upon attentional processing. However, as yet, there has been limited investigation into the possible relationships between these anxiety-linked differences in attentional processing in characterising heightened anxiety vulnerability. One possibility is that the relationship between selective attention to negative information and anxiety vulnerability occurs indirectly through variation in attentional control. Another possibility is that the relationship between attentional control and anxiety vulnerability occurs indirectly through variation in selective attention to negative information. Alternative to these possibilities, a third possibility is that the relationship between anxiety vulnerability and selective attention to negative information is functionally independent from the relationship between anxiety vulnerability and attentional control. The aim of the present research programme was to investigate the validity of each of these proposed models.

To accomplish this aim, the research programme developed a series of experiments that incorporated novel methodologies intended to observe anxiety-linked heightened selective attention to negative information and anxiety-linked impairment in attentional control. Using the data obtained from these methodologies, each experiment examined the validity of the proposed models via statistical analyses of mediation.
Previous research into anxiety-linked heightened selective attention to negative information, and anxiety-linked impairment in attentional control, has employed experimental methodologies that differ greatly across methodological parameters. In order to optimise the capacity to determine the relationship between selective attention to negative information, attentional control, anxiety vulnerability it is important that an experimental design minimises variance in the methods used to assess the two aspects of attention. Thus, it was a feature of the novel methodologies developed in each experiment to minimise variance between the methodological conditions used to measure each attentional process.

The primary findings of the research programme concerned the validity of the proposed models describing the relationship between selective attention to negative information, attentional control, and anxiety vulnerability. Importantly, no experiment in the research programme supported proposal that the relationship between selective attention to negative information and anxiety vulnerability occurs indirectly through variation in attentional control, or the proposal that the relationship between attentional control and anxiety vulnerability occurs indirectly through variation in selective attention to negative information. Hence, the results of the research programme were most compatible with the proposal that the relationship between anxiety vulnerability and selective attention to negative information, and the relationship between anxiety vulnerability and attentional control, are independent characteristics of anxiety vulnerability.

In the final chapter of this thesis, methodological, theoretical, and applied implications arising from the findings of the research programme are described, and avenues for future research are discussed.
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Statement of Candidate’s Contribution

The candidate played a significant role in all aspects of the studies reported within this thesis. This included experimental design and development, participant recruitment and testing, data entry, data analysis and interpretation, and the preparation and revision of the thesis. Development of the experimental tasks used in all experiments was conducted in collaboration with the candidate’s supervisor, Professor Colin MacLeod. Participant recruitment and testing for Experiment 5 was conducted in collaboration with Dr Ben Grafton. Participant recruitment and testing for Experiment 6 was conducted in collaboration with Dr Ben Grafton and an undergraduate student whose assistance contributed to partial fulfilment of their degree.
Chapter 1: Introduction

Individuals differ in the degree to which they are vulnerable to experiencing state anxiety in response to the same situation. This individual difference dimension involving variability in susceptibility in experiencing anxiety states is known as “anxiety vulnerability”. Researchers have sought to investigate differences in the cognitive systems of individuals with different levels of anxiety vulnerability in the hope that such knowledge will aid the development of procedures that aim to ameliorate anxiety-related dysfunction. In doing so researchers have studied the attentional systems of individuals with elevated anxiety vulnerability, whether indicated by anxiety-related clinical diagnoses or by self-report measures of anxiety vulnerability. Two attentional processes and their relation to individual differences in anxiety vulnerability have been the focus of considerable investigation. One attentional process, selective attention to negative information, concerns the degree to which attention is selectively allocated towards negative information relative to non-negative information. The other, attentional control, concerns the degree to which individuals are able to allocate attention in accordance with their attentional objectives.

Two lines of investigation have examined anxiety-linked differences in each of these attentional processes by assessing the degree to which individuals who vary in anxiety vulnerability selectively allocate attention to negative information, and are able to allocate attention in correspondence with attentional objectives. As will be seen, whether elevated anxiety vulnerability has been indexed by elevated levels of trait anxiety, or has been revealed through clinical diagnoses of anxiety pathology, a large body of research has revealed that heightened anxiety vulnerability is characterised by heightened selective attention to negative information over non-negative information, and by impairments in attentional control. Markedly less research, however, has investigated the nature of relationships between these three constructs. Investigation of
these relationships has the potential to yield crucial knowledge that can illuminate the nature of attentional mechanisms that underpin heightened anxiety vulnerability, in ways that may aid the development of procedures designed to ameliorate anxious dysfunction. Hence, the present research programme was designed to experimentally investigate hypothesised relationships between selective attention to negative information, attentional control, and anxiety vulnerability.

The present chapter will now present a review of experimental findings supporting the existence of anxiety-linked heightened selective attention to negative information, and experimental findings supporting the existence of anxiety-linked impairment in attentional control. This chapter will then consider alternative theoretical possibilities regarding the relationships between anxiety-linked heightened selective attention to negative information, anxiety-linked impairment in attentional control, and anxiety vulnerability, before distinguishing three hypotheses that will serve as the focus of the present research programme.

**Evidence that Heightened Anxiety Vulnerability is characterised by Heightened Selective Attention to Negative Information**

A number of theorists have proposed theoretical models of anxiety vulnerability that, though differing with respect to their precise accounts, each share the common proposal that heightened anxiety vulnerability is characterised by heightened selective attention to negative information (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Bishop, 2007; Mathews & Mackintosh, 1998). Across the literature, a range of experimental findings have supported this hypothesis and these findings will now be reviewed.

**Evidence of anxiety-linked heightened selective attention to negative information from self-report measures.** Evidence of an association between heightened anxiety vulnerability and selective attention to negative information
originated through the administration of questionnaires that directly ask individuals about their propensity to selectively attend towards negative information. Specifically, investigators have found that individuals with a clinical diagnosis of an anxiety disorder report that they selectively attend towards negative information related to the source of their anxious distress (McNally & Lorenz, 1987; Wardle, Ahmad, & Hayward, 1990). However, studies that attempt to measure selective attentional responding through self-report are limited by the indeterminate validity of such measures. Critically, such measures assume individuals’ have accurate introspective access to their cognitive processes, however such assumptions are often invalid (Nisbett & Wilson, 1977). Given the limitations of self-report measures, investigators have sought to examine anxiety-linked differences in selective attention to negative information using objective, performance based, measures of selective attention to negative information.

**Evidence of anxiety-linked heightened selective attention to negative information from performance based measures.** One method used by researchers to overcome the limitations of self-report measures is the dichotic listening task. In the dichotic listening task participants are simultaneously exposed to two prose passages, with one passage presented in the left ear and one in the right ear. The content of each passage differs in emotional valence and participants are required to detect the presence of target words that appear within each passage. In this approach greater identification of target words presented in the negatively valenced passage relative to targets words presented in the non-negatively valenced passage indicates greater selective attention to negative information. Burgess, Jones, Robertson, Radcliffe, and Emerson (1981) employed this procedure among groups of individuals with high and low levels of anxiety vulnerability. One passage presented neutrally valenced content, while the other passage presented negatively valenced content, and participants were instructed to identify the presence of target words in either passage. It was found that individuals
with heightened levels of anxiety vulnerability detected significantly more target words embedded within negatively valenced passages compared to individuals lower in anxiety vulnerability. Similarly, Foa and McNally (1986) presented individuals high in anxiety vulnerability with two simultaneous passages containing either neutrally valenced or negatively valenced content. It was found that these individuals detected more target words embedded within negatively valenced passage than neutrally valenced passage.

These findings provided early support for the hypothesis that heightened anxiety vulnerability is characterised by heightened selective attention to negative information. More recent performance based assessments have obtained converging support for this hypothesis using a range of different assessment procedures. One such procedure is the Emotional-Stroop task. The Emotional-Stroop paradigm represented a modification of the original Stroop paradigm (Stroop, 1935). The Stroop paradigm presents participants with lists of colour names in text (e.g. ‘red’, ‘blue’) displayed in different ink colours. Participants are required to name the ink colour of each word in the list as quickly as possible. It is commonly found that that participants are consistently delayed in correctly naming the ink colour of words when word content and ink colour are incongruent (e.g. the word ‘blue’ presented in red ink), compared to when they represent the congruent colour (e.g. the word ‘blue’ presented in blue ink; (MacLeod, 1991). The delay with which the execution of colour naming responses occurs is used to demonstrate the degree to which semantic content of the words was processed during the presentation of the word.

The Emotional-Stroop task assesses the delay with which the execution of colour naming responses occurs, in order to demonstrate the degree to which emotional word content is processed. The task presents participant with a sequence of words that differ in emotional valence. These words are presented in different colours and participants
are required to name the colour of each word as it is presented onscreen quickly as possible. The latency at which participants identify the colour of the words is taken as an indication of the degree of interference caused by processing of the emotional content of the word. Greater delay in identifying the colour of negatively valenced words compared to non-negatively valenced words is taken to demonstrate greater selective attention to negative information. A large amount of research has shown that disproportionate slowing to colour name negatively valenced words is characteristic of individuals with heightened levels of anxiety vulnerability, when compared to individuals with lower anxiety vulnerability. For example, Mathews and MacLeod (1985) found that clinically anxious individuals showed disproportionate slowing to name the colour of words with negatively valenced meanings relative to non-negatively valenced meanings, compared to a non-clinically anxious control group. Other studies have also reported observations of disproportionate slowing to colour name threatening words in patients with generalised anxiety (Mogg, Mathews, & Weinman, 1989), post-traumatic stress disorder (Kaspi, McNally, & Amir, 1995; McNally, Amir, & Lipke, 1996), specific phobia (Watts, McKenna, Sharrock, & Trezise, 1986) and social anxiety disorder (Spector, Pecknold, & Libman, 2003). Hence, these findings in clinically anxious populations support the hypothesis that heightened selective attention to negative information characterises heightened anxiety vulnerability. Such findings are characteristic not only of clinically anxious individuals. A number of studies using this assessment approach have found evidence of anxiety-linked heightened selective attention to negative information across populations exhibiting non-clinical heightened anxiety vulnerability. MacLeod and Rutherford (1992) presented an Emotional-Stroop task to individuals who varied in level of trait anxiety and found that individuals high in trait anxiety showed disproportionate slow latencies to name the ink colour of personally relevant words with negatively valenced meanings relative to non-negatively
valenced meanings, compared to individuals low in trait anxiety. Similarly, Mogg, Kentish and Bradley (1993) also found increased levels of trait anxiety to be associated with greater slowing to colour name words with negatively valenced meanings relative to non-negatively valenced meanings. These findings have been replicated by other researchers (Richards, French, Johnson, Naparstek, & Williams, 1992; Rutherford, MacLeod, & Campbell, 2004). Once again, these findings are consistent with the hypothesis that heightened anxiety vulnerability is characterised by heightened selective attention to negative information. However, interpretation of findings drawn from the Emotional-Stroop task is compromised by limitations that hinder the degree to which slowed colour naming of words can be considered indicative of attention to these words’ semantic content.

For example, due to the fact that the task presents the semantic and ink-colour information within the same stimulus, the task is unable to distinguish response slowing that may result from attentional vigilance for semantic content of negatively valenced words, or attentional avoidance of negatively valenced stimuli. In each case, such patterns of attentional responding would result in delayed responding in the presence of negatively valenced words, but not non-negatively valenced words. It also is possible that delayed colour naming of negatively valenced words compared to non-negatively valenced words could reflect general response freezing in the presence of negative information rather than selective attention to negative information. Specifically, in this case individuals high in anxiety vulnerability may experience greater delays in executing responses generally when in the presence of negative information, relative to individuals who are low in anxiety vulnerability. This anxiety-linked delayed responding may not reflect patterns of anxiety-linked selective attention to negative information. Hence, whilst findings from the Emotional-Stroop task are consistent with the hypothesis that heightened anxiety vulnerability is characterised by heightened
CHAPTER 1: INTRODUCTION

selective attention to negative information, findings from the Emotional-Stroop task do not provide conclusive evidence that this hypothesis is valid. For this reason, other methodologies have been employed to more clearly measure individual differences in selective attention to negative information.

These tasks have sought to identify the distribution of attention by assessing the relative speed at which individuals respond to targets presented spatially proximal or distal to threat. Thus any patterns of attentional distribution are not confounded with global slowing of response latency. In some variants of this approach, experimenters have presented a single emotional stimulus in one of these loci prior to presentation of the probe (Fox, Russo, Bowles, & Dutton, 2001; Koster, Leyman, Raedt, & Crombez, 2006). This methodology has commonly been referred to as the emotional-cueing paradigm. More often however, probe methodologies have presented two stimuli simultaneously that differ in emotional tone. This methodology has commonly be referred to as the attentional-probe task. Crucially, both variants permit the detection of selective attention by contrasting the time taken for individuals to respond to probes proximal, or distal, to negative information.

The attentional-probe task is the most common task used to examine the prediction that heightened selective attention to negative information is characteristic of heightened anxiety vulnerability. In the attentional-probe task participants are exposed to pairs of stimuli that differ in emotional valence, usually comprising a negative and non-negative stimulus. Image pairs are briefly exposed, commonly in the range of 500 ms to 1000 ms, before being replaced by a small probe presented in the location previously occupied by either the negatively valenced or non-negatively valenced member of the presented stimulus pair. The degree to which participants are speeded to discriminate probes appearing in the location previously occupied by the negatively valenced stimulus relative to the non-negatively valenced stimulus is taken as an index
of selective attention to the location of negative information compared to non-negative information. Thus, heightened selective attention to negative information is revealed by disproportionately greater relative attentional allocation to the location of the negative stimulus compared to non-negative stimulus.

The attentional-probe task methodology overcomes the limitations of the Emotional-Stroop task described previously. First, the spatial separation of the source of negative and non-negative information ensures that patterns of attentional avoidance of negative information, and selective attention to negative information cannot be mistaken. Specifically, while selective attention to negative information can confidently be inferred from speeded discriminate of probes in the location of negatively valenced information relative to non-negatively valenced information, attentional avoidance of negative information would instead produce delayed discrimination of probes in the location of negatively valenced information relative to non-negatively valenced information. Second, as the attentional-probe task presents negatively valenced information on every trial, any global slowing to respond to probes in the face of such information will be not obscure the relative speed at which probes are responded to in each location. Thus, observations of relatively speeded responding to probes that appear in the locating of negatively valenced information compared to non-negatively valenced information is not compromised by the possibility of a global slowing to respond in the face of negative information.

MacLeod, Mathews, and Tata (1986), and Mogg, Mathews, and Eysenck (1992), used this task to assess selective attention to negatively valenced words and non-negatively valence words in clinically anxious and non-anxious individuals. Results showed that clinically anxious individuals demonstrated speeded response latencies to probes presented in the location of negatively valenced words compared to non-negatively valenced words, which was not the case for non-anxious individuals. Since
then, a number of studies have also observed this pattern of response latencies across individuals with a variety of disorders characterised by heightened anxiety vulnerability including social phobia (Asmundson & Stein, 1994; Musa, Lépine, Clark, Mansell, & Ehlers, 2003; Pishyar, Harris, & Menzies, 2008), obsessive-compulsive disorder (Tata, Leibowitz, Prunty, Cameron, & Pickering, 1996), panic fear (Kroeze & van den Hout, 2000), and specific fears (Mogg & Bradley, 2006). Together these findings strongly indicate support for the hypothesis that heightened anxiety vulnerability is characterised by heightened selective attention to negative information.

Again, such effects are not only characteristic of clinically anxious populations, with a number of studies also finding disproportionately speeded response latencies to probes in the location of negative information in non-clinical participants with heightened anxiety vulnerability. For example, Mogg, Bradley, de Bono, and Painter (1997) found that non-clinical individuals with heightened trait anxiety showed faster response latencies for probes that appeared in the location of negatively valenced words compared to probes that appeared in the location of non-negatively valenced words. Researchers have observed these patterns of findings across a variety of stimulus presentation durations suggesting that anxiety-linked heightened selective attention to negative information occurs across the range of 100 to 1,500 milliseconds (Bradley, Mogg, Falla, & Hamilton, 1998; Mogg et al., 1997). They have also been obtained using stimulus pairs that contain emotionally valenced images, rather than emotional words (Bradley et al., 1997; Koster, Crombez, Verschuere, & De Houwer, 2006; Yiend & Mathews, 2001), as well as when negatively valenced information has been presented with positively valenced information, rather than emotionally neutral information (Bradley et al., 1998; Bradley, Mogg, White, Groom, & de Bono, 1999; Grafton & MacLeod, 2014; Rudaizky, Basanovic, & MacLeod, 2014).

Investigators have also sought to examine the causal influence of selective
attention to negative information on the expression of anxiety vulnerability. For example, MacLeod et al. (2002) experimentally induced differential patterns of attentional responding to negative information, and then examined the impact on anxiety vulnerability. The result revealed that the induction of heightened selective attention to negative information served to heighten anxiety vulnerability, while the induction of attenuated selective attention to negative information served to reduce anxiety vulnerability. A review of the literature concerning the existence of a causal impact of selective attention to negative information on anxiety vulnerability supported the proposal that heightened selective attention to negative information causally contributes to the expression of heightened anxiety vulnerability (Hakamata et al., 2010).

The literature described in this section provides strong convergent evidence that heightened anxiety vulnerability is characterised by heightened selective attention to negative information. The chapter will now shift its focus to a review of the evidence for the quite separate hypothesis that heightened anxiety vulnerability is characterised by impairment in attentional control.

**Evidence that Heightened Anxiety Vulnerability is characterised by Impaired Attentional Control**

A separate line of inquiry into cognitive processes underpinning anxiety vulnerability has led theorists to propose that individuals with heightened anxiety vulnerability exhibit an impaired ability to control the allocation of their attentional resources in correspondence with attentional objectives (Eysenck & Calvo, 1992; Eysenck, Derakshan, Santos, & Calvo, 2007). Once again, across the literature a range of experimental findings have supported this hypothesis and these findings will now be reviewed.
Evidence of anxiety-linked impairment in attentional control from self-report measures. Investigators have asked individuals who vary in anxiety vulnerability to report upon their ability to control the allocation of their attention, such that they successfully direct attention towards intended objectives. In their investigation, Derryberry and Reed (2002) observed that higher levels of trait anxiety were associated with lower levels of attentional control as revealed on self-reported measures of attentional control. Other investigators have also demonstrated a relationship between heightened trait anxiety and self-reported impairment in attentional control (Reinholdt-Dunne, Mogg, & Bradley, 2012). The association between self-reported impairment in attentional control and heightened anxiety vulnerability is not limited to heightened trait anxiety in non-clinical cohorts. Clinically anxious patients and analogue non-clinical individuals have been shown to exhibit negative associations between symptom severity and self-reported levels of attentional control (Bardeen, Fergus, & Orcutt, 2014; Sippel & Marshall, 2013).

As discussed in the previous section it is important to recognise that self-report measures of cognitive processes are compromised by the fact that introspective access to cognitive processes is commonly inaccurate (Nisbett & Wilson, 1977). Indeed when investigators have examined the association between self-report measures of attentional control with performance based measures of attentional control they often reveal no association between such measures (Reinholdt-Dunne, Mogg, & Bradley, 2009, 2012). Thus, studies which have assessed anxiety-linked impairment in attentional control through self-report measures alone do not provide an adequate test of the hypothesis that heightened anxiety vulnerability is characterised by impaired attentional control.

In order to avoid the limitations of self-report measures, researchers have employed performance based assessments of attentional control, and findings from these studies will now be reviewed.
Evidence of anxiety-linked impairment in attentional control from performance based measures. A number of investigators have sought to measure attentional control using tasks that objectively assess the ability for individuals to control the allocation of their attention to the location that intend it to be, and these procedures have been employed to assess attentional control in individuals who experience both clinical and non-clinical levels of heightened anxiety vulnerability.

Mathews, May, Mogg, and Eysenck (1990) tested this hypothesis by presenting clinically anxious and non-anxious individuals with a task providing the objective of allocating attention to a target word, exposed in the presence or absence of distracting words. It was revealed that clinically anxious participants relative to non-anxious participants showed disproportionately delayed processing of target words in the presence of distracting words, compared to when they were presented alone, consistent with a failure to allocate attention in correspondence with their intended objective.

Similar patterns of results have also been observed across tasks requiring the allocation of attention to target non-word stimuli in the presence, or absence, of distracting non-word stimuli. In these studies clinically anxious individuals have shown delays in the processing of target stimuli in the presence of distracting stimuli (Pacheco-Unguetti, Acosta, Marqués, & Lupiáñez, 2011). Other studies have assessed the association between non-clinical heightened anxiety vulnerability and the ability to control attention in correspondence with intended objectives. Pacheco-Unguetti, Acosta, Callejas, & Lupiáñez (2010) recruited participants who were high in trait anxiety, and low in trait anxiety, to complete a task providing the objective of allocating attention to a target stimulus in the presence of distracting stimuli. Results revealed that participants high in anxiety vulnerability showed greater slowing to process target stimuli in the presence of distracting stimuli compared to participants who were low in anxiety vulnerability, indicating that heightened trait anxiety is also characterised by impairment in attentional
control. Bishop (2009) provided participants a task requiring the identification of a target letter that could be accompanied by a peripheral distractor. The distractor could either be target congruent, in which the distractor and target were the same, or target incongruent, in which the target and distractor were different. Results revealed that participants with heightened levels of anxiety vulnerability showed disproportionality long latencies to identify targets in the presence of target incongruent distractors, compared to participants with low levels of anxiety vulnerability, indicating heightened levels of distraction among high anxious participants. Together these results suggest individuals with heightened trait anxiety also show greater distraction towards extraneous stimuli consistent with a reduced ability to control the allocation of attention in the manner they intend. Thus, the findings provide support for the hypothesis that heightened anxiety vulnerability is associated with impairment in attentional control.

Investigators have also assessed the ability of individuals varying in anxiety vulnerability to control the inhibition of attentional allocation, by measuring eye movements during an anti-saccade task. An anti-saccade task is designed to assess inhibitory attentional control, reflecting the ability of participants to inhibit a pre-potent attentional response of attending towards a stimulus, as compared to their ability to make the pre-potent attentional response. Specifically, the task requires participants to initially fixate eye-gaze upon a central screen location prior to the abrupt onset of a peripheral stimulus. Participants are provided with the attention objective of executing a shift in gaze either toward this latter stimulus, or to the opposite screen location. Inhibitory attentional control is indexed by the relative slowing for participants to make shifts to the opposite screen location (i.e. an anti-saccade) relative to the same screen location as the stimulus (i.e. a pro-saccade). Greater slowing to make anti-saccades relative to pro-saccades in such tasks is taken to reflect greater impairment in the ability to inhibit the pre-potent response to allocate attention to the stimulus, reflecting the
poorer capacity to control attention in correspondence with intended attentional objectives. Derakshan et al. (2009) utilised this task to measure attentional control across groups of individuals who were high and low in anxiety vulnerability. It was revealed that high anxious participants exhibited disproportionately slow speeds to make anti-saccades relative to pro-saccades when compared to low anxious participants, demonstrating impaired attentional control in participants with heightened anxiety vulnerability. These findings have since been replicated (Ansari & Derakshan, 2010, 2011), providing additional support to the hypothesis that heightened anxiety vulnerability is characterised with impaired attentional control.

Recently, investigators have examined the possibility that impairment in attentional control may causally contribute to heightened anxiety vulnerability. Researchers have revealed changes in anxiety vulnerability following procedures designed to increase attentional control (Roughan & Hadwin, 2011; Sari, Koster, Pourtois, & Derakshan, 2015). Although few studies have directly investigated this possibility, these findings provide support for the proposal that impaired anxiety vulnerability causally contributes to heightened anxiety vulnerability.

The literature described in this section provides strong support for the hypothesis that heightened anxiety vulnerability is characterised by impaired attentional control. This avenue of research, together with research supporting anxiety-linked heightened selective attention to negative information represent two distinct lines of research. Little research has investigated the possibility that there may be an important relationship between these two anxiety-linked attentional effects. The present research programme was designed to experimentally investigate alternative hypothesised relationships between selective attention to negative information, attentional control, and anxiety vulnerability. The next section will now delineate these alternative hypotheses regarding the relationships between these two types of anxiety-linked attentional anomalies.
Hypotheses Concerning the Nature of Associations between Selective Attention to Negative Information, Attentional Control, and Anxiety Vulnerability

The above-mentioned findings concerning two attentional anomalies that characterise heightened anxiety vulnerability permit theoretical convergence between these two lines of research. Investigators have described two cognitive factors that influence patterns of selective attentional responding to negative information (Bishop 2007). One factor involves variation in bottom up processes that serve to engage attention with salient, threat relevant, stimuli. The other factor involves variation in top-down processes that allow for the voluntary control over the allocation of attention (attentional control) necessary to ensure that attention is allocated in accordance with current goals. Hence, there exists the prospect that variation in selective attention to negative information and variation in attentional control may share a causal relationship, and that this relationship influences the maintenance of heightened anxiety vulnerability. This important possibility has been raised by several other investigators (Cisler & Koster, 2010; Price, Eldreth, & Mohlman, 2011; Wieser, Pauli, & Mühlberger, 2009; Zvielli, Bernstein, & Koster, 2015). However, until now, no research has employed appropriate cognitive-experimental procedures to directly investigate whether selective attention to negative information and impaired attentional control share a causal relationship. Should such a causal relationship exist, then it follows that previously observed associations between either attentional phenomena and anxiety vulnerability could be indirect, mediated by an underlying functional association between the two attentional phenomena themselves. The examination of the validity of this possibility, as well as the nature of such a relationship if it exists, presents a vital step towards the enhanced understanding of the attentional mechanisms that underpin heightened anxiety vulnerability.
Such examination also provides potential applied implications. As described earlier, evidence demonstrates that variation in anxiety-linked heightened selective attention to negative information, or anxiety-linked impairment in attentional control can causally influence anxiety vulnerability. Literature concerning attentional training to reduce anxiety vulnerability has noted the need for the identification and development of more effective procedures (Bar-Haim, 2010; Kuckertz & Amir, 2015). Heightened understanding of the associations between these three variable can inform for procedures that seek to modify these two attentional processes in order to ameliorate heightened anxiety. For example, if it were the case that variation in selective attention to negative information was found to causally impact anxiety vulnerability due to its direct impact upon attentional control, this would imply that the amelioration of anxiety vulnerability may be most effectively achieved through the modification of attentional control, rather than the modification of selective attention to negative information. Conversely, if it were the case that variation in attentional control was found to causally impact anxiety vulnerability due to its direct impact upon selective attention to negative information, this would imply that the amelioration of anxiety vulnerability may be most effectively achieved through the modification of selective attention to negative information, rather than the modification of attentional control. Alternately however, if it were the case that variation in selective attention and attentional control were not found to share such relationships, supporting the possibility that each process independent influences anxiety vulnerability, then this would imply that the amelioration of anxiety vulnerability may be most effectively achieved through the simultaneous modification of selective attention to negative information and attentional control. Thus, the understanding of the validity of these alternative possibilities carries implications concerning the specific types of attentional training procedure(s) likely to prove of most benefit in ameliorating anxiety vulnerability.
Hence, for both theoretical and applied motives there is a vital need to determine the nature of associations between selective attention to negative information, attentional control, and anxiety vulnerability. The current section will now illustrate the three key alternative candidate models concerning the associations between these three variables that will be tested in the present research programme. As mentioned previous, one possibility is that anxiety-linked heightened selective attention to negative information and anxiety-linked impaired attentional control reflect independent characteristics of heightened anxiety vulnerability that do not share a causal relationship. A second possibility is that variation in selective attention to negative information influences variation in attentional control. A final possibility is that variation in attentional control influences variation in selective attention to negative information. Each of these possible models will now be described in more detail, in turn.

**No causal relationship between attentional control and selective attention to negative information.** It may be the case that selective attention to negative information and attentional control have no direct causal association, and instead represent functionally independent characteristics of anxiety vulnerability. This relationship will be presently labelled the *non-mediational associations model*. This model contends that it is not the case that attentional control and selective attention to negative information share a causal relationship in underpinning anxiety vulnerability, but rather that anxiety may be characterised by either one, or both, of these attentional processes.

**Attentional control influences selective attention to negative information.** It has been proposed that the degree to which individuals show heightened levels of selective attention to attention to negative information is dependent upon their impaired capacity to recruit attentional control (Derryberry & Reed, 2002; Schoenmakers et al.,
Thus, it may be the case that impaired attentional control drives heightened selective attention to negative information, which turn drives heightened anxiety vulnerability. This relationship will be presently construed by a selective attention mediator model (see Figure 1.1). Crucially, this model would predict that anxiety-linked differences in both attentional processes will occur, and that variation in selective attention to negative information will be found to statistically mediate the association between variation in anxiety vulnerability and variation in attentional control.

![Figure 1.1. Representation of the selective attention mediator model.](image)

**Selective attention to negative information influences attentional control.**

Effective attentional control requires that sufficient processing capacity is recruited for the accomplishment of task relevant attentional objectives (Eysenck & Calvo, 1992; Eysenck et al., 2007). Hence, the reduction of processing capacity available for accomplishment of task-relevant attentional objectives, resulting from attentional capture by task-irrelevant negatively valenced information, could impair attentional control (Eysenck et al., 2007). Therefore, it may be the case that increased selective attention to negative information drives impairment in attentional control, and impairment in attentional control subsequently contributes to heightened anxiety vulnerability. This relationship will be presently construed by an attentional control mediator model (see Figure 1.2). Crucially, this model would also predict that, that anxiety-linked differences in both attentional processes will occur, but also makes the specific prediction that variation in attentional control will be found to statistically
mediate the association between variation in anxiety vulnerability and variation in selective attention to negative information.

![Diagram of attentional control mediator model]

*Figure 1.2. Representation of the attentional control mediator model.*

**Description of the Present Research Programme**

The present chapter has provided three alternative accounts of the relationship between selective attention to negative information, attentional control, and anxiety vulnerability. The purpose of the present research programme is to systematically examine the validity of these three alternative accounts.

There exist criteria that must be adhered to within the methodological procedure of any experiment seeking to effectively differentiate between the presently proposed alternative models. Such criteria clearly include that experiments must assess anxiety vulnerability, selective attention to negative information, and attentional control, that participants should vary in anxiety vulnerability, and that each attentional process should be measured through objective performance based measures. However, a less obvious, though important criterion that will aide in the effective examination of these models involves the development of assessment tasks that permit the simultaneous assessment of attentional control and selective attention to negative information under highly similar conditions. By assessing anxiety-linked differences in each attentional process at the same time, in the same participants, during the processing of similar stimuli, presented in identical spatial and temporal configurations, using equivalent dependent measures, methodological variance will be minimised, thereby optimising the
ability to determine the association between these two aspects of attention, and anxiety vulnerability. Hence, one key objective of the present research programme will be to adhere to this criterion in its investigation of the validity of the presently proposed alternative models.

Experiments seeking to differentiate between the presently proposed alternative models may do so by examining statistical evidence for presence of the pattern of mediational associations predicted by the models under scrutiny. Experiments in which evidence of both anxiety-linked heightened selective attention to negative information and anxiety-linked impairment in attentional control has been observed will provide the optimal conditions in which to conduct such examinations. Therefore, experiments in the research programme will establish whether such conditions have been met by establishing the presence of each of these effects using analysis of variance and correlational approaches\(^1\). Importantly however, such conditions do not serve as a pre-requisite for the examination of mediation, with modern approaches permitting the statistical examination of mediation under conditions where an association involved in the proposed mediation is not statistically significant (Hayes, 2009; Preacher & Hayes, 2004). Thus, even in cases where the association between anxiety vulnerability and only one of the attentional processes is found, and the association between anxiety vulnerability and the other attentional process falls short of significance, formal analyses of the patterns of mediation predicted by the models under scrutiny will still be conducted.

Together, these analyses will reveal whether either the selective attention mediator model, or the attentional control mediator model, is supported by the collected data.

\(^1\) Due to the strongly predicted unidirectional direction of the association between anxiety vulnerability and each attentional process, correlational tests of these associations will adopt a 1-tailed significance criterion. Additionally, Spearman rank-order correlation coefficients will be provided in addition to Pearson correlation coefficients.
data, or whether the collected data is more parsimonious with the account described by the non-mediational associations model. If it is the case that mediational analyses find evidence of attentional control mediating the relationship between

Experiment 1 will now be described, which represents the programme’s first investigation of the validity of the proposed models.
Chapter 2: Experiment 1

As reviewed in the previous chapter, there is considerable evidence to show that heightened anxiety vulnerability is characterised by two types of attentional anomaly. One is an anxiety-linked heightened selective attention to negative information. The other is an impairment in the ability to control attention, by allocating attention as intended. As noted in the preceding chapter, the aim of the present research programme was to discriminate the validity of three alternative models concerning the relationship between attentional control, selective attention to negative information, and trait anxiety. One model describes the relationship between anxiety vulnerability and selective attention to negative information as being mediated by attentional control. A second model describes the relationship between anxiety vulnerability and attentional control as being mediated by selective attention to negative information. Finally, the third model describes the relationships between anxiety vulnerability and each attentional process as being functionally independent of one another.

In Experiment 1 a procedure was developed in order to test the validity of these models. This procedure included a novel attentional task that was designed to measure attentional control and selective attention to negative information under closely matching conditions. The attentional task contained two subtasks, each designed to measure one of these attentional processes. An overview of these subtasks will now be provided.

Trials in each subtask initially presented participants with a central cue, followed by the presentation of an image pair consisting of one representational and emotionally valenced image and one emotionally neutral abstract image. These stimuli were required to permit the expression of selective attention to negative information, and so it was desired that the emotional valence of the representational stimuli already be established. It also was considered essential to employ emotional negative images that did not
containing information that would be deemed negative only by people vulnerable to one particular form of anxiety (for example socially negative information that had emotional relevance only for people with heightened social anxiety). The International Affective Pictures System image set (IAPS; Lang, Bradley, & Cuthbert, 2005) met these criteria, and so images from this set were used in the present tasks. It was also imperative that the duration for which image pairs were presented would permit be short enough to reveal attentional capture by emotional information, but long enough to permit a voluntary attentional movement to be executed. Thus, an image presentation duration of 1000 ms was chosen, as this represented the upper end of durations previously demonstrated to be capable of revealed selective attention to emotional information on probe detection tasks. After the presentation of the image pair a probe appeared in one of the locations previously occupied by the two images. Participants were required to respond to the probe as quickly as possible. It was important that the latency of the response made by participants could indicate the location of attentional allocation at the time when probes appeared. Hence, during development of the tasks two alternative methods of responding were considered for inclusion in the task. One method would have required participants to respond to the location that the probe appears (e.g. left side or right side of the visual display). However, it was recognised that such a decision would not require that attention be assigned to the locus of the probe, and so this method of probe response was considered undesirable. The other method required participants to classify the identity of the probe based on some characteristic of the probe (e.g. probe orientation). Crucially, as participants must attend to each probe in order to maintain a high degree of accuracy this method was proposed to ensure that biased monitoring of one hemi-field could be mitigated. For this reason, when probes appeared on each trial participants were required to classify the identity of the target probe as quickly as possible.
While equivalent in the above features, each subtask was designed to assess one of the two attentional processes of interest. Specifically, in those trials designed to assess attentional control the central cue provided an instruction informing participants to attend to either the representational image or abstract image within the presented image pair. On these trials, variation in attentional control would be revealed by assessing the degree to which participants were speeded to identify probes in the location of the image they were instructed to attend to, compared to the image they were not instructed to attend to. In those trials designed to assess selective attention to negative information the central cue provided no instruction to participants. On these trials, variation in selective attention to negative information would be revealed by assessing the degree to which participants were disproportionally speeded to identify probes in the location of representational images compared to abstract images, when these representational images were negatively valenced compared to positively valenced.

Two issues were addressed in statistical analysis. First, analyses determined whether an anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information were evident from the data. Second, in order to assess the validity of the three alternative models of interest to the research programme two mediational analyses were conducted. One analysis tested whether attentional control mediated the relationship between anxiety vulnerability and selective attention to negative information. The other analysis tested whether selective attention to negative information mediated the relationship between anxiety vulnerability and attentional control. Under the predictions of the attentional control mediator model, only the former of these effects would be supported by the data. Alternatively, under the predictions of the selective attention mediator model, only the latter of these effects would be supported by the data. Lastly, under the prediction of the
non-mediational associations model, neither of these patterns of effects would be supported by the data.

**Method**

**Participants**

Seventy-two university undergraduate psychology students were recruited to participate in the experiment. The aim of participant selection was to create two groups of participants that differed in level of trait anxiety. As such, participant selection was based on scores obtained from the trait scale of the Spielberger State-Trait Anxiety Inventory (STAI-T) questionnaire completed earlier in the teaching semester by a large cohort of the psychology students (N = 841). Participants were drawn from the bottom third (STAI-T score of 36 or below) and top third of scores (STAI-T score 45 or above).

Those participants drawn from the bottom third of STAI-T scores (n = 36, 18 males; \(M_{\text{age}} = 19.22, SD_{\text{age}} = 3.50; M_{\text{STAI-T}} = 29.42, SD_{\text{STAI-T}} = 3.67\) range = 23 to 36) were labelled the low trait anxiety group. Those participants drawn from the top third of STAI-T scores (n = 36, 15 males; \(M_{\text{age}} = 18.72, SD_{\text{age}} = 2.33; M_{\text{STAI-T}} = 54.86, SD_{\text{STAI-T}} = 5.86,\) range = 45 to 72) were labelled the high trait anxiety group. This gave rise to a between-groups factor of Trait Anxiety Group (high trait anxiety, low trait anxiety).

Analysis confirmed that the two groups did not significantly differ in age, \(t(70) = .71, p = .48\), or gender ratio, \(\chi^2(1, N = 72) = .51, p = .48\), but did significantly differ in STAI-T scores, \(t(70) = 22.09, p < .001\), as expected.

**Materials**

**Spielberger State-Trait Anxiety Inventory.** The trait anxiety scale of the Spielberger State-Trait Anxiety Inventory (STAI-T; Spielberger, 1983) was used to measure of anxiety vulnerability. The STAI-T is a 20 item scale which requires participants to indicate how often, in general, they experienced the anxiety symptom described by each item (e.g. “I feel nervous and restless”). Participants respond by
selecting one of four options; “almost never”, “sometimes”, “often”, or “almost always”. Scores on the STAI-T range from 20 to 80, with higher scores reflecting higher levels of trait anxiety. The STAI-T has been shown to have high test-retest reliability among university student populations and high concurrent and construct validity (Spielberger & Sydeman, 1994).

**Apparatus.** The attentional assessment task was presented on a 22-inch widescreen monitor set at a resolution of 1680 x 1050 pixels with a 15 ms refresh rate. Participant responses were made using a standard keyboard and mouse.

**Attentional assessment task stimuli.** The objective of stimuli selection was to create an image set that included 256 emotionally valenced representational images, comprising 128 negatively valenced images and 128 positively valenced images, and 256 non-representational abstract images. This image set will be referred to as the attentional assessment image set.

The 256 representational images included in the attentional assessment image set were selected from the International Affective Picture System (IAPS). IAPS images have been rated on a nine-point scale measuring emotional valence, such that higher scores represent more “pleasant” images, and lower scores represent more “unpleasant” images, with a midpoint of 5 reflecting affectively neutral images. Images were chosen based on their valence ratings to create a subset of 128 images with a positive emotional valence and a subset of 128 images with a negative emotional valence. Images with valence score standard deviations greater than 2.0 as well as images depicting sexualised scenes were omitted from selection in the set. The 128 images selected for inclusion in the negatively valenced subset had a mean valence rating score of 2.20 (SD = 0.30; Range: 1.51 - 2.71), which was significantly below the neutral midpoint of the IAPS valence scale, \( t(127) = 106.13, p < .001 \). The 128 images selected for inclusion in the positively valenced subset had a mean valence rating score of 7.37 (SD = 0.40;
Range: 6.65 – 8.34), which was significantly above the neutral midpoint score of the IAPS valence scale, $t(127) = 66.61, p < .001$. The 256 abstract images in the set consisted of cropped segments of abstract art\(^1\). Examples of positively valenced, negatively valenced, and abstract images contained in the attentional assessment image set are provided in Figure 2.1.

\[\text{Figure 2.1. Examples of positively valenced, negatively valenced, and abstract images, used in the attentional assessment task. Examples not to scale.}\]

An additional practice image set of 32 negative and 32 positive IAPS images, together with 64 abstract images, was created for use in a practice task. No image in the practice image set was contained in the attentional assessment image set. All images used in the attentional assessment image set and practice image set had a resolution of 350 x 350 pixels.

**Attentional assessment task.** The attentional assessment task contained 256 trials that were equally divided among two subtasks. The *attentional control assessment subtask* assessed attentional control, while the *selective attention to negative information assessment subtask* assessed selective attention to negative information. The task was delivered across four blocks each presenting 64 trials. In order to reduce the possibility of contamination across subtasks, successive trial blocks alternated

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\(^1\) The abstract images were obtained via a Google image search for open source images using the search term “abstract art”. These images were rated using the same procedure as was originally employed for the IAPS images. The mean emotional valence rating of the abstract images was 4.77 (SD = .23).
between subtasks. The order of subtasks was counterbalanced across participants such that for half of participants the first block of trials were drawn from the *attentional control assessment subtask*, and for the other half of participants the first block of trials were drawn from the *selective attention to negative information assessment subtask*.

Trials in each subtask were similar in presentation format, but differed in important ways that rendered them capable of measuring the specific attentional process of interest. Those aspects of trials that were common across the subtasks will be described first, followed by a description of specific aspects of trials in each subtask that enabled assessment of the intended attentional process.

**Trial features common to subtasks.** Trials in each subtask began with a cue in the centre of the screen. Participants were required to press to space-bar key when ready to progress the trial. When the space-bar key was pressed the cue was cleared and an image pair comprising one representational image and one abstract image was presented. Across trials the representational image was negatively valenced or positively valenced with equal frequency. Each image was 85 mm x 85 mm in size, and subtended a visual angle of 8° x 8° at a viewing distance of 60 cm. One image of the image pair was presented on the left side of the screen with its right edge 25 mm from the centre of the screen, and the other image was presented on the right side of the screen with its left edge 25 mm from the centre of the screen. This provided a visual angle between the centres of each stimulus image of 12.82° at a viewing distance of 60 cm. The representational image appeared in the left or right location with equal frequency. After 1000 ms the image pair was removed from screen and a probe appeared in either the left or right location with equal frequency. This probe comprised two red dots diagonally aligned, with the top dot offset slightly to the left or right of the bottom dot. Participants were required to quickly indicate the identity of the probe by pressing the left mouse button if the top dot was offset to the left, or the right mouse
button if the top dot was offset to the right, of the lower dot. If participants correctly discriminated the identity of the probe the screen was cleared and the next trial commenced after a 1000 ms inter-trial interval. It is well-established that delayed response latencies occur when a subsequent trial rapidly follows after execution of an incorrect response on the preceding trial (Botvinick, Braver, Barch, Carter, & Cohen, 2001). Hence, it was considered important to ensure that probe discrimination latencies on subsequent trials would not be influenced by errors made or previous trials. For this reason, if participants made an incorrect response to the probe by pressing the wrong mouse button an on-screen message (“ERROR TRIGGERED DELAY”) was presented for five seconds prior to the next trial commencing after a 1000 ms delay. On each trial, the latency to discriminate the probe (as well as the accuracy of probe discrimination) was recorded.

Because probe discrimination latencies can only provide an indication of attentional distribution when probes are correctly discriminated, only probe discrimination latencies resulting from such trials were employed to compute mean latencies for trial conditions. Additionally, a participant inclusion criterion was adopted that required 90% accuracy, or greater, on probe discrimination judgements in the attentional assessment task, for a participant’s mean response latencies to be included in analyses.

**Trial features specific to the attentional control assessment subtask.** On trials in this subtask the cue always delivered an attentional control instruction. This instruction communicated an attentional objective to participants by instructing them to attend to either the representational image or to the abstract image in the subsequent image pair. Specifically, the instructions presented on screen were, “ATT REP” (meaning attend to the representational image), “AVD REP” (meaning avoid the representational image), “ATT ABS” (meaning attend to the abstract image), and “AVD ABS” (meaning avoid
the abstract image). Each instruction was presented an equal number of times across trials. A visual example of these trials is presented in Figure 2.2 below.

Figure 2.2. Example of a trial in the attentional control assessment subtask. Note items in figure not to scale.

To measure whether participants were able to control their attention as instructed, probes could appear in either location across trials. Compliance with attentional control instructions was encouraged by presenting probes in the location congruent with the image participants were instructed to attend to on 75% of trials, and in the incongruent opposite location on the remaining 25% of trials. This gave rise to a within-groups factor of Probe Congruency (congruent with instruction, incongruent with instruction) in the attentional control assessment subtask.

If participants were generally capable of moving attention to the location they were instructed to attend to in the subtask, then this would be revealed by a main effect of Probe Congruency. This effect would reveal that participants were speeded to discriminate probes appearing in locations that were congruent with attentional control instructions, relative to locations incongruent with attentional control instructions.
Importantly therefore, if it were the case that heightened trait anxiety was associated with reduced attentional control during this task, then this will be revealed by a two-way interaction between Probe Congruency and Trait Anxiety Group. This interaction effect would reveal that the degree to which the main effect of Probe Congruency was evident was attenuate amongst high trait anxious participants, as compared to low trait anxious participants.

**Trial features specific to the selective attention to negative information assessment subtask.** On trials in this subtask the cue provided participants with no attentional objective concerning which subsequent image should be attended to. The cue instead presented two strings of question marks (“?? ??”). As described prior, the emotional valence of representational images in the subtask was negative, or positive, with equal frequency. This gave rise to a within-groups factor of Representational Image Valence (negative, positive). Across the subtask, probes were presented in the location of the representational image, or abstract image, with equal frequency. This gave rise to a second within-groups factor of Probe Location (representational image, abstract image). A visual example of these trials is presented in Figure 2.3 below.
In this subtask, if there were a general tendency for participants to attend to the location of the representational image this would be indicated by a main effect of Probe Location. This effect would show that participants were speeded to discriminate probes appearing in the location of representational images, as compared to abstract images. If it were the case that participants generally allocated greater attention to the location of representational images, compared to abstract images, when representational images were negatively valenced, this would be revealed by a two-way interaction involving Representational Image Valence and Probe Location. Crucially therefore, if it were the case that heightened trait anxiety was associated with selective attention to negative information, this aforementioned two-way interaction would be subsumed within a three-way interaction involving Representational Image Valence, Probe Location, and Trait Anxiety Group. This interaction effect would reveal the two-way interaction effect was disproportionately evident in high trait anxious participants, as compared to low trait anxious participants.
CHAPTER 2: EXPERIMENT 1

Allocation of images to subtasks. The attentional assessment task employed images from the attentional assessment image set described earlier. For each participant, images were randomly allocated to each subtask, with the constraint that half of the positive representational image subset, half of the negative representational image subset, and half of the abstract image set was allocated to each subtask. Within each subtask image pairs were randomly generated and these pairs were allocated randomly across trial conditions.

Procedure

Upon arrival participants were provided with an information sheet and consent form. After, to allow for assessment of whether the required difference in anxiety vulnerability between participant groups remained at the time of the experimental session participants completed the STAI-T questionnaire. Participants were then seated at the computer at a distance 60 cm and verbally instructed by the experimenter about the requirements of the attentional assessment task. Participants were told that some trials would present attentional control instructions, while other trials would not. Participants were further told that on those trials in which no attentional control instruction was given probes would appear with equal probability in either image location, but for those trials in which an attentional control instruction was given they should comply with the instruction as accurately as possible, as probes would most often appear in the location of the image they had been instructed to attend to. Participants were told to indicate the orientation of each probe by pressing the appropriate response button as quickly as possible, whilst maintaining a high level of accuracy. The experimental task was preceded by a short practice version of the task that exposed participants to all possible conditions, comprising 64 trials and employing images from the practice image set described earlier. Participants then completed the attentional assessment task, and were subsequently debriefed.
Results

To confirm that participants allocated to the two trait anxiety groups continued to differ in trait anxiety at the time of the experimental session, a \(t\)-test was conducted to compare trait anxiety scores obtained at the time of the experimental session between the trait anxiety groups. This analysis revealed that STAI-T scores of participants in the High Trait Anxiety Group (\(M = 54.56, SD = 7.50\)) was significantly higher than STAI-T scores of participants in the Low Trait Anxiety Group (\(M = 30.83, SD = 5.22\)), \(t(70) = 15.57, p < .001\), confirming that the recruited trait anxiety groups differed in level of trait anxiety at the time of the experiment as required.

Next, statistical analyses examined whether the current attentional assessment task revealed evidence of anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information, before then examining the validity of the hypothesised models; the attentional control mediator model, the selective attention mediator model, and the non-mediational associations model.

Preparation of probe discrimination latency data

One participant from the high trait anxiety group failed to meet the 90% probe discrimination accuracy criterion and thus was excluded from subsequent analyses. The mean accuracy of remaining participants was reassuringly high at 97.27% (\(SD = 1.83, range = 92.27\% – 99.61\%\)). Accuracy did not differ between trait anxiety groups, \(t(69) = 0.43, p = .67\).

Prior to analysis of probe discrimination latencies, the data were filtered to exclude outlying latencies using the exclusion approach commonly adopted in previous research (e.g. Bradley et al., 1999; Clarke, Browning, Hammond, Notebaert, & Macleod, 2014; Mogg, Bradley, de Bono, & Painter, 1997). This approach first eliminated all latencies that exceeded 2000 ms, then eliminated any remaining latencies that, for each participant, fell more than 1.96 standard deviations from their mean.
latency under each experimental condition. This resulted in 1.87% of probe
discrimination latencies being excluded.

**Assessment of Anxiety-linked Impairment in Attentional Control**

Analyses next assessed whether the attentional assessment task was sensitive to
anxiety-linked impairment in attentional control. A summary of probe discrimination
latencies for each condition in the *attentional control assessment subtask*, for each trait
anxiety group, can be seen in Table 2.1.

Table 2.1. *Mean and standard deviation of probe discrimination latencies, in
milliseconds, under each level of Probe Congruency in the attentional control
assessment subtask, for each level of Trait Anxiety Group; M(SD).*

<table>
<thead>
<tr>
<th>Probe Congruency</th>
<th>Trait Anxiety Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Trait Anxiety</td>
</tr>
<tr>
<td>Congruent with instruction</td>
<td>596.48 (113.59)</td>
</tr>
<tr>
<td>Incongruent with instruction</td>
<td>884.40 (146.92)</td>
</tr>
</tbody>
</table>

These data were subject to a mixed-design ANOVA that considered the within-
groups factor Probe Congruency (congruent with instruction, incongruent with
instruction), and the between-groups factor Trait Anxiety Group (high trait anxiety, low
trait anxiety). The analysis revealed a significant main effect of Probe Congruency, \( F(1, 69) = 328.93, p < .001, \eta^2_p = .83 \), showing participants were faster to discriminate
probes located congruent with attentional control instructions \( M = 625.50 \) relative to
probes located incongruent with attentional control instructions \( M = 884.17 \). This main
effect confirmed that across participants, there was a general capacity to move attention
to the location indicated by attentional control instructions.

As described earlier, the presence of anxiety-linked impairment in attentional
control would predict the occurrence of a two-way interaction involving Probe
Congruency and Trait Anxiety Group in the present analysis. This two-way interaction was found to be significant, $F(1, 69) = 4.21, p = .044, \eta^2_p = .06$. This interaction is shown in Figure 2.4.

![Figure 2.4](image)

*Figure 2.4. Probe discrimination latencies for probes in instruction congruent and incongruent locations in the *attentional control assessment subtask*, for each trait anxiety group. Bars represent standard error.*

Consistent with the prediction of an anxiety-linked impairment in attentional control, the interaction effect indicated that the degree to which participants were speeded to discriminate probes appearing congruent with the location they were instructed to attend, relative to probes appearing incongruent with that location, was attenuated in the high trait anxiety group (congruent: $M = 654.52$ ms; incongruent: $M = 883.93$ ms; speeding = 229.41 ms) relative to the low trait anxiety group (congruent: $M = 596.48$ ms; incongruent: $M = 884.40$ ms; speeding = 287.92 ms). No other effects were found to reach significance in the analysis\(^2\).

---

\(^2\) This ANOVA analysis was repeated to include a factor reflecting the emotional valence of the representational image. The analysis did not reveal any effect of this factor upon effects reported above.
Correlational analysis of the data obtained from this subtask verified that heightened levels of trait anxiety were associated with impaired attentional control. To enable this assessment an index of attentional control was computed. This Attentional Control Index (ACI) revealed the degree to which participants were faster to discriminate probes presented in the location of the stimulus they were instructed to attend to, relative to probes presented in the location of the stimulus they were not instructed to attend to. Hence, increasing values on this index were considered to reflect greater success allocating attention in accordance with attentional instructions, signalling greater attentional control. This analysis revealed that trait anxiety scores were negatively correlated with ACI scores, $r(69) = -.22, p = .031^3$. Thus, the present experiment was sensitive to anxiety-linked impairment in attentional control.

**Assessment of Anxiety-linked Heightened Selective Attention to Negative Information**

Analysis next assessed whether the attentional assessment task was sensitive to anxiety-linked heightened selective attention to negative information. A summary of probe discrimination latencies for each condition in the *selective attention to negative information assessment subtask*, for each trait anxiety group, can be seen in Table 2.2.

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$^3 r_{69} = -.19, p = .054$
Table 2.2. Mean and standard deviation of probe discrimination latencies, in milliseconds, under each level of Valence and Probe Location in the selective attention to negative information assessment subtask, for each Trait Anxiety Group: M(SD).

<table>
<thead>
<tr>
<th>Representational Image Valence</th>
<th>Probe Location</th>
<th>Trait Anxiety Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low Trait Anxiety</td>
</tr>
<tr>
<td>Negative</td>
<td>Representational Image</td>
<td>713.95 (127.08)</td>
</tr>
<tr>
<td></td>
<td>Abstract Image</td>
<td>730.09 (128.15)</td>
</tr>
<tr>
<td>Positive</td>
<td>Representational Image</td>
<td>695.18 (107.43)</td>
</tr>
<tr>
<td></td>
<td>Abstract Image</td>
<td>715.80 (113.11)</td>
</tr>
<tr>
<td></td>
<td>High Trait Anxiety</td>
<td>740.10 (136.26)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>768.70 (135.88)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>719.11 (115.46)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>753.07 (125.49)</td>
</tr>
</tbody>
</table>

These data were subject to a mixed-design ANOVA that considered the within-groups factors of Probe Location (representational image, abstract image) and Valence (negative, positive), and the between-groups factor Trait Anxiety Group (high trait anxiety, low trait anxiety).

Importantly, the presence of anxiety-linked heightened selective attention to negative information would predict the occurrence of a three-way interaction involving Valence, Probe Location, and Trait Anxiety Group in the present analysis. This three-way interaction effect would reveal the high trait anxiety group, as compared to the low trait anxiety group, to show disproportionate speeding to discriminate probes in the location of the representational image, relative to those in the location of the abstract image, when this representational image was negatively valenced rather than to positively valenced.

The analysis revealed a significant main effect of Valence, $F(1, 69) = 16.12, p < .001, \eta_p^2 = .19$, indicating that, across participants, probe discrimination latencies were generally longer when representational images were negatively valenced ($M = 738.21$) than when they were positively valenced ($M = 720.79$). There was also a significant
main effect of Probe Location, $F(1, 69) = 8.31, p = .005, \eta^2_p = .12$. This effect showed that participants had shorter probe discrimination latencies when probes replaced representational images ($M = 717.09$) compared to abstract images ($M = 741.91$), suggesting that representational images received greater attentional allocation than abstract images. No other effects were found to reach significance in the analysis. Thus, the interaction effect involving Valence, Probe Location, and Trait Anxiety Group was not significant, $F(1, 69) = .002, p = .97, \eta^2_p < .001$, providing no evidence of anxiety-linked heightened selective attention to negative information.

Correlational analysis of data obtained during the experimental session likewise failed to reveal evidence that heightened levels of trait anxiety were associated with heightened selective attention to negative information. To enable this assessment an index of selective attention to negative information was computed. This Attention to Negative Information Index (ANII) reflected the degree to which speeding to discriminate probes in the location of representational images, compared to probes in the location of abstract images, was greater when representational images were negatively valenced rather than positively valenced. This index may be formally expressed by the equation below:

$$\text{Attention to Negative Information Index} =$$

$$[(\text{Representational image negative; Probe in representational image location})$$

$$\quad - (\text{Representational image negative; Probe in abstract image location})]$$

$$\quad - [(\text{Representational image positive; Probe in representational image location})$$

$$\quad - (\text{Representational image positive; Probe in abstract image location})]$$

Thus, increasing values on this index represent greater selective attention to negative information. The correlational analysis revealed no correlation between trait
anxiety scores and ANII scores, $r(69) = -.018, p = .56^4$. This indicated that the present experiment detected no evidence of an association between heightened anxiety vulnerability and heightened selective attention to negative information.

**Assessment of Mediation Models**

Statistical analysis next examined the validity of each of the mediational models of interest to the research programme. It is important note that while some previously favoured statistical approaches for conducting mediational analyses (e.g. Baron & Kenny, 1986) mandate that evidence of significant associations between variables in the proposed mediational model must be obtained before mediation is tested, modern approaches do not require such preconditions (Cerin & Mackinnon, 2009; Hayes, 2009, 2013; Rucker, Preacher, Tormala, & Petty, 2011; Shrout & Bolger, 2002). Therefore, the absence of a significant association between anxiety vulnerability and selective attention to negative information in the present experiment does not preclude testing the mediating accounts of interest. Thus, it was considered appropriate to continue with analysis of pertinence to the research programme.

In order to examine the validity of the alternative mediational models, statistical analyses employed the methodology proposed by Preacher and Hayes (2004) and Hayes (2009, 2013). Using this above described methodology statistical analyses tested the validity of the alternative models under consideration in the research programme. One analysis tested whether attentional control mediated the relationship between anxiety vulnerability and selective attention to negative information, thereby testing the validity of the **attentional control mediator model**. A second analysis tested whether selective attention to negative information mediated the relationship between anxiety vulnerability and attentional control thereby testing the validity of the **selective attention mediator model**.

\(^4 r_s(69) = -.12, p = .15\)
Lastly, the non-mediational associations model supposes that neither of these effects would be supported by the analyses, thus a failure of each of these analyses to find evidence of mediation would support the validity of this model.

In each analysis Attentional Control Index (ACI) scores were used as a measure of attentional control, Attention to Negative Information Index (ANII) scores were used as a measure of selective attention to negative information, and STAI-T scores recorded during the experimental session were used as a measure of anxiety vulnerability.

The first analysis tested the validity of the attentional control mediator model, which proposes that attentional control mediates the relationship between anxiety vulnerability and selective attention to negative information. In order to test the validity of the mediating pathway in this model the analysis examined whether the association between STAI-T scores and Attention to Negative Information Index scores was statistically mediated by Attentional Control Index scores. This was achieved by computing a bias-corrected bootstrapped confidence interval based on 10,000 samples for the effect of the mediating pathway (ab, b = -0.01). The computed confidence interval (95% CI; -0.02 to 0.01) contained zero within its range revealing no evidence that Attentional Control Index scores mediated the relationship between STAI-T scores and Attention to Negative Information Index scores. Thus, the result of this mediation analysis provided no support for the validity of the attentional control mediator model.

Mediational analyses were next employed to test the validity of the selective attention mediator model. This model proposes that selective attention to negative information mediates the relationship between anxiety vulnerability and attentional control. In order to test the validity of the mediating pathway in this model, analyses examined whether the association between STAI-T scores and Attentional Control Index scores was statistically mediated by Attention to Negative Information Index scores. Identical to the previous mediation test, this was achieved by computing a bias-
corrected bootstrapped confidence interval based on 10,000 samples for the effect of the mediating pathway in the model \((ab, b < 0.001)\). The computed confidence interval \((95\%\ CI; -0.005\ to\ 0.003)\) contained zero within its range revealing no evidence that Attention to Negative Information Index scores mediated the association between STAI-T scores and Attentional Control Index scores. Hence, the result of this mediation analysis provided no support for the validity of the selective attention mediator model.

**Discussion**

The purpose of the present experiment was to discriminate the validity of alternative theoretical models describing the relationship between attentional control, selective attention to negative information and anxiety vulnerability. The experiment employed a novel task designed to assess attentional control and selective attention to negative information under highly similar experimental conditions.

It was revealed that the current attentional assessment task was sensitive to anxiety-linked impairment in attentional control. Specifically, participants with low levels of anxiety vulnerability, compared to high levels of anxiety vulnerability, showed disproportionate attention to images they were instructed to attend, relative to images they were not instructed to attend to, as evidence by the pattern of probe discrimination latencies. This finding is consistent with previous research that has also observed anxiety-linked impairment in attentional control (Eysenck et al., 2007). However, the current attentional assessment task did not reveal the anticipated evidence of anxiety-linked heightened selective attention to negative information. Specifically, high trait anxious participants, compared to low trait anxious participants, did not show greater allocation of attention to the location of negatively valenced representational images, relative to positively valenced representational images, as indicated by the pattern of probe discrimination latencies. This finding runs contrary to the expectation drawn from the literature, as is inconsistent with previous evidence that heightened anxiety
vulnerability is associated with heightened selective attention to negative information (Bar-Haim et al., 2007). Ideally, the validity of the alternative mediational models under consideration would be tested by first finding evidence of both anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information, and following this, with the intended set of mediational analyses. The failure of the present experiment to detect the latter anxiety-linked effect means that this ideal was not fulfilled. Nonetheless, the findings of these tests will now be considered, after which consideration will be given to possible reasons for the present task having been unable to detect anxiety-linked heightened selective attention to negative information.

In the present experiment statistical tests of mediation did not reveal evidence of the pattern of effects prediction by either the attentional control mediational model or the selective attention mediator model. Thus, the experiment revealed no support for the validity of either model. Of course, these findings do not challenge validity of the non-mediational associations model, as this model does not describe the variables holding either of the mediational relationships that were under test. Moreover, if anxiety-linked heightened selective attention to negative information, and anxiety-linked impairment in attentional control are truly independent of one another, then the presence of one such effect need not imply the presence of the other. The findings of the present experiment therefore challenge the veracity of the alternative mediational models under consideration in the research programme, and are better accommodated by the non-mediational associations model.

A large literature supports the existence of anxiety-linked heightened selective attention to negative information. Thus, it is reasonable to suppose that the absence of evidence indicating such anxiety-linked heightened selective attention to negative information in the present experiment may reflect a failure of the experiment to
sensitively detect this anxiety-linked effect. Clearly, the possible insensitivity of the present attentional task to this attentional effect would make it non-optimal for testing the validity of the proposed mediational models. Hence, it remains possible that one of the proposed mediational models accurately reflects the associations between attentional control, selective attention to negative information, and anxiety vulnerability that would be observed on a task sensitive to both anxiety-linked effects. It is therefore important to consider how the present experiment may be rendered more sensitive to anxiety-linked heightened selective attention to negative information.

One plausible possibility is that a particular characteristic of the attentional control instructions presented during the attentional control assessment subtask in the present task served to reduce the manifestation of anxiety-linked heightened selective attention to negative information in the other subtask. The instructions presented during these trials identified the image that participants were required to attend to via the representational or abstract quality of the to-be-attended image. Although this feature intended to ensure that attentional control instructions clearly defined the image that participants were required to attend to, these instructions may have led participants to adopt an information processing style that inhibited processing of the emotional content of the images, therefore compromising the degree to which this emotional content influenced attention selectively on the selective attention to negative information assessment subtask.

Indeed, there is evidence that certain affective processing effects can be eliminated by requiring participants to categorise emotional material on the basis of non-emotional features (Spruyt, De Houwer, Hermans, & Eelen, 2007). Some investigators claim that selective attention to negative information can be eliminated by having participants practice categorising emotional material on the basis of non-emotional features (Everaert, Spruyt, & De Houwer, 2012). In two experiments,
Everaert et al. (2012) presented participants with an attentional-probe task or Emotional-Stroop task, each designed to assess selective attention to negative information under two conditions. In one condition intermittent trials required participants to categorise a series of emotional images as ‘‘negative’’ or ‘‘not negative’’. In the other condition these trials required participants to categorise the emotional images as ‘‘human’’ or ‘‘not human’’. In each experiment, selective attention to negative information was found only under conditions that required participants to categorise images on the basis of their emotional features, and not under conditions that required participants to categorise images on the basis of their non-emotional features. Thus, while Everaert et al. (2012) were not assessing anxiety-linked heightened selective attention to negative information, their findings show that tasks which require participants to process information in ways that implicate its non-emotional dimensions might eliminate anxiety-linked differences in attentional responding to emotional information.

In view of this possibility, Experiment 2 adopted a modification of the present task, designed to foster, rather than suppress, the processing of the emotional content of representational images. The experiment continued the objective of obtaining both anxiety-linked attentional effects, and examining the validity of the alternative models proposed by the research programme.
Chapter 3: Experiment 2

As will be recalled from the previous chapter, the attentional assessment task used in Experiment 1 may have led participants to adopt an information processing style that inhibited processing of the emotional content of presented images, therefore compromising the degree to which emotional content influenced attention selectively.

One possible means of circumventing this problem would be to present all the trials assessing selective attention to negative information prior to the trials assessing attentional control. This would ensure that any tendency to inhibit the processing of emotional content of images fostered by the attentional control instructions on the attentional assessment task could not compromise the detection of selective attention to negative information. However, employing such a fixed order would introduce other potential problems, by preventing the counter-balancing of trials across participants. This approach would mean that factors, such as practice effects and fatigue, would differentially influence responding on trials that assess attentional control, as compared to trials that assess selective attention to negative information.

A second possible resolution might be to introduce additional trials into the attentional assessment task that designed to encourage processing of the emotional content of images. If such trials increased the processing of emotional information, then they may render the attentional assessment task more sensitive to selective attention responding to emotional information. However, this approach too has limitations, as this approach would require additional trials in the attentional assessment task that do not themselves measure the variables of interest to the research programme.

A third means of promoting emotional information processing is by altering the attentional control instructions used in the subtask assessing of attentional control, such that these instructions no longer encourage participants to inhibit processing of the emotional content of presented images. Specifically, the instructions could provide
participants with their attentional objective by specifying the images that must be attended to in terms of its emotional tone. These instructions would therefore require participants to classify the emotional content of images. Such a variant of the attentional assessment task would continue to allow for the assessment of attentional control. Crucially however, the instructions would require participants to categorise the emotional content of the representational image of the presented image pair in order to execute the required attentional objective. By encouraging the processing of emotional image content in this manner, this approach overcomes the limitations faced by the alternative approaches described above, as this approach would allow for counterbalancing of trials assessing attentional control and selective attention to negative information, as was conducted in the previous experiment, and does not require the inclusion of additional trials in the task that do not measure the variables of interest.

This approach was therefore adopted in Experiment 2 in an effort to circumvent the potential problem identified in Experiment 1.

As in Experiment 1, the aim of Experiment 2 was to discriminate the validity of the three alternative models describing the relationship between attentional control, selective attention to negative information, and anxiety vulnerability, that are the focus of the research programme. To achieve this aim, the design of Experiment 2 remained identical to the designed employed in Experiment 1.

Once again, two issues were addressed in statistical analysis. First, analyses determined whether an anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information were evident. Second, in order to assess the validity of the three alternative models of interest to the research programme two mediational analyses were conducted. One analysis tested whether attentional control mediated the relationship between anxiety vulnerability and selective
attention to negative information. The other analysis tested whether selective attention to negative information mediated the relationship between anxiety vulnerability and attentional control. Under the predictions of the attentional control mediator model, only the former of these effects would be supported by the data. Alternatively, under the predictions of the selective attention mediator model, only the latter of these effects would be supported by the data. Lastly, under the prediction of the non-mediational associations model, neither of these patterns of effects would be supported by the data.

**Method**

**Participants**

Seventy-two university undergraduate psychology students were recruited to participate in the experiment. The aim and manner of participant selection was identical to that in Experiment 1. Specifically, participant selection aimed to recruit two groups of participants that would differ in level of anxiety vulnerability. Thus, participants were selected based on scores obtained from the trait scale of the Spielberger State-Trait Anxiety Inventory (STAI-T) questionnaire completed earlier in the teaching semester by the same cohort of psychology students used in Experiment 1 (N = 841). Participants were drawn from the same bottom third (STAI-T score of 36 or below) and top third of scores (STAI-T score 45 or above) as determined in Experiment 1. Individuals who had previously participated in Experiment 1 were not recruited.

Those participants drawn from the bottom third of STAI-T scores (n = 36, 18 males; $M_{age} = 18.75$, $SD_{age} = 1.80$; $M_{STAI-T} = 29.25$, $SD_{STAI-T} = 3.32$, range = 21 to 36) were labelled the low trait anxiety group. Those participants drawn from the top third of STAI-T scores (n = 36, 18 males; $M_{age} = 18.31$, $SD_{age} = 1.74$; $M_{STAI-T} = 53.69$, $SD_{STAI-T} = 5.59$, range = 45 to 71) were labelled the high trait anxiety group. This gave rise to a between-groups factor of Trait Anxiety Group (high trait anxiety, low trait anxiety). Analysis confirmed that the two groups did not significantly differ in age, $t(70) = 1.07$,
$p = .29$, or gender ratio, $\chi^2(1, N = 72) = .00, p = 1$, but did significantly differ in STAI-T scores, $t(70) = 22.57, p < .001$, as expected.

**Materials**

**Spielberger State-Trait Anxiety Inventory.** As in Experiment 1, the trait anxiety scale of the Spielberger State-Trait Anxiety Inventory (STAI-T; Spielberger, 1983) was used to assess anxiety vulnerability.

**Apparatus.** The same apparatus used in Experiment 1 were used for the delivery of the attentional assessment task in the present experiment.

**Attentional assessment task stimuli.** The same images selected for use in Experiment 1 were selected for use in the attentional assessment task in the present experiment. This set of images was again referred to as the attentional assessment image set. As described previously, this set comprised 256 emotionally valenced representational images, including 128 negatively valenced images and 128 positively valenced images, as well as 256 non-representational abstract images. Additionally, the same practice image set that was used in Experiment 1 was used in the present experiment for an initial practice task.

**Attentional assessment task.** In a manner identical to Experiment 1, the attentional assessment task contained 256 trials equally divided among two subtasks. The *attentional control assessment subtask* assessed attentional control, while the *selective attention to negative information assessment subtask* assessed selective attention to negative information. The task was delivered across four trial blocks of 64 trials each. Trial blocks were delivered in a manner that alternated between subtasks, and were counterbalanced across participants such that half of participants were first
assessed on the *attentional control assessment subtask*, and half of participants were first assessed on the *selective attention to negative information assessment subtask*.

Trials in each subtask were identical in almost all aspects, but differed in important ways that yielded the capacity to measure anxiety-linked differences in each attentional process. The structure of trials common to each subtask will now be described, followed by a description of critical differences in the structure of trials between subtasks.

**Trial features common to subtasks.** Trial features that were common across subtasks did not differ from those detailed in Experiment 1. As described previously, trials in each subtask began with a cue in the centre of the screen. Participants were then required to press to space-bar key when ready to progress the trial. When the space-bar key was pressed the cue was cleared and an image pair comprising one representational image and one abstract image was presented. Across trials the representational image was negatively valenced or positively valenced with equal frequency. Each image was presented 85 mm x 85 mm in size, and subtended a visual angle of $8^\circ \times 8^\circ$, at a viewing distance of 60 cm. One image of the image pair was presented on the left side of the screen with its right edge 25 mm from the centre of the screen, and the other image was presented on the right side of the screen with its left edge 25 mm from the centre of the screen. This provided a visual angle between the centres of each image of $12.82^\circ$ at a viewing distance of 60 cm. Across trials, the representational image appeared in the left or right location with equal frequency. After 1000 ms the image pair was removed from screen and a probe appeared in either the left or right location with equal frequency. This probe comprised two red dots diagonally aligned, with the top dot offset slightly to the left or right of the bottom dot. Participants were required to quickly indicate the identity of the probe by pressing the left mouse button if the top dot was offset to the left, or the right mouse button if the top dot was offset to the right. If participants
correctly discriminated the identity of the probe, then the screen was cleared and the next trial commenced after a 1000 ms inter-trial interval. If participants made an incorrect response to the probe by pressing the wrong mouse button an on-screen message (“ERROR TRIGGERED DELAY”) was presented for five seconds before the next trial commenced after a 1000 ms delay. On each trial, the latency to discriminate the probe (as well as the accuracy of probe discrimination) was recorded.

As detailed in the previous chapter, probe discrimination latencies can only provide an indication of attentional distribution when probes are correctly discriminated. Hence, only probe discrimination latencies resulting from such trials were employed to compute mean latencies for task conditions. As previously enacted, a participant inclusion criterion was adopted that required 90% accuracy, or greater, on probe discrimination judgements in the attentional assessment task, for a participant’s mean response latencies to be included in analyses.

**Trial features specific to the attentional control assessment subtask.** Trial features specific to this subtask were closely matched those described in Experiment 1, albeit for a modification that meant the subtask now presented attentional control instructions that encouraged the encoding of the emotional content of images. These instructions encouraged such processing as they required the classification of the emotional tone of the representational image. Specifically, the attentional control instructions could require participants to attend to the representational image only if it were negatively valenced, to attend to the representational image only if it were positively valenced, to avoid the representational image only if it were negatively valenced, or to avoid the representational image only if it were positively valenced. Specifically, the instructions as presented on screen were, “ATT NEG” (meaning attend to the representational image if it is negatively valenced), “AVD NEG” (meaning avoid the representational image if it is negatively valenced), “ATT POS” (meaning attend to
the representational image if it is positively valenced), and “AVD POS” (meaning avoid the representational image if it is positively valenced). Each instruction was presented an equal number of times across trials, and the instruction type did not predict the valence of the presented representational image.

Probes could appear in either location across trials, and compliance with attentional control instructions was encouraged by presenting probes in the location congruent with the image participants were instructed to attend to in 75% of trials, and in the incongruent opposite location in the remaining 25% of trials. This gave rise to a within-groups factor of Probe Congruency (congruent with instruction, incongruent with instruction). An illustration of trials in this task is presented in Figure 3.1 below.

Figure 3.1. Example of a trial in the attentional control assessment subtask. Note items in figure not to scale.

As with Experiment 1, if it were the case that heightened trait anxiety was associated with reduced attentional control during this task, then this would be revealed by a two-way interaction between Probe Congruency and Trait Anxiety Group. This interaction effect would reveal that the degree to which participants were speeded to
discriminate probes in the location they were instructed to attend was attenuated amongst high trait anxious participants, as compared to low trait anxious participants.

**Trial features specific to the selective attention to negative information assessment subtask.** Trial features specific to this subtask matched those described in Experiment 1. Specifically, trials in this subtask presented a cue that provided no attentional objective concerning which subsequent image should be attended to, instead presenting two strings of question marks (“???”). As described prior, the emotional valence of representational images in the subtask was negative, or positive, with equal frequency. This gave rise to a within-groups factor of Representational Image Valence (negative, positive). Across the subtask, probes were presented in the location of the representational image, or abstract image, with equal frequency. This gave rise to a second within-groups factor of Probe Location (representational image, abstract image).

As with Experiment 1, in this subtask anxiety-linked selective attention to negative information would be revealed by a three-way interaction involving Representational Image Valence, Probe Location, and Trait Anxiety Group. This interaction effect would reveal the high trait anxiety group to be disproportionately speeded, compared to the low trait anxiety group, to discriminate probes in the location of the representational image relative to the abstract image, when the representational image was negatively valenced relative to positively valenced.

**Allocation of images to subtasks.** The attentional assessment task employed images from the attentional assessment image set described earlier. In the present experiment the allocation of stimuli across trials in the attentional assessment task was conducted in a method identical to that detailed in Experiment 1. Specifically, for each participant images were randomly allocated to each subtask, with the constraint that half of the positive representational image subset, half of the negative representational image subset, and half of the abstract image set was allocated to each subtask. Within each
subtask image pairs were randomly generated and these pairs were allocated randomly across trial conditions.

**Procedure**

The procedure of the present experiment matched the procedure followed in Experiment 1. Specifically, upon arrival participants provided an information sheet and consent form. Next, to allow assessment of whether the differences in anxiety vulnerability between participant groups remained at the time of the experimental session participants completed the STAI-T questionnaire. Participants were then seated at the computer at a distance 60 cm and verbally instructed by the experimenter about the requirements of the attentional assessment task. Participants were told that some trials would present attentional control instructions, while other trials would not, and on those trials in which no attentional control instruction was given probes would appear with equal probability in either image location, but for those trials in which an attentional control instruction was given they should comply with the instruction as accurately as possible as probes would most often appear in the location of the image they had been instructed to attend to. Participants were told to indicate the orientation of each probe by pressing the appropriate response button as quickly as possible, whilst maintaining a high level of accuracy. The experimental task was preceded by a short practice version of the task that exposed participants to all possible conditions and employing images from the practice image set described earlier. Participants then completed the attentional assessment task, and were subsequently debriefed.

**Results**

To confirm that participants allocated to the two trait anxiety groups continued to differ in trait anxiety at the time of the experimental session, a $t$-test was conducted to compare trait anxiety scores obtained during the experimental session between the trait anxiety groups. This test revealed STAI-T scores of participants in the High Trait.
Anxiety Group ($M = 51.22, SD = 7.31$) was significantly higher than STAI-T scores of participants in the Low Trait Anxiety Group ($M = 32.11, SD = 5.68$), $t(70) = 12.39, p < .001$. This confirmed that the recruited trait anxiety groups differed in level of trait anxiety at the time of the experiment as required.

Next, statistical analyses examined whether the current attentional assessment task was capable of revealing evidence of anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information, before then examining the validity of the hypothesised models; the _attentional control mediator model_, the _selective attention mediator model_, and the _non-mediation associations model_.

**Preparation of probe discrimination latency data**

One participant from the high trait anxiety group and one participant from the low trait anxiety group failed to meet the 90% probe discrimination accuracy criterion and they were excluded from subsequent analyses. Mean accuracy of remaining participants was reassuringly high at 97.46% ($SD = 1.77$, range = 91.4% – 100%). Accuracy did not differ between trait anxiety groups, $t(68) = 0.68, p = .50$.

Probe discrimination latencies were filtered to exclude outlying latencies using the same approach used in Experiment 1. This approach first eliminated all latencies that exceeded 2000 ms, then eliminated any remaining latencies that, for each participant, fell more than 1.96 standard deviations from their mean latency under each experimental condition. This resulted in 2.54% of probe discrimination latencies being excluded.

**Assessment of Anxiety-linked Impairment in Attentional Control**

Analyses next assessed whether the attentional assessment task was sensitive to anxiety-linked impairment in attentional control. A summary of probe discrimination
latencies for each condition in the *attentional control assessment subtask*, for each trait anxiety group, can be seen in Table 3.1.

Table 3.1. *Mean and standard deviation of probe discrimination latencies, in milliseconds, under each level of Probe Congruency in the attentional control assessment subtask, for each level of Trait Anxiety Group; M(SD).*

<table>
<thead>
<tr>
<th>Probe Congruency</th>
<th>Trait Anxiety Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Trait Anxiety</td>
</tr>
<tr>
<td>Congruent with instruction</td>
<td>660.91 (125.89)</td>
</tr>
<tr>
<td>Incongruent with instruction</td>
<td>865.87 (138.58)</td>
</tr>
</tbody>
</table>

These data were subject to a mixed-design ANOVA that considered the within-groups factor Probe Congruency (congruent with instruction, incongruent with instruction), and the between-groups factor Trait Anxiety Group (high trait anxiety, low trait anxiety). As described earlier, the presence of anxiety-linked impairment in attentional control would predict the occurrence of a two-way interaction involving Probe Congruency and Trait Anxiety Group in the present analysis. This two-way interaction effect would reveal that the degree to which participants were speeded to discriminate probes presented in the location they were instructed to attend, relative to probes presented in the location they were not instructed to attend, was attenuated in the high trait anxiety group as compared to the low trait anxiety group.

The analysis revealed a significant main effect of Probe Congruency, $F(1, 68) = 246.22, p < .001, \eta_p^2 = .78$, revealing that, in general, participants were faster to discriminate probes that were located congruent with attentional control instructions ($M = 648.98$), compared to probes that were located incongruent with attentional control instructions ($M = 865.68$). This result confirmed that across participants there was a general capacity to move attention to the location directed by the attentional control.
instructions employed in the task.

As described earlier, if it is the case that the attentional assessment task was sensitive to anxiety-linked impairment in attentional control, then the main effect of Probe Congruency should be attenuated in the high trait anxiety group compared to the low trait anxiety group, giving rise to a two-way interaction effect involving Probe Congruency and Trait Anxiety Group. However, this effect was not observed to be significant, $F(1, 68) = .72, p = .40, \eta^2_p = .011$, indicating that the aforementioned main effect was not attenuated across trait anxiety groups. Thus, this result provided no evidence of anxiety-linked impairment in attentional control. No other effects reached significance in the analysis.

Correlational analysis of data obtained from this subtask was also verified that heightened levels of anxiety vulnerability were not associated with impaired attentional control. To enable this assessment an index of attentional control was computed. This Attentional Control Index (ACI) reflected the degree to which participants were speeded to discriminate probes presented in the location they were instructed to attend, relative to probes presented in the location they were not instructed to attend. Thus, increasing values on this index represent greater attentional control. This analysis did not reveal an association between STAI-T scores and ACI scores $r(68) = .11, p = .81^2$, indicating that the present experiment did not detect anxiety-linked impairment in attentional control.

\[1\] This ANOVA analysis was repeated to include a factor reflecting the emotional valence of the representational image. The analysis did not reveal any effect of this factor upon effects reported above.

\[2\] $r_d(68) = .13, p = .85$
Assessment of Anxiety-linked Heightened Selective Attention to Negative Information

Analysis next assessed whether the attentional assessment task was sensitive to anxiety-linked heightened selective attention to negative information. A summary of probe discrimination latencies for each condition in the selective attention to negative information assessment subtask, for each trait anxiety group, can be seen in Table 3.2.

Table 3.2. Mean and standard deviation of probe discrimination latencies, in milliseconds, under each level of Valence and Probe Location in the selective attention to negative information assessment subtask, for each level of Trait Anxiety Group; M(SD).

<table>
<thead>
<tr>
<th>Representational Image Valence</th>
<th>Probe Location</th>
<th>Low Trait Anxiety</th>
<th>High Trait Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>Representational Image</td>
<td>764.36 (154.12)</td>
<td>711.01 (79.57)</td>
</tr>
<tr>
<td></td>
<td>Abstract Image</td>
<td>745.77 (122.30)</td>
<td>751.20 (111.74)</td>
</tr>
<tr>
<td>Positive</td>
<td>Representational Image</td>
<td>693.17 (107.81)</td>
<td>710.12 (102.36)</td>
</tr>
<tr>
<td></td>
<td>Abstract Image</td>
<td>757.83 (141.43)</td>
<td>722.15 (87.46)</td>
</tr>
</tbody>
</table>

These data were subject to a mixed-design ANOVA that that considered the within-groups factor Probe Location (representational image, abstract image) and Representational Image Valence (negative, positive), and the between-groups factor Trait Anxiety Group (high trait anxiety, low trait anxiety). The presence of anxiety-linked heightened selective attention to negative information would give rise to a three-way interaction involving Representational Image Valence, Probe Location, and Trait Anxiety Group in the present analysis. Specifically, this three-way interaction effect would reflect the fact that the high anxiety group, as compared to the low trait anxiety group, would to show disproportionate speeding to discriminate probes in the location.
of the representational image relative to the abstract image, when the representational image was negatively valenced rather than positively valenced.

The analyses revealed a significant main effect of Valence, $F(1, 68) = 34.80, p < .001, \eta^2_p = .34$, such that probe discrimination latencies were longer when representational images were negatively valenced ($M = 743.09$) relative to positively valenced ($M = 720.82$). This finding suggests that generally participants experienced a delay in attentional processing in response to the presence of negatively valenced information during the task. There was also a significant main effect of Probe Location, $F(1, 68) = 13.00, p = .001, \eta^2_p = .16$, that indicated participants had shorter probe discrimination latencies when probes replaced representational images ($M = 719.67$) compared to abstract images ($M = 744.24$). This result indicated that generally participants showed a preference to attend to the location of representing images, over abstract images. Importantly, the three-way interaction effect involving Representational Image Valence, Probe Location, and Trait Anxiety Group was observed to be significant, $F(1, 68) = 4.72, p = .033, \eta^2_p = .07$, indicating the potential detection of an anxiety-linked heightened selective attention to negative information. No other significant effects were observed in this analysis.

In order to investigate whether the nature of the significant three-way interaction effect was consistent with the presence of anxiety-linked heightened selective attention to negative information, two indices were computed for each participant. These indices reflected the degree to which attention was selectively allocated to representational images, for each level of the Representational Image Valence factor. Higher scores reflected greater attention to the representational member of the image pair, for each valence condition. Scores on these indices, for each trait anxiety group, are shown in Figure 3.2.
As can be seen in Figure 3.2, the significant interaction effect reflected the fact that the high trait anxiety group showed greater speeding to discriminate probes in the location of representational images, when representational images were negatively valenced ($M = 40.19$) compared to when they were positively valenced ($M = 12.03$). In contrast the low trait anxiety group demonstrated speeding to discriminate probes in the location of representational images, when these images were positively valenced ($M = 64.66$), compared to when they were negatively valenced ($M = -18.58$).

Correlational analysis of data obtained from this subtask was also used assess whether heightened levels of trait anxiety were associated with heightened selective attention to negative information. To enable this assessment an index of selective attention to negative information was computed. This Attention to Negative Information Index (ANII) reflected the degree to which speeding to discriminate probes in the location of representational images, compared to probes in the location of the abstract images, was greater when representational images were negatively valenced compared
to positively valenced. Increasing values on this index represent greater selective attention to negative information. The results of this analysis confirmed a significant positive correlation between STAI-T scores and ANII scores, $r(68) = .31, p = .004^3$, thus indicating that trait anxiety was associated with increased selective attention to negative information in the present experiment.

**Assessment of Mediation Models**

Statistical analysis next examined the validity of each of the meditational models of interest to the research programme. These analyses utilised the same statistical approach as employed in Experiment 1. One analysis tested whether attentional control mediated the relationship between anxiety vulnerability and selective attention to negative information, thereby testing the validity of the attentional control mediator model. A second analysis tested whether selective attention to negative information mediated the relationship between anxiety vulnerability and attentional control thereby testing the validity of the selective attention mediator model. Lastly, the *non-mediational associations model* supposes that neither of these effects would be supported by the analyses, thus a failure of each of these analyses to find evidence of mediation would support the validity of this model.

Analysis first assessed the *attentional control mediator model*, which proposes that attentional control mediates the relationship between anxiety vulnerability and selective attention to negative information. In order to test the validity of the mediating pathway of this model the analysis examined whether the association between STAI-T scores and Attention to Negative Information Index scores was mediated by Attentional Control Index scores. This test was achieved by computing a bias-corrected bootstrapped confidence interval based on 10,000 samples for the effect of the

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$^3 r_{d}(68) = .36, p = .001$
mediating pathway in the model (ab, b = -0.002). The computed confidence interval for the mediating pathway contained zero within its range (95% CI; -0.01 to 0.001), providing no evidence that Attentional Control Index scores mediated the relationship between STAI-T scores and Attention to Negative Information Index scores. Hence, the result of this mediation analysis provided no support for the validity of the attentional control mediator model.

Analysis next tested the validity of the selective attention mediator model. This model proposes that selective attention to negative information mediates the relationship between anxiety vulnerability and attentional control. To test the validity of the mediating pathway proposed by this model the analysis examined whether the association between STAI-T scores and Attentional Control Index scores was statistically mediated by Attention to Negative Information Index scores. This was achieved by computing a bias-corrected bootstrapped confidence interval based on 10,000 samples for the effect of the mediating pathway in the model (ab, b = -0.006). The computed confidence interval contained zero within its range (95% CI; -0.02 to 0.007), revealing no evidence that Attention to Negative Information Index scores mediated the association between STAI-T scores and Attentional Control Index scores. Therefore, the mediation analysis provided no support for the validity of the selective attention mediator model.

**Discussion**

The purpose of the present experiment was once again to discriminate the validity of three specific alternative models concerning the relationship between attentional control, selective attention to negative information and anxiety vulnerability. The present experiment employed a methodology closely similar to the methodology of Experiment 1, but introduced novel attentional control instructions designed to promote
the processing of the emotional content of images during the attentional assessment task.

Importantly the present experiment proved sensitive to anxiety-linked heightened selective attention to negative information, with analyses revealing that high trait anxious participants, compared to low trait anxious participants, showed greater attention to the location of negatively valenced images, than to the location of positively valenced images. This finding is consistent with the expectation drawn from the literature, and supports the existence of anxiety-linked heightened selective attention to negative information (Bar-Haim et al., 2007). This finding also reveals that the modification adopted by the present experiment was effective at influencing the processing of emotional content of images in a way that allowed greater capability to detect his anxiety-linked effect, as intended.

However, in contrast to Experiment 1 and inconsistent with expectations based on the wider literature concerning anxiety-linked impairment in attentional control (Eysenck et al., 2007), the present experiment did not detect anxiety-linked impairment in attentional control. Participants high in anxiety vulnerability, compared to low in anxiety vulnerability, showed no difference in the degree to which greater attention was allocated to the location of images they were instructed to attend to, relative to the location of images they were not instructed to attend to. These findings have methodological implications that will be considered shortly.

Tests of statistical mediation did not support the validity of the pattern of mediational effects predicted by the attentional control mediator model or the selective attention mediator model. Thus, the present experiment again provided no support for the validity either of the mediational models under test. However, once again the present findings do not challenge validity of the non-mediational associations model, which does describe attentional control, selective attention to negative information, and
anxiety vulnerability as holding either of the mediational relationships under test. The findings of the present experiment therefore provide a further challenge to the validity of the two mediational models proposed by the present research programme, but do not challenge the validity of the non-mediational associations model.

While Experiment 1 obtained evidence of anxiety-linked impairment in attentional control, but not anxiety-linked heightened selective attention to negative information, the present experiment obtained evidence of anxiety-linked heightened selective attention to negative information, but not anxiety-linked impairment in attentional control. In the present experiment, this failure to detect anxiety-linked impairment in attentional control raises the concern that the present methodology may have been insensitive to detecting the anxiety-linked effect. Importantly, if this were the case then the conditions under which tests of mediational models were conducted would be not be ideally suited for the verification of the validity of the alternative models. Given this concern it would be premature to completely disregard the possibility that anxiety vulnerability, attentional control, and selective attention to negative information share one of the proposed mediational relationships. Thus, it is important to consider how the design of the present experiment may have been insensitive to detecting anxiety-linked impairment in attentional control so as to inform the development of subsequent experiments.

The methodologies of the present and previous experiment differed only in the nature of the attentional control instructions presented during the assessment of attentional control. Thus, it is highly plausible that the inconsistent pattern of findings between the present experiment and the previous experiment resulted from this differences in attentional control instructions used in the attentional assessment subtask. One feature of the attentional control instructions used in the present experiment that may have limited their capacity to reveal anxiety-linked impairment in attentional
control, is their heightened complexity relative to the attentional control instruction used in Experiment 1. Specifically, in order to identify the attentional objective conveyed by attentional control instructions in Experiment 1, participants were required to categorise images based on their representational or abstract content prior to moving attention to the instructed location. Conversely to identify the attentional objective conveyed by attentional control instructions in the present instructions, participants were required to engage in two stages of processing that involved initially categorising images based upon their representational or abstract content, in order to locate the representational image, before then categorising the emotional content of the representational image. If it were the case that participants generally found identification of the attentional objective delivered by these attentional control instructions more difficult, this could have ultimately resulted in heightened variability of probe latencies within and across participants, thereby reducing the capacity of the task to detect individual differences in probe discrimination latencies reflecting the accomplishment of the attentional objectives delivered by the attentional control instructions. It is also possible that individual differences in the ability of participants to categorise the emotional content of representational images may have ultimately heightened variation in probe decimation latencies, also reducing the capacity of the task to detect individual differences in the accomplishment of the attentional objectives.

The findings of the present and previous experiment suggest that the attentional control instructions employed in each experiment may differentially suited to supporting the detection of anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information. This raises the possibility that a methodology that incorporates both types of attentional control instruction may be able to simultaneously detect each anxiety-linked effect. Experiment 3 therefore considered a methodology that incorporated both types of attentional control.
instructions, with the objective of obtaining both anxiety-linked attentional effects, and testing the validity of the alternative models proposed by the research programme.
Chapter 4: Experiment 3

The two experiments conducted in the research programme thus far have been differentially capable of detecting anxiety-linked impairment in attentional control, and anxiety-linked heightened selective attention to negative information. The attentional assessment task employed in Experiment 1 proved capable of detecting anxiety-linked impairment in attentional control, but not anxiety-linked heightened selective attention to negative information. Conversely the attentional assessment task employed in Experiment 2 proved capable of detecting anxiety-linked heightened selective attention to negative information, but not anxiety-linked impairment in attentional control. The finding that the approach taken in each attentional assessment task rendered them differentially capable of detecting anxiety-linked differences in attentional control, and in selective attention to negative information, suggests the possibility that an attentional assessment task that combines both approaches may be capable of detecting both anxiety-linked differences in attentional processing. Specifically, this would include both the attentional control instructions employed in Experiment 1 and the attentional control instructions employed in Experiment 2. Importantly, the purpose of melding these two designs was not to reduce the complexity of attentional instructions employed in Experiment 2, or to heighten the capacity of instructions employed in Experiment 1 to reveal selective attention, but rather was to present these instructions alongside each other, such that anxiety-linked differences in attentional control and selective attention to negative information could be observed within a single task.

In order for attentional control assessment trials that promote the processing of the emotional content of images to yield its intended influence upon attentional responding to emotional information, such trials should be presented proximal to trials that assess selective attention to negative information. A design that interchanges the type of attentional control instruction across each block of trials assessing attentional control
will result in this requirement being differentially true for each block of trials assessing selective attention to negative information. Thus, such a design would be problematic. Therefore, the present design intermixed each type of attentional control instruction within each block of trials assessing attentional control, ensuring that each block of trials assessing selective attention to negative information were equally proximal to trials that promote the processing of the emotional content of images.

As in the preceding experiments, the aim of Experiment 3 was to discriminate the validity of the three alternative models describing the relationship between attentional control, selective attention to negative information, and anxiety vulnerability, that are the focus of the research programme. To achieve this aim Experiment 3 adopted a design that interleaved both types of attentional control instructions used respectively in Experiment 1 and Experiment 2. As the intention in Experiment 3 was the same as in previous experiments, the statistical procedures remained unchanged. Once again, analyses first determined whether an anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information were evident. After this, mediational analyses were conducted to test the validity of the three models of interest to the research programme.

Method

Participants

Seventy-two university undergraduate psychology students were recruited to participate in the experiment. Identical to previous experiments in the research programme, the aim of participant selection was to create two groups of participants that would differ in level of anxiety vulnerability during the experimental session. Participants were recruited based on scores obtained from the trait scale of the Spielberger State-Trait Anxiety Inventory (STAI-T) questionnaire completed earlier in the teaching semester by a large cohort of psychology students (N = 672). Participants
were drawn from the bottom third (STAI-T score of 36 or below) and top third of scores (STAI-T score 45 or above), using the same tertile cut-offs as determined in the preceding experiments. Individuals who had previously participated in an experiment in the research programme were not recruited.

Those participants drawn from the bottom third of STAI-T scores (n = 36, 18 males; \( M_{\text{age}} = 18.67, SD_{\text{age}} = 1.85; M_{\text{STAI-T}} = 29.89, SD_{\text{STAI-T}} = 4.54 \) range = 20 to 36) were labelled as the low trait anxiety group. Those participants drawn from the top third of STAI-T scores (n = 36, 16 males; \( M_{\text{age}} = 18.47, SD_{\text{age}} = 1.65; M_{\text{STAI-T}} = 51.28, SD_{\text{STAI-T}} = 4.77, \) range = 45 to 60) were labelled the high trait anxiety group. This gave rise to a between-groups factor of Trait Anxiety Group (high trait anxiety, low trait anxiety). Analysis confirmed that the two groups did not significantly differ in age, \( t(70) = .47, p = .64, \) or gender ratio, \( \chi^2(1, N = 72) = .22, p = .64, \) but did significantly differ in STAI-T scores, \( t(70) = 19.50, p < .001, \) as expected.

Materials

Spielberger State-Trait Anxiety Inventory. As in previous experiments in the research programme, the trait anxiety scale of the Spielberger State-Trait Anxiety Inventory (STAI-T; Spielberger, 1983) was used to assess anxiety vulnerability.

Apparatus. The same apparatus used in previous experiments in the research programme were used for the delivery of the attentional assessment task in the present experiment.

Attentional assessment task stimuli. The same images selected for use in previous experiments were selected for use in the attentional assessment task in the present experiment. This set of images was once more referred to as the attentional assessment image set. As detailed previously, this set was comprised of 256 emotionally valenced representational images, including 128 negatively valenced images and 128 positively valenced images, as well as 256 non-representational abstract images.
Additionally, the same practice image set that was used in previous experiments was used in the present experiment for an initial practice task.

**Attentional assessment task.** The attentional assessment task contained 384 trials. The task consisted of two subtasks, one designed to measure attentional control, the *attentional control assessment subtask*, and the other designed to measure selective attention to negative information, the *selective attention to negative information assessment subtask*.

The *selective attention to negative information assessment subtask* was identical to those subtasks used to measure selective attention in previous experiments. Thus, the subtask delivered 128 trials across four blocks.

Although closely matching the preceding experiments, the *attentional control assessment subtask* now mixed together trials that employed each of the two types of instructions respectively employed in Experiment 1 and Experiment 2. Thus, on half of the trial these attentional control instructions did not require the classification of the emotional content of images, and on the other half of trials the attentional control instructions did require classification of the emotional content of images. To ensure sufficient methodological power to detect each type of trial was presented the same number of times as in the two previous experiments. Thus, each type of attentional control instruction was employed across 128 trials.

Trial blocks were alternated between subtasks, and were counterbalanced across participants such that half of participants were first assessed on the *attentional control assessment subtask*, and half of participants were first assessed on the *selective attention to negative information assessment subtask*. The structure of trials common to each subtask will be now be described, followed by a description of critical differences in the structure of trials between subtasks.
Trial features common to subtasks. Trial features that were common across subtasks were identical to previous experiments in the research programme. Specifically, trials in each subtask began with a cue in the centre of the screen. Participants were then required to press to space-bar key when ready to progress the trial. When the space-bar key was pressed the cue was cleared and an image pair comprising one representational image and one abstract image was presented. Across trials the representational image was negatively valenced or positively valenced with equal frequency. Each image was presented 85 mm x 85 mm in size, and subtended a visual angle of 8° x 8°, at a viewing distance of 60 cm. One image of the image pair was presented on the left side of the screen with its right edge 25 mm from the centre of the screen, and the other image was presented on the right side of the screen with its left edge 25 mm from the centre of the screen. Thus the visual angle between the centres of each image was 12.82° at a viewing distance of 60 cm. The representational image appeared in the left or right location with equal frequency. After 1000 ms the image pair was removed from screen and a probe appeared in either the left or right location with equal frequency. This probe comprised two red dots diagonally aligned, with the top dot offset slightly to the left or right of the bottom dot. Participants were required to quickly indicate the identity of the probe by pressing the left mouse button if the top dot was offset to the left, or the right mouse button if the top dot was offset to the right. If participants correctly discriminated the identity of the probe, then the screen was cleared and the next trial commenced after a 1000 ms inter-trial interval. If participants made an incorrect response to the probe by pressing the wrong mouse button an on-screen message (“ERROR TRIGGERED DELAY”) was presented for five seconds before the next trial commenced after a 1000 ms delay. On each trial, the latency to discriminate the probe (as well as the accuracy of probe discrimination) was recorded.
As probe discrimination latencies can only provide an indication of attentional distribution when probes are correctly discriminated, only probe discrimination latencies resulting from such trials were employed to compute mean latencies. Additionally, a participant inclusion criterion was adopted that required 90% accuracy, or greater, on probe discrimination judgements in the attentional assessment task, for a participant’s mean response latencies to be included in analyses.

**Trial features specific to the attentional control assessment subtask.** Trials in this subtask employed both types of attentional control instructions that were used in each of the two preceding experiments. Half of trials displayed cues presenting attentional control instructions identical to those used in Experiment 1, which directed attention in ways that required the classification of images on the basis of their representational or abstract characteristics. The other half of trials displayed cues presenting attentional control instructions identical to those used in Experiment 2, which directed attention in ways that required the classification of images on the basis of their emotional content. This gave rise to a within-groups factor of Image Classification Required (representational-status, emotional-status). Probes could appear in either location across trials, and compliance with attentional control instructions was encouraged by presenting probes in the location congruent with the image participants were instructed to attend to in 75% of trials, and in the incongruent opposite location in the remaining 25% of trials. This gave rise to a within-groups factor of Probe Congruency (congruent with instruction, incongruent with instruction).

As with the preceding experiments, if it were the case that heightened trait anxiety was associated with reduced attentional control during this task, then this would be revealed by a two-way interaction between Probe Congruency and Trait Anxiety Group. This interaction effect would reveal that the degree to which participants were speeded
to discriminate probes in the location they were instructed to attend was attenuated amongst high trait anxious participants, as compared to low trait anxious participants.

**Trial features specific to the selective attention to negative information assessment subtask.** Trial features specific to this subtask were identical to those features of previous experiments in the research programme. As in previous experiments, these trials employed a cue consisting of two strings of question marks (“?? ??”) which communicate no attentional objective. The representational image was negatively valenced or positively valenced with equal frequency across trials, giving rise to a within-groups factor of Representational Image Valence (negative, positive). As probes were presented in the either image location with equal frequency, this gave rise to a within-groups factor of Probe Location (representational image, abstract image).

As in the preceding experiments, in this subtask anxiety-linked selective attention to negative information would be revealed by a three-way interaction involving Representational Image Valence, Probe Location, and Trait Anxiety Group. Such an interaction effect would reveal the high trait anxiety group to be disproportionately speeded, compared to the low trait anxiety group, to discriminate probes in the location of the representational image relative to the abstract image, when the representational image was negatively valenced relative to positively valenced.

**Allocation of images to subtasks.** In the present experiment the attentional assessment task employed images from the attentional assessment image set described earlier. Images were allocated to subtasks randomly for each participant, with the constraint that half of the positive representational image subset, half of the negative representational image subset, and half of the abstract image set was allocated to each subtask. Within each subtask image pairs were randomly generated and these pairs were allocated randomly to trial conditions. Importantly, each image allocated to the
**attentional control assessment subtask** was assigned to be presented once during under conditions that presented emotional-status instructions, and once under conditions that presented attentional control instructions that required classification of images based on their representational status.

**Procedure**

The procedure of the present experiment was identical to that followed in previous experiments in the research programme. Participants were first provided with an information sheet and consent form. Next, participants completed the STAI-T questionnaire. Participants were then seated at the computer at a distance 60 cm and verbally instructed by the experimenter about the requirements of the attentional assessment task. Participants were told that some trials would present attentional control instructions, while other trials would not. They were further told that on trials in which no attentional control instruction was given probes would appear with equal probability in either image location. For those trials in which an attentional control instruction was given they were told to comply with the instruction as accurately as possible as probes would most often appear in the location of the image they had been instructed to attend to. Participants were told to indicate the orientation of each probe by pressing the appropriate response button as quickly as possible, whilst maintaining a high level of accuracy. The experimental task was preceded by a short practice version of the task that exposed participants to all possible conditions, and employing images from the practice image set described earlier. Participants then completed the attentional assessment task, and were subsequently debriefed.

**Results**

To confirm that participants allocated to the two trait anxiety groups continued to differ in trait anxiety at the time of the experimental session, a *t*-test was conducted to compare trait anxiety scores obtained in the experimental session between the trait
anxiety groups. As required, the STAI-T scores of participants in the High Trait Anxiety Group ($M = 50.83, SD = 7.30$) were higher than STAI-T scores of participants in the Low Trait Anxiety Group ($M = 31.14, SD = 6.46$), $t(70) = 12.13, p < .001$. This confirmed that the trait anxiety groups continued to differ in level of trait anxiety at the time of the experiment as intended.

Next, statistical analyses examined whether the current attentional assessment task was capable of revealing evidence of anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information, before then examining the validity of the hypothesised models; the *attentional control mediator model*, the *selective attention mediator model*, and the *non-mediational associations model*.

**Preparation of probe discrimination latency data**

All participants met the 90% probe discrimination accuracy criterion and so no participants were excluded from statistical analyses. The mean accuracy of participants was 97.03% ($SD = 1.89$, range = 90.89% to 99.74%), and did not differ between trait anxiety groups, $t(70) = .21, p = .83$.

Probe discrimination latencies were filtered to exclude outlying latencies using the same approach used in previous experiments in the research programme. Specifically, this approach first eliminated all latencies that exceeded 2000 ms, then eliminated any remaining latencies that, for each participant, fell more than 1.96 standard deviations from their mean latency under each experimental condition. This resulted in 2.97% of probe discrimination latencies being excluded.

**Assessment of Anxiety-linked Impairment in Attentional Control**

Analysis next assessed whether the attentional assessment task was sensitive to anxiety-linked impairment in attentional control. A summary of probe discrimination
latencies for each condition in the *attentional control assessment subtask*, for each trait anxiety group, can be seen in Table 4.1.

Table 4.1. *Mean and standard deviation of probe discrimination latencies, in milliseconds, under each level of Image Classification Required and Probe Congruency in the attentional control assessment subtask, for each level of Trait Anxiety Group: M(SD).*

<table>
<thead>
<tr>
<th>Image Classification Required</th>
<th>Probe Congruency</th>
<th>Low Trait Anxiety</th>
<th>High Trait Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M(SD)</td>
<td>M(SD)</td>
</tr>
<tr>
<td>Representational-status</td>
<td>Congruent with instruction</td>
<td>557.54 (56.97)</td>
<td>624.63 (121.26)</td>
</tr>
<tr>
<td></td>
<td>Incongruent with instruction</td>
<td>778.91 (92.02)</td>
<td>829.17 (135.35)</td>
</tr>
<tr>
<td>Emotional-status</td>
<td>Congruent with instruction</td>
<td>575.75 (66.88)</td>
<td>659.73 (141.93)</td>
</tr>
<tr>
<td></td>
<td>Incongruent with instruction</td>
<td>761.53 (91.60)</td>
<td>805.27 (131.76)</td>
</tr>
</tbody>
</table>

These data were subject to a mixed-design ANOVA that considered the within-groups factors Probe Congruency (congruent with instruction, incongruent with instruction) and Image Classification Required (representational-status, emotional-status), and the between-groups factor Trait Anxiety Group (high trait anxiety, low trait anxiety). The presence of anxiety-linked impairment in attentional control would result in the occurrence of a two-way interaction involving Probe Congruency and Trait Anxiety Group in the present analysis. This two-way interaction effect would reflect the fact that the degree to which participants were speeded to discriminate probes presented in the location they were instructed to attend, relative to probes presented in the location they were not instructed to attend, was attenuated in the high trait anxiety group as compared to the low trait anxiety group.
This analysis revealed a significant main effect of Trait Anxiety Group, $F(1, 70) = 7.32, p = .009, \eta_p^2 = .10$, revealing that, in general, participants in the high trait anxiety group ($M = 729.69$) showed longer probe discrimination latencies than participants in the low trait anxiety group ($M = 668.43$). The analysis also revealed a significant main effect of Probe Congruency, $F(1, 70) = 290.46, p < .001, \eta_p^2 = .81$, reflecting the fact that participants were generally faster to discriminate probes located congruent with attentional control instructions ($M = 604.41$) compared to probes located in the opposite location ($M = 793.72$). This result confirmed that across participants there was a general capacity to move attention to the location indicated by the attentional control instructions employed in the task.

As predicted, this main effect was subsumed within a two-way interaction effect involving Probe Congruency and Image Classification Required, $F(1, 70) = 49.15, p < .001, \eta_p^2 = .41$. This effect reflected the fact that participants were more capable of moving attention in the manner required by attentional control instructions when these instructions required the classification of images based upon their emotional status, as compared to their representational status. Reassuringly however, when the simple main effect of Probe Congruency was examined under each level of Image Classification Required, this simple main effect remained significant under both conditions (emotional-status, $F(1, 70) = 345.72, p < .001, \eta_p^2 = .78$; representational-status, $F(1, 70) = 287.34, p < .001, \eta_p^2 = .80$), thereby indicating that participants were generally able to move attention to the location indicated by each type of attentional control instructions.

As detailed prior, if it is the case that the attentional assessment task was sensitive to anxiety-linked impairment in attentional control, then it would be expected that this analysis would reveal an interaction effect involving Probe Congruency and Trait Anxiety Group. While this two-way interaction was not significant, $F(1, 70) = .52, p = \ldots$
.47, η² < .01, the analysis did reveal a trend towards a significant three-way interaction effect that involved Probe Congruency, Trait Anxiety Group, and Image Classification Required, \(F(1, 70) = 3.01, p = .087, \eta^2 = .04\). No other effects were observed in this analysis.

While recognising the caution needed when interpreting effects that fall outside of conventional level of statistical significance it was thought appropriate to investigate the nature of this three-way interaction. To do so, the simple two-way interaction involving Probe Congruency and Trait Anxiety Group was analysed under each level of the Image Classification Required factor. Under the “representation-status” level the simple two-way interaction did not approach significance, \(F(1, 70) = .45, p = .51, \eta^2 = .01\). Hence, there was no evidence of anxiety-linked impairment in attentional control in the present experiment when this type of attentional control instruction was employed. Under the “emotional-status” level the simple two-way interaction of Probe Congruency and Trait Anxiety Group did approach significance, \(F(1, 70) = 3.63, p = .061, \eta^2 = .05\). The pattern of this simple two-way interaction can be seen in Figure 4.1.

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11 This ANOVA analysis was repeated to include a factor reflecting the emotional valence of the representational image. The analysis did not reveal any effect of this factor upon effects reported above.
Figure 4.1. Probe discrimination latencies for probes in instruction congruent and instruction incongruent locations, for trials that presented emotional-status attentional control instructions in the attentional control assessment subtask, for each trait anxiety group. Bars represent standard error.

The effect revealed that high trait anxious participants showed an attenuated degree of speeding to identify probes that were located congruent with attentional control instructions relative to probes located incongruent with attentional control instructions (congruent: $M = 659.73$ ms; incongruent: $M = 805.27$ ms; speeding = 145.54 ms) relative to the low trait anxiety group (congruent: $M = 575.75$ ms; incongruent: $M = 761.53$ ms; speeding = 185.78 ms). This is consistent with anxiety-linked impairment in attentional control being present across trials that employed attentional control instructions requiring the classification of images based on their emotional-status, but not trials that employed attentional control instructions requiring the classification of images based on their representational-status.

Correlational analysis of data obtained during the experimental session was also used to assess whether heightened levels of anxiety vulnerability were associated with impaired attentional control under each level of Image Classification Required. To enable this assessment, the same index of attentional control computed in preceding experiments was computed separately for trials under each level of the Image
Classification Required factor, as well as across the Image Classification Required factor. In each case, this Attentional Control Index (ACI) reflected the degree to which participants were speeded to discriminate probes presented in the location they were instructed to attend, relative to probes presented in the location they were not instructed to attend. Therefore, for each index higher values represented greater attentional control. Consistent with the results of the ANOVA analyses, an association was not evident across both levels of the Image Classification Required factor, \( r(70) = -0.15, p = .11^2 \), or for trials under the “representational-status” level of the Image Classification Required factor, \( r(70) = -0.11, p = .18^3 \). However, correlational analysis did reveal a trend towards a negative correlation between STAI-T scores and attentional control index scores for trials under the “emotional-status” level of the Image Classification Required factor, \( r(70) = -0.18, p = .069^4 \). These results indicated that the attentional assessment task was sensitive to anxiety-linked impairment in attentional control, though only under conditions that employed attentional control instructions that required the classification of images on the basis of their emotional status.

**Assessment of Anxiety-linked Heightened Selective Attention to Negative Information**

Analysis next assessed whether the present attentional assessment task was capable of detecting anxiety-linked heightened selective attention to negative information. A summary of probe discrimination latencies for each condition in the selective attention to negative information assessment subtask, for each trait anxiety group, is provided in Table 4.2. These data were subject to a mixed-design ANOVA that that considered the within-groups factors Probe Location (representational image,
abstract image) and Representational Image Valence (negative, positive), and the between-groups factor Trait Anxiety Group (high trait anxiety, low trait anxiety).

Table 4.2. *Mean and standard deviation of probe discrimination latencies, in milliseconds, under each level of Valence and Probe Location in the selective attention to negative information assessment subtask, for each level of Trait Anxiety Group; M(SD).*

<table>
<thead>
<tr>
<th>Valence</th>
<th>Probe Location</th>
<th>Low Trait Anxiety</th>
<th>High Trait Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>Representational Image</td>
<td>649.08 (61.74)</td>
<td>681.83 (98.41)</td>
</tr>
<tr>
<td></td>
<td>Abstract Image</td>
<td>647.35 (77.50)</td>
<td>697.84 (96.15)</td>
</tr>
<tr>
<td>Positive</td>
<td>Representational Image</td>
<td>640.67 (66.22)</td>
<td>681.15 (96.24)</td>
</tr>
<tr>
<td></td>
<td>Abstract Image</td>
<td>656.19 (60.40)</td>
<td>685.15 (88.34)</td>
</tr>
</tbody>
</table>

As in previous experiments, the presence of anxiety-linked heightened selective attention to negative information give rise to a three-way interaction involving Valence, Probe Location, and Trait Anxiety Group in the present analysis. Specifically, this three-way interaction effect would reflect the fact that the high anxiety group, as compared to the low trait anxiety group, would to show disproportionate speeding to discriminate probes in the location of the representational image relative to the abstract image, when the representational image was negatively valenced rather than positively valenced.

The analysis revealed a significant main effect of Trait Anxiety Group, $F(1, 70) = 4.60, p = .035, \eta_p^2 = .06$, reflecting the fact that the low trait anxiety group ($M = 648.32$) generally showed shorter probe discrimination latencies compared to the high trait anxiety group ($M = 686.49$). The only other effect to emerge from the analysis was a trend towards the predicted three-way interaction involving Representational Image Valence, Probe Location, and Trait Anxiety Group, $F(1, 70) = 3.09, p = .083, \eta_p^2 = .04$. While once again recognising the caution needed when interpreting effects that fall
outside of conventional level of statistical significance, as this three-way interaction
effect was predicted it was thought appropriate to investigate the nature of this
interaction.

In order to more clearly illustrate this interaction effect, index scores were
computed that reflected the degree to which participants were speeded to discriminate
probes in the location of representational images compared to abstract images across
image valence conditions. The pattern of these index scores, for each anxiety group, can
be seen in Figure 4.2.

![Figure 4.2](image)

*Figure 4.2. Speeding to discriminate probes in the location of representational
images, compared to abstract images, when representational images were negative
compared to positive in the *selective attention to negative information assessment
subtask*, for each trait anxiety group. Bars represent standard error.*

Consistent with the pattern that would indicate anxiety-linked heightened
selective attention to negative information, the interaction effect reflected the fact that
the high trait anxiety group were speeded to discriminate probes in the location of
representational images, compared to probes in the location of abstract images, when
representational images were negatively valenced (speeding; $M = 16.01$) compared to
when representational images were positively valenced (speeding; $M = 3.99$). In
contrast, the low trait anxiety group were speeded to discriminate probes in the location of representational images, compared to probes in the location of abstract images, when representational images were positively valenced (speeding; \( M = 15.53 \)) as compared to negatively valenced (speeding; \( M = -1.73 \)).

Correlational analysis of data obtained from the experimental session was also used to assess whether heightened levels of trait anxiety were associated with heightened selective attention to negative information. To enable this, an index of selective attention to negative information was computed. This Attention to Negative Information Index (ANII) reflected the degree to which speeding to discriminate probes in the location of representational images, compared to probes in the location of the abstract images, was greater when representational images were negatively valenced, compared to when they were positively valenced. Higher values on this index represented greater selective attention to negative information. In correspondence with the findings of the ANOVA analysis, the results of this correlational analysis revealed a trend towards a significant positive correlation between STAI-T scores and ANII scores, \( r(70) = .16, p = .09 \), suggesting that the present experiment may have been sensitive to anxiety-linked heightened selective attention to negative information.

**Assessment of Mediation Models**

While the evidence from the present attentional assessment task concerning anxiety-linked impairment in attentional control, and concerning anxiety-linked heightened selective attention to negative information, fell just outside of conventional levels of statistical significance, the fact that both effects were now present, albeit at trend levels, strengthens faith in the outcomes of the mediational analyses next employed to test the validity of the models of interest to the research programme. As in

\[ r_d(70) = .16, p = .096 \]
preceding experiments, mediational analyses first tested the validity of predictions
arising from the **attentional control mediator model**, before then testing the validity of
predictions arising from the **selective attention mediator model**.

Each analysis used Attention to Negative Information Index (ANII) scores as a
measure of selective attention to negative information, and STAI-T scores recorded
during the experimental session as a measure of anxiety vulnerability. Due to the fact
that attentional control was assessed under two types of attentional control instruction,
the predictions of each mediation model was tested using Attentional Control Index
(ACI) scores obtained under conditions that employed attentional control instructions
that required the classification of images on the basis of their emotional status, under
conditions that employed attentional control instructions that required the classification
of images on the basis of their representational status, as well as across both conditions.

The first analysis tested the validity of the **attentional control mediator model**.
This model proposes that attentional control mediates the relationship between anxiety
vulnerability and selective attention to negative information. In order to test the validity
of this model, the analysis examined whether the association between STAI-T scores
and Attention to Negative Information Index scores was mediated by Attentional
Control Index scores. This was done by computing a bias-corrected bootstrapped
confidence interval, based on 10,000 samples, for the effect of the mediating pathway in
the model.

First, this analysis was conducted using ACI scores computed across attentional
control assessment trials that employed attentional control instructions that required the
classification of images on the basis of their emotional status. The computed confidence
interval for the mediating pathway \((ab, b = 0.003)\) contained zero within its range (95% CI; -0.01 to 0.01), revealing no evidence that Attentional Control Index scores mediated
the relationship between STAI-T scores and Attention to Negative Information Index
scores. Next, this analysis was conducted using ACI scores computed across attentional control assessment trials that employed attentional control instructions that required the classification of images on the basis of their representational status. The computed confidence interval for the mediating pathway \((ab, b = 0.002)\) also contained zero within its range (95% CI; -0.01 to 0.01), providing no evidence that these Attentional Control Index scores mediated the relationship between STAI-T scores and Attention to Negative Information Index scores. Lastly, this analysis was conducted using ACI scores computed across all attentional control assessment trials. The computed confidence interval for the mediating pathway \((ab, b = 0.0)\) also contained zero within its range (95% CI; -0.01 to 0.01), providing no evidence that these Attentional Control Index scores mediated the relationship between STAI-T scores and Attention to Negative Information Index scores. Thus, in each case the result of the mediation analysis provided no support for the validity of the attentional control mediator model.

The next analysis tested the validity of the selective attention mediator model. This model proposes that selective attention to negative information mediates the relationship between anxiety vulnerability and attentional control. In order to test this model, the analysis examined whether the association between STAI-T scores and Attentional Control Index scores was mediated by Attention to Negative Information Index scores. This was done by computing a bias-corrected bootstrapped confidence interval based on 10,000 samples for the effect of the mediating pathway in the model.

First, this analysis was conducted using ACI scores computed across attentional control assessment trials that employed attentional control instructions that required the classification of images on the basis of their emotional status. The computed confidence interval for the mediating pathway \((ab, b = -0.01)\) contained zero within its range (95% CI; -0.01 to 0.01), revealing no evidence that Attention to Negative Information Index scores mediated the association between STAI-T scores and Attentional Control Index
scores. Next, this analysis was conducted using ACI scores computed across attentional control assessment trials that employed attentional control instructions that required the classification of images on the basis of their representational status. Again, the computed confidence interval for the mediating pathway \((ab, b = -0.01)\) contained zero within its range (95% CI; -0.01 to 0.01), providing no evidence that Attention to Negative Information Index scores mediated the association between STAI-T scores and these Attentional Control Index scores. Lastly, this analysis was conducted using ACI scores computed across all attentional control assessment trials. The computed confidence interval for the mediating pathway \((ab, b = 0.01)\) also contained zero within its range (95% CI; -0.01 to 0.01), once again providing no evidence that Attention to Negative Information Index scores mediated the association between STAI-T scores and Attentional Control Index scores. Hence, none of these mediation analyses provided support for the validity of the selective attention mediator model.

**Discussion**

The attentional assessment tasks in the two prior experiments in this research programme were differentially capable of revealing anxiety-linked impairment in attentional control, and anxiety-linked heightened selective attention to negative information. It was considered that this may have been due to the type of attentional control instructions used in attentional assessment tasks in each experiment. Hence, to simultaneously detect each anxiety-linked difference in attentional processing in the present experiment a methodology was developed that incorporated both types of attentional control instruction.

The present experiment obtained trend-level evidence of anxiety-linked heightened selective attention to negative information, suggesting that the attentional assessment task may have been sensitive to anxiety-linked differences in this attentional process. While this result reached only marginal levels of significance, and so
appropriate caution must be taken with respect to the interpretation of these effects, the nature of this finding is consistent with the pattern of findings reported in Experiment 2, as well as in the broader literature (Bar-Haim et al., 2007). This finding also consistent with the expectation that incorporating experimental conditions that require the classification of the emotional content of images would be conducive to the detection of this effect.

The present experiment also obtained trend-level evidence of anxiety-linked impairment in attentional control. This result corresponds with the findings of Experiment 1, as well as findings reported in the wider literature (Eysenck et al., 2007). Once again, as this result fell marginally outside the conventional level of significance, appropriate caution must be taken with respect to the interpretation of this effect. The detection of this effect occurred only under conditions that presented attentional control instructions that required the classification images with respect to their emotional content. No evidence of anxiety-linked impairment attentional control was detected under the attentional control instruction condition that required the classification images with respect to their representational status. Notably, this finding is contrary to the findings of the preceding two experiments, across which only the attentional control instructions that required the classification images with respect to their representational status were capable of detecting anxiety-linked impairment in attentional control. This inconsistency is cause for concern, but across all three experiments thus far in the research programme, the findings suggest that both types of attentional control instruction are capable of detecting this anxiety-linked effect, but do not always do so sensitively. This suggests that the failure of Experiment 2 to detect this effect may plausibly reflect something other than the attentional control instructions employed. This holds implications for how attentional control should be assessed in subsequent experiments in the research programme, which will be considered later in this section.
Examination of the alternative mediational models revealed no evidence that attentional control mediated the association between anxiety vulnerability and selective attention to negative information, and thereby provided no support for the validity of the *attentional control mediator model*. Such examination also revealed no evidence that selective attention to negative information mediated the association between anxiety vulnerability and attentional control, thereby providing no support for the *selective attention mediator model*. Once again these findings are most readily accommodated by the *non-mediational associations model*. Hence, the findings of the present experiment again provide no support for either mediational model under consideration, but do not challenge the validity of the *non-mediational associations model*.

The optimal conditions under which to test the validity of the models of interest to the research programme would be those that present significant evidence of anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information. Although such conditions are not necessary for such tests, because the results of the present experiment provide the closest instance of achieving these optimal conditions in the research programme thus far, this encourages consideration of potential implications that the present findings would have upon the wider literature in the event that had they been observed under the most optimal conditions.

One implication of these findings is that they support a theoretical account of anxiety-linked heightened selective attention to negative information and impaired attentional control that do not construe these effects to be functionally related. Hence, theorists seeking to describe the means by which these effects underpin anxiety vulnerability should regard them as functionally independent characteristics of anxiety vulnerability.
A second potential implication of the present findings concerns the attentional mechanisms that may underpin procedures designed to reduce selective attention to negative information (Hakamata et al., 2010), or designed to increase attentional control (Sportel, Nauta, de Hullu, de Jong, & Hartman, 2011; Susa, Pitică, Benga, & Miclea, 2012), in order to ameliorate heightened anxiety vulnerability. The present findings suggest that procedures training change in selective attention to negative information are not exerting impact upon anxiety vulnerability as a result of a mediated change in attentional control. Likewise, the present findings also suggest that procedures training change in attentional control are not exerting impact upon anxiety vulnerability as a result of a mediated change in selective attention to negative information. While evidence of either mediational model would suggest that training change in either attentional process may be equally effective at changing anxiety vulnerability, the present findings suggest that procedures that intend to change heightened anxiety vulnerability may do so most optimally by simultaneously targeting the modification of selective attention to negative information, and attentional control.

This chapter will now consider how the research programme may tailor the development of the attentional assessment task, so that significant evidence of anxiety-linked impairment in attentional control, and anxiety-linked heightened selective attention to negative information, may be simultaneously obtained, thereby yielding the optimal conditions under which to test to validity of the models of interest to the research programme. Two amendments that may result in a heightened capacity to detect anxiety-linked differences in selective attention, followed by an amendment that may result in a heightened capacity to detect anxiety-linked impairment in attentional control, will now be described.

Across the three experiments in the research programme the failure to detect anxiety-linked heightened selective attention to negative information has, so far,
occurred only when the attentional control assessment subtask has employed attentional control instructions that require classification of the non-emotional content of images. Arguably, it is possible that the interleaving of such instructions, with trials that assess selective attention, may have resulted in the adoption of a processing style that suppressed the processing of emotional information during the assessment of selective attention to negative information. This proposal is consistent with research suggesting that attentional assessment tasks that discourage classification of the emotional content of images do not observe individual differences in selective attentional responding to emotional information (Everaert et al., 2012; Spruyt et al., 2007). Hence, in order to heighten their sensitivity to anxiety-linked differences in selective attention to negative information future experiments in the research programme should ideally seek to ensure that attentional control instructions do not suppress the processing of emotional information, when interleaving the assessment of attentional control with selective attention to negative information.

An amendment to image pairs used in the attentional assessment task presents another potential means of increasing the capacity of the task to detect anxiety-linked heightened selective attention to negative information. Investigators examining attentional processing of representational and abstract information have revealed that during passive viewing representational images disproportionately attract greater levels of attentional processing relative to abstract images (Hindi Attar, Andersen, & Müller, 2010). Consistent with such findings, evidence of greater attention to representational images, compared to abstract images, was observed during the assessment of selective attention to negative information in Experiment 1 and Experiment 2 in the present research programme. If a pattern of attention responding may predominate patterns of selective attention to negative information specifically, then this would critically reduce the capacity of the attentional assessment task to detect anxiety-linked differences in
selective attention to negative information. Future attentional assessment tasks may increase the capacity to detect anxiety-linked heightened selective attention to negative information by presenting two representational images that differ in emotional tone.

Another amendment may increase the capacity of the attentional assessment task to detect anxiety-linked impairment in attentional control. This amendment would assess attention at a time shorter than 1000 ms after the onset of images, thereby allowing assessment of the accomplishment of attentional objectives delivered by attentional control instructions at a briefer interval. Experiments in the research programme thus far have assessed attentional distribution using probes presented 1000 ms after the onset of image pairs. Although the research programme thus far has detected anxiety-linked impairment attentional control in some instances, it is possible that such difference may be more reliably detected if attentional distribution was assessed after a briefer interval.

For example, it may be the case that in the previous three experiments participants with heightened anxiety vulnerability were delayed in the accomplishment of attentional objectives delivered by attentional control instructions, but that this objective was accomplished by the time probes eventually appeared. Attentional-probe assessment tasks only provide a measure of attentional distribution at the time the probes appear, and thus anxiety-linked differences in attentional distribution prior to the onset of probes cannot be revealed. Hence, it is possible that anxiety liked impairment in attentional control may be more evident if a shorter image-probe stimulus onset asynchrony (SOA), perhaps 500ms rather than 1000 ms, were employed. Indeed a range of paradigms demonstrating anxiety-linked impairment in attentional control have assessed attentional distribution in the region of 500 ms (Ansari, Derakshan, & Richards, 2008; Derakshan, Ansari, et al., 2009; Pacheco-Unguetti et al., 2011). Thus, the assessment of attentional distribution using shorter image-probe SOA represents a
plausible means of improving the capacity of the attentional assessment task to detect anxiety-linked impairment in attentional control.

If it were the case that anxiety-linked heightened selective attention to negative information was also more evident at shorter intervals after the onset of emotional information, then this amendment may also be beneficial to the detection of this effect. Indeed, a number of paradigms that have demonstrated this effect have assessed attentional distribution at periods earlier than 1000 ms after the onset of negative information, commonly in the region of 500 ms (Fox et al., 2001; Koster, Verschuere, Crombez, & Van Damme, 2005; C. MacLeod et al., 1986; Mogg et al., 1997). Hence, the assessment of attentional distribution using shorter image-probe SOAs plausibly may also heighten the capacity of the attentional assessment task to detect anxiety-linked heightened selective attention to negative information.

The amendments described above offer potential ways of increasing the capacity of the attentional assessment task to detect anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information. Experiment 4 implemented each of these features, with the continued aim of examining the validity of the alternative models that are of interest to the research programme.
Chapter 5: Experiment 4

The design of Experiment 4 incorporated two alterations to the attentional assessment tasks, intended to improve its capacity to detect anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information. One alteration involved the assessment of attentional distribution 500 ms, as well as 1000 ms, after the onset of image pairs. The second alteration involved the use of image pairs that contained representational images only, rather than pairs that contained one representational image and one abstract image. The implementation of each of these alternations in the present experiment will now be considered in turn.

As noted in the previous chapter, the previous three experiments in the research programme have not assessed anxiety-linked differences in attentional distribution at periods earlier than 1000 ms after the onset of image pairs. It is possible that such differences may be more greatly evidenced when examined at shorter periods. Hence, the capacity of the attentional assessment task to detect anxiety-linked differences in selective attention to negative information and attentional control could be increased by incorporating the assessment of attentional distribution at periods earlier than 1000 ms after the onset of image pairs. Therefore, the present attentional assessment task contained two different stimulus onset asynchronies (SOA) between the onset of image pairs and the onset of probes. The 1000 ms SOA was retained as this has been the SOA in some prior studies designed to assess anxiety-linked attentional anomalies (e.g. Bradley, Mogg, White, Groom, & de Bono, 1999; Mogg, Bradley, de Bono, & Painter, 1997). However, to assess anxiety-linked differences at earlier periods, SOA was also employed, as this has also been employed in a number of studies assessing anxiety-linked attentional anomalies.

A large number of investigators have detected anxiety-linked heightened selective attention to negative information when assessing attentional distribution 500 ms after
the onset of stimuli (Bradley et al., 1998; Koster, Crombez, et al., 2006; C. MacLeod &
Mathews, 1988; Yiend & Mathews, 2001). In their review of studies examining anxiety-
linked heightened selective attention to negative information, Bar-Haim et al. (2007)
also concluded that the assessment of attentional distribution 500 ms after the onset of
negative information demonstrated a robust capacity to detect anxiety-linked heightened
selective attention to negative information. These findings suggest that the assessment
of attentional distribution 500 ms after the onset of negative information may optimise
detection anxiety-linked heightened selective attention to negative information. A
number of investigators who have detected anxiety-linked differences in attentional
control also have assessed attentional distribution in the region of 500 ms after the onset
of attentional stimuli (Ansari et al., 2008; Chen, Clarke, Watson, Macleod, & Guastella,
2014; Derakshan, Ansari, et al., 2009). Thus, the assessment of attentional distribution
at this time may optimise detection of anxiety-linked impairment in attentional control.
Thus, the attentional assessment task included in the present experiment incorporated a
condition that employed a 500 ms SOA, and a condition that employed a 1000 ms SOA,
between the onset of image pairs, and the onset of probes.

The second modification to the attentional assessment task altered the content of
the image pairs. As previously noted, some researchers have found that representational
images generally attract greater attention than abstract images (Hindi Attar et al., 2010).
Such patterns of attentional responding have also been observed in previous
experiments in the research programme. This may potentially reduce the capacity of the
task to detect anxiety-linked heightened selective attention to negative information.
Thus, it was important to overcome this potential shortcoming. One straightforward
means to accomplish this, is to ensure that both images in each image pairs each contain
representational content, while continuing to differ in emotional valence. This would
involve the use of images pairs that contain one negatively valenced representational
image, and one positively valenced representational image. A number of investigators have obtained evidence of anxiety-linked selective attention to negative information using representational image pairs that differ in emotional tone (Bradley et al., 1997; Mogg, Bradley, Miles, & Dixon, 2004; Yiend & Mathews, 2001). Hence, this approach was adopted in the present experiment.

The aim of Experiment 4 was to once again discriminate the validity of the three alternative models describing the relationship between attentional control, selective attention to negative information, and anxiety vulnerability, that are the focus of the research programme. The methodology of Experiment 4 remained exactly the same as previous experiments in the research programme with the exception of the two modifications described above. As in previous experiments in the programme, two issues were addressed in statistical analysis. First, analyses determined whether an anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information were evident from the data. Second, the validity of the three alternative models of interest to the research programme were examined via mediational analyses.

**Method**

**Participants**

Seventy-two university undergraduate psychology students were recruited to participate in the experiment. As with previous experiments in the research programme the aim of participant selection was to create two groups of participants that would differ in level of anxiety vulnerability during the experimental session. Participants were recruited based on scores obtained from the trait scale of the Spielberger State-Trait Anxiety Inventory (STAI-T) questionnaire completed earlier in the teaching semester by a large cohort of psychology students (N = 1,135). Participants were drawn from the bottom third (STAI-T score of 36 or below) and top third (STAI-T score 45 or
above) of STAI-T scores, using the same tertile cut-offs as determined in the preceding experiments. Individuals who had previously participated in an experiment in the research programme were not recruited.

Participants drawn from the bottom third of STAI-T scores \( (n = 36, 17 \text{ males}; M_{\text{age}} = 18.36, SD_{\text{age}} = 1.69; M_{\text{STAI-T}} = 32.11, SD_{\text{STAI-T}} = 3.40, \text{ range} = 20 \text{ to } 36) \) were labelled the low trait anxiety group. Participants drawn from the top third of STAI-T scores \( (n = 36, 15 \text{ males}; M_{\text{age}} = 18.75, SD_{\text{age}} = 1.86; M_{\text{STAI-T}} = 53.14, SD_{\text{STAI-T}} = 7.17, \text{ range} = 45 \text{ to } 76) \) were labelled the high trait anxiety group. This gave rise to a between-groups factor of Trait Anxiety Group (low trait anxiety, high trait anxiety). The two groups did not significantly differ in age, \( t(70) = .93, p = .36, \) or gender ratio, \( \chi^2(1, N = 72) = .23, p = .64, \) but did significantly differ in STAI-T scores as required, \( t(70) = 21.12, p < .001. \)

**Materials**

**Spielberger State-Trait Anxiety Inventory.** As in previous experiments in the research programme the trait anxiety scale of the Spielberger State-Trait Anxiety Inventory (STAI-T; Spielberger, 1983) was used to measure anxiety vulnerability.

**Apparatus.** The same apparatus used in previous experiments in the research programme were used for the delivery of the attentional assessment task in the present experiment.

**Attentional assessment task stimuli.** In the present experiment the assessment of attentional distribution required the presentation of image pairs that contained emotionally valenced representational images only. Hence, the same 256 representational images used in previous experiments in the research programme were used in the present experiment. As detailed previously, this set contained 128 negatively valenced images and 128 positively valenced images. This set was referred to as the attentional assessment image set. Additionally, the same 32 representational images
used in practice tasks of previous experiments in the research programme were selected for use in an initial practice task in the present experiment. These image were labelled the practice image set.

**Attentional assessment task.** The attentional assessment task contained 256 trials. As in previous experiments these trials were equally divided across two subtasks. The *attentional control assessment subtask* assessed attentional control, while the *selective attention to negative information assessment subtask* assessed selective attention to negative information. The task was delivered across four trial blocks of 64 trials each. Blocks alternated between subtasks, and their order was counterbalanced across participants, such that for half of participants, the first block presented trials from the *attentional control assessment subtask*, and for half of participants the first block presented trials from the *selective attention to negative information assessment subtask*.

The structure of trials common to each subtask will now be described, followed by a description of critical differences in the structure of trials between subtasks.

**Trial features common to subtasks.** Trials in each subtask began with a cue in the centre of the screen. Participants were then required to press the space-bar key when ready to progress. When the space-bar key was pressed the cue was cleared and an image pair was presented. In order to ensure that attention was not generally drawn to a sole representational member of the image pair, image pairs now contained one negatively valenced representational image and one positively valenced representational image. Each image was presented 85 mm x 85 mm in size, and subtended a visual angle of 8° x 8°, at a viewing distance of 60 cm. One image of the image pair was presented on the left side of the screen with its right edge 25 mm from the centre of the screen, and the other image was presented on the right side of the screen with its left edge 25 mm from the centre of the screen. This provided a visual angle between the centres of each image of 12.82° at a viewing distance of 60 cm. Across trials, the negatively
valenced image appeared in the left or right location with equal frequency. A key motivation of the present experiment was to assess attentional distribution 500 ms, and 1000 ms, after the onset of image pairs. Thus, across the attentional assessment task, on half of trials the image pair was removed from screen after 500 ms, while on the remaining half of trials the image pair was removed from screen after 1000 ms. This gave rise to a within-groups factor of Stimulus Onset Asynchrony (SOA; 500 ms, 1000 ms). In each condition, immediately following the removal of the image pair a probe was presented in either the left or right image location with equal frequency. The probe comprised two red dots diagonally aligned, with the top dot offset slightly to the left or right of the bottom dot. Participants were required to quickly indicate the identity of the probe by pressing the left mouse button if the top dot was offset to the left, or the right mouse button if the top dot was offset to the right. If participants correctly discriminated the identity of the probe, then the screen was cleared and the next trial commenced after a 1000 ms inter-trial interval. If participants made an incorrect response to the probe by pressing the wrong mouse button an on-screen message (“ERROR TRIGGERED DELAY”) was presented for five seconds before the next trial commenced after a 1000 ms delay. On each trial, the latency to discriminate the probe (as well as the accuracy of probe discrimination) was recorded.

As probe discrimination latencies can only provide an indication of attentional distribution when probes are correctly discriminated, only latencies resulting from accurate discrimination of the probe were employed to compute mean latencies. Also, a participant inclusion criterion was adopted that required 90% accuracy, or greater, on probe discrimination judgements in the attentional assessment task, for a participant’s mean response latencies to be included in analyses.

**Trial features specific to the attentional control assessment subtask.** Trial features specific to this subtask closely matched those features detailed in previous
experiments in the research programme. Attentional control instructions used in the present subtask directed participants to allocate attention to the negatively valenced image or positively valenced image in the presented image pair, using the same instructions as were employed in Experiment 2. Specifically, the instructions presented on screen were, “ATT NEG” (meaning attend to the negatively valenced image), “AVD NEG” (meaning avoid the negatively valenced image), “ATT POS” (meaning attend to the positively valenced image), and “AVD POS” (meaning avoid the positively valenced image). Each instruction was presented an equal number of times across trials. As in the previous three experiments in the research programme, while probes could appear in either location across trials, compliance with attentional control instructions was encouraged by presenting probes in the location congruent with the image participants were instructed to attend to in 75% of trials, and in the location incongruent with the instruction in the remaining 25% of trials. This gave rise to a within-groups factor of Probe Congruency (congruent with instruction, incongruent with instruction).

An illustration of trials in this task is presented in Figure 5.1 below.

*Figure 5.1. Example of a trial in the attentional control assessment subtask. Note items in figure not to scale.*
As with the preceding experiments, if it were the case that heightened trait anxiety was associated with reduced attentional control during this task, then this would be revealed by a two-way interaction between Probe Congruency and Trait Anxiety Group. This interaction effect would reveal that the degree to which participants were speeded to discriminate probes in the location they were instructed to attend was attenuated amongst high trait anxious participants, as compared to low trait anxious participants. However, this effect is more greatly evident as attention is assessed at the shorter SOA, then this would result in a three-way interaction involving the factors Probe Congruency, Trait Anxiety Group, and SOA. This interaction would reflect the fact that the above described two-way interaction would be greater under the 500 ms SOA condition, as compared to the 1000 ms SOA condition.

**Trial features specific to the selective attention to negative information assessment subtask.** Trial features specific to this subtask were identical to those features describe in previous experiments in the research programme. Specifically, trials in this subtask presented a cue consisting of two strings of question marks (“???? ????”) that did not communicate an attentional objective. Probes were presented in the either location with equal frequency. This this gave rise to a within-groups factor of Probe Location (negative image, positive image). An illustration of trials in this task is presented in Figure 5.2 below.
If this task is sensitive to anxiety-linked heightened selective attention to negative information, then this would be revealed by a two-way interaction effect involving Trait Anxiety Group and Probe Location. This two-way interaction effect would reflect the fact that the high trait anxious group were disproportionately speeded to discriminate probes in the location of negatively valenced images relative to positively valenced images, as compared to the low trait anxiety group. However, if anxiety-linked selective attention to negative information is more evident under the 500 ms SOA condition, as compared to the 1000 ms SOA condition, then this would result in a three-way interaction involving the factors Probe Location, Trait Anxiety Group, and SOA. This interaction would reflect the fact that the above described two-way interaction was greater under the 500 ms SOA condition, as compared to the 1000 ms SOA condition.

**Allocation of images to subtasks.** Images were allocated to subtasks randomly for each participant, with the constraint that half of the positively valenced representational images, and half of the negatively valenced representational images, were allocated to
each subtask. Within each subtask image pairs were randomly generated and these pairs were allocated randomly to trial conditions.

**Procedure**

The procedure of the present experiment matched that used by previous experiments in the research programme. Specifically, upon arrival participants were provided with an information sheet and consent form. Then, participants completed the STAI-T questionnaire. Participants were then seated at the computer at a distance 60 cm and verbally instructed by the experimenter about the requirements of the attentional assessment task. Participants were told that some trials would present attentional control instructions, while other trials would not. They were further told that for those trials in which no attentional control instruction was given probes would appear with equal probability in either image location, but for those trials in which an attentional control instruction was given they should comply with the instruction as accurately as possible as probes would most often appear in the location of the image they had been instructed to attend. Participants were told to indicate the orientation of each probe by pressing the appropriate response button as quickly as possible, whilst maintaining a high level of accuracy. The experimental task was preceded by a short practice version of the task that exposed participants to all possible conditions, comprising 64 trials and employing images from the practice image set described earlier. Participants then completed the attentional assessment task, and were subsequently debriefed.

**Results**

To confirm that participants allocated to the two trait anxiety groups continued to differ in trait anxiety at the time of the experimental session, a *t*-test was conducted to compare trait anxiety scores obtained during the experimental session between the trait anxiety groups. This test revealed that STAI-T scores of participants in the High Trait Anxiety Group (\(M = 53.14, SD = 7.17\)) were higher than STAI-T scores of participants
in the Low Trait Anxiety Group ($M = 32.89$, $SD = 5.60$), $t(70) = 13.35$, $p < .001$. This confirmed that trait anxiety groups continued to differ in level of trait anxiety at the time of the experiment as was intended.

Next, analysis of the data examined whether the current attentional assessment task was capable of revealing evidence of anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information, before then examining the validity of the hypothesised models; the attentional control mediator model, the selective attention mediator model, and the non-mediational associations model.

**Preparation of probe discrimination latency data**

All participants met the 90% probe discrimination accuracy criterion, and so no participants were excluded from subsequent analysis. The mean accuracy level was high at 97.25% ($SD = 2.42$, range = 91.02% to 100%), and accuracy did not differ between trait anxiety groups, $t(70) = 0.78$, $p = .44$.

Probe discrimination latencies were filtered to exclude outlying latencies using the same approach employed in the preceding experiments in the research programme. This approach first eliminated all latencies that exceeded 2000 ms, then eliminated any remaining latencies that fell more than 1.96 standard deviations from a participant’s mean latency under each experimental condition. This resulted in 2.75% of probe discrimination latencies being excluded.

**Assessment of Anxiety-linked Impairment in Attentional Control**

Analysis assessed whether the attentional assessment task was sensitive to anxiety-linked impairment in attentional control. A summary of probe discrimination latencies for each condition in the attentional control assessment subtask, for each trait anxiety group, is shown in Table 5.1.
Table 5.1. Mean and standard deviation of probe discrimination latencies, in milliseconds, under each level of SOA and Probe Congruency in the attentional control assessment subtask, for each level of Trait Anxiety Group; M(SD).

<table>
<thead>
<tr>
<th>SOA</th>
<th>Probe Congruency</th>
<th>Low Trait Anxiety</th>
<th>High Trait Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 ms</td>
<td>Congruent with instruction</td>
<td>724.86 (124.30)</td>
<td>733.84 (90.53)</td>
</tr>
<tr>
<td></td>
<td>Incongruent with instruction</td>
<td>887.18 (164.79)</td>
<td>872.48 (98.30)</td>
</tr>
<tr>
<td>1000 ms</td>
<td>Congruent with instruction</td>
<td>657.83 (116.91)</td>
<td>646.76 (92.10)</td>
</tr>
<tr>
<td></td>
<td>Incongruent with instruction</td>
<td>875.46 (163.87)</td>
<td>870.31 (98.10)</td>
</tr>
</tbody>
</table>

These data were subject to a mixed-design ANOVA that included Probe Congruency (congruent with instruction, incongruent with instruction) and Stimulus Onset Asynchrony (SOA; 500 ms, 1000 ms) as within-groups factors, and Trait Anxiety Group (high trait anxiety, low trait anxiety) as a between-groups factor. The analysis revealed a main effect of Probe Congruency, $F(1, 70) = 188.58, p < .001, \eta_p^2 = .73$, which reflected the fact that participants showed shorter discrimination latencies for probes presented in locations congruent with attentional control instructions ($M = 690.82$) relative to probes presented in the opposite locations ($M = 876.36$). This result confirmed that across participants there was a general capacity to move attention to the location indicated by the attentional control instructions employed in the task. A significant main effect of SOA was also revealed, $F(1, 70) = 76.76, p < .001, \eta_p^2 = .52$, reflecting that participants showed longer probe discrimination latencies when images were presented for 500 ms ($M = 804.59$) as compared to 1000 ms ($M = 762.59$).

Both these main effects were subsumed within a significant two-way interaction between SOA and Probe Congruency, $F(1, 70) = 76.90, p < .001, \eta_p^2 = .52$. The nature of this two-way interaction was that the degree to which participants were speeded to discriminate probes located congruent with attentional control instructions, relative to probes in the opposite location, was disproportionately great for trials in the 1000 ms
SOA condition, \( M = 652.30 \) and \( M = 872.88 \) respectively), as compared to trials in the 500 ms SOA condition \( (M = 729.35 \) and \( M = 879.83 \) respectively). This indicated that, in general, participants were better able to accomplish attentional objectives within the duration of the SOA, under the 1000 ms SOA condition, as compared to the 500 ms SOA condition. This pattern of findings is consistent with the possibility that individual differences in attentional control might well be more evident when examined under the shorter SOA condition. If true, this would be evidenced by a three-way interaction involving Probe Congruency, Trait Anxiety Group, and SOA. This three-way interaction effect approached significance, \( F(1, 70) = 3.43, p = .068, \eta^2_p = .05 \). While noting that caution is needed when interpreting effects that fall outside of conventional statistical significance, the nature of this trend suggests that anxiety-linked differences in attentional control may be more evident the shorter SOA. No other effects in the analysis reached or approached significance.

In order to investigate the nature of the three-way interaction, an index score was computed. This score reflected the degree to which participants were speeded to discriminate probes presented in the location they were instructed to attend, relative to probes presented in the location they were not instructed to attend. Hence, higher values on this index represented greater attentional control. The pattern of these scores, as reflected by the three-way interaction, are present in Figure 5.3. As can be seen, the three-way interaction reflected the fact that the degree to which the high trait anxiety group were showing impairment in attentional control compared to the low trait anxiety group was greater under the 500 ms SOA condition, as compared to the 1000 ms SOA condition.
Figure 5.3. Speeding to discriminate probes in locations congruent with attentional control instructions, compared to incongruent with attentional control instructions, under each SOA condition in the attentional control assessment subtask, for each trait anxiety group. Bars represent standard error.

However, upon inspection of the simple two-way interaction involving Probe Congruency and Trait Anxiety Group under each level of SOA, it was found that anxiety-linked impairment in attention control was not significantly observed at either level of SOA. Under the “1000 ms” level of the SOA factor, the simple two-way interaction was not significant, $F(1, 70) = .04, p = .85, \eta^2_p < .01$. Likewise, under the “500 ms” level of the SOA factor, the simple two-way interaction effect also was not significant, $F(1, 70) = .84, p = .36, \eta^2_p = .01$.

Correlational analyses of data obtained during the experimental session were also used assess whether heightened levels of anxiety vulnerability were associated with impaired attentional control. To enable this assessment an index of attentional control was computed. This Attentional Control Index (ACI) reflected the degree to which participants were speeded to discriminate probes presented in the location they were instructed to attend, relative to probes presented in the location they were not instructed to attend. Hence, higher values represented greater attentional control. Correlational analyses revealed no evidence of a significant negative association between STAI-T
scores and this Attentional Control Index score, whether it was computed across both SOA conditions $r(70) = .03, p = .61^1$, only under the 1000 ms SOA condition, $r(70) = .06, p = .70^2$, or only under the 500 ms SOA condition, $r(70) = -.01, p = .50^3$. Thus, while there may have been a trend towards greater evidence of an anxiety-linked attentional control impairment under the 500 ms SOA condition, compared to the 1000 ms SOA condition, there was no evidence of the effect under either SOA conditions alone.

**Assessment of Anxiety-linked Heightened Selective Attention to Negative Information**

Analysis next assessed whether the attentional assessment task was sensitive to anxiety-linked heightened selective attention to negative information. A summary of probe discrimination latencies for each condition in the *selective attention to negative information assessment subtask*, for each trait anxiety group, can be seen in Table 5.2.

<table>
<thead>
<tr>
<th>Trait Anxiety Group</th>
<th>SOA</th>
<th>Probe Location</th>
<th>Low Trait Anxiety</th>
<th>High Trait Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>500 ms</td>
<td>Negative image</td>
<td>755.52 (113.29)</td>
<td>753.39 (75.39)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Positive image</td>
<td>763.50 (113.96)</td>
<td>763.87 (72.44)</td>
</tr>
<tr>
<td></td>
<td>1000 ms</td>
<td>Negative image</td>
<td>738.81 (135.26)</td>
<td>738.45 (90.77)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Positive image</td>
<td>730.22 (108.65)</td>
<td>738.22 (81.02)</td>
</tr>
</tbody>
</table>

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$^1 r_s(70) = -.02, p = .42$

$^2 r_s(70) = .02, p = .56$

$^3 r_s(70) = -.03, p = .39$
These data were subject to a mixed-design ANOVA that considered the within-groups factors Probe Location (negative image, positive image) and Stimulus Onset Asynchrony (SOA; 500 ms, 1000 ms), and the between-groups factor Trait Anxiety Group (high trait anxiety, low trait anxiety). As described earlier, if the present task was equally sensitive to anxiety-linked heightened selective attention to negative information under each SOA condition, this would be revealed by a two-way interaction involving Probe Location, and Trait Anxiety Group, and if this effect was more evident at the shorter SOA, this would give rise to a significant three-way interaction involving Probe Location, Trait Anxiety Group, and SOA.

The analysis revealed a significant main effect of SOA, $F(1, 70) = 39.15, p < .001, \eta_p^2 = .36$, reflecting that, in general, participants’ probe discrimination latencies were shorter on trials that used a 1000 ms SOA ($M = 736.40$) compared to trials that used a 500 ms SOA ($M = 759.08$). The analysis also revealed that this main effect was subsumed within a significant two-way interaction effect involving Probe Location and SOA, $F(1, 70) = 5.29, p = .024, \eta_p^2 = .07$. This interaction effect reflected that fact that, in general, participants allocated disproportionately greater attention to the location of negative images compared to positive images, under the shorter SOA condition, relative to the longer SOA condition. No other significant effects were observed in this analysis.

Of most relevance to the assessment of anxiety-linked heightened selective attention to negative information, the two-way interaction effect involving Probe Location and Trait Anxiety Group did not reach significance, $F(1, 70) = .33, p = .57, \eta_p^2 = .01$, and the three-way interaction effect involving Probe Location, Trait Anxiety Group and SOA, likewise failed to reach significance, $F(1, 70) = .24, p = .63, \eta_p^2 < .01$. Therefore, the task was not sensitive to anxiety-linked heightened selective attention to negative information.
Correlation analysis of data obtained during the experimental session was also used to assess whether heightened levels of trait anxiety were associated with heightened selective attention to negative information under each SOA condition. To do so, an index of selective attention to negative information was computed. This Attention to Negative Information Index (ANII) reflected the degree to which participants were speeded to discriminate probes in the location of negatively valenced images compared to positively valenced images. Hence, for each index higher values represented greater selective attention to negative information. The analyses revealed no evidence of an association between STAI-T scores and the index score, whether this index score was computed across SOA conditions $r(70) = .12, p = .17$\textsuperscript{4}, or whether it was computed only under the 1000 ms SOA condition, $r(70) = .08, p = .25$\textsuperscript{5}, or only under the 500 ms SOA condition, $r(70) = .12, p = .16$\textsuperscript{6}. Thus, the present experiment did not detect evidence of anxiety-linked heightened selective attention to negative information.

**Assessment of Mediation Models**

Although the present experiment failed to obtain evidence of anxiety-linked differences in either attentional process, it was considered prudent to continue with the intended mediational analyses. As in preceding experiments, mediational analyses first tested the validity of predictions arising from the *attentional control mediator model*, before then testing the validity of predictions arising from the *selective attention mediator model*. Each analysis used Attentional Control Index scores as a measure of attentional control, Attention to Negative Information Index (ANII) scores as a measure of selective attention to negative information, and STAI-T scores recorded during the

\[\text{\textsuperscript{4}} r_s(70) = .11, p = .19\]
\[\text{\textsuperscript{5}} r_s(70) = .06, p = .31\]
\[\text{\textsuperscript{6}} r_s(70) = .10, p = .20\]
experimental session as a measure of anxiety vulnerability. Due to the fact that selective attention to negative information and attentional control was assessed under two SOA conditions, the predictions of each mediation model was tested using Attentional Control Index scores and Attention to Negative Information Index scores obtained under conditions that employed a 500 ms SOA, under conditions that employed a 1000 ms SOA, as well as across both SOA conditions.

The first analysis tested the validity of the *attentional control mediator model*. This model proposes that attentional control mediates the relationship between anxiety vulnerability and selective attention to negative information. In order to test the validity of this model, the analysis examined whether the association between STAI-T scores and Attention to Negative Information Index scores was mediated by Attentional Control Index scores. This was done by computing a bias-corrected bootstrapped confidence interval, based on 10,000 samples, for the effect of the mediating pathway in the model.

First, this analysis was conducted using ACI scores and ANII computed across trials that employed a 500 ms SOA. The computed confidence interval for the mediating pathway \((ab, b = -0.001)\) contained zero within its range (95% CI; -0.12 to 0.12), revealing no evidence that Attentional Control Index scores mediated the relationship between STAI-T scores and Attention to Negative Information Index scores, under this SOA condition. Next, this analysis was conducted using ACI scores and ANII scores computed across trials that employed a 1000 ms SOA. The computed confidence interval for the mediating pathway \((ab, b = 0.02)\) also contained zero within its range (95% CI; -0.35 to 0.07), providing no evidence that these Attentional Control Index scores mediated the relationship between STAI-T scores and Attention to Negative Information Index scores, under this condition. Lastly, the analysis was conducted using ACI scores and ANII scores computed across all trials. The computed confidence
interval for the mediating pathway \((ab, b = 0.006)\) contained zero within its range (95% CI; -0.18 to 0.06), providing no evidence that these Attentional Control Index scores mediated the relationship between STAI-T scores and Attention to Negative Information Index scores across all trials. Thus, in each case the result of these mediation analyses provided no support for the validity of the attentional control mediator model.

The next analysis tested the validity of the selective attention mediator model. This model proposes that selective attention to negative information mediates the relationship between anxiety vulnerability and attentional control. In order to test this model, the analysis examined whether the association between STAI-T scores and Attentional Control Index scores was mediated by Attention to Negative Information Index scores. This was done by computing a bias-corrected bootstrapped confidence interval based on 10,000 samples for the effect of the mediating pathway in the model.

First, this analysis was conducted using ACI scores and ANII computed across trials that employed a 500 ms SOA. The computed confidence interval for the mediating pathway \((ab, b = 0.04)\) contained zero within its range (95% CI; -0.23 to 0.64), revealing no evidence that Attention to Negative Information Index scores mediated the association between STAI-T scores and Attentional Control Index scores, under this SOA condition. Next, this analysis was conducted using ACI scores and ANII scores computed across trials that employed a 1000 ms SOA. Once again, the computed confidence interval for the mediating pathway \((ab, b = -0.06)\) contained zero within its range (95% CI; -0.97 to 0.19), providing no evidence that Attention to Negative Information Index scores mediated the association between STAI-T scores and these Attentional Control Index scores, under this condition. Lastly, this analysis was conducted using ACI scores and ANII scores computed across all trials. The computed confidence interval for the mediating pathway \((ab, b = 0.06)\) contained zero within its
range (95% CI; -0.80 to 0.19), providing no evidence that Attention to Negative Information Index scores mediated the association between STAI-T scores and Attentional Control Index scores, across all trials. Hence, none of these mediation analyses provided support for the validity of the selective attention mediator model.

**Discussion**

Previous experiments in the research programme have been unable to simultaneously detect significant evidence of anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information. In order to heighten the capacity of the attentional task to detect each anxiety-linked effect, the present experiment presented image pairs that contained representational images only, and assessed attentional distribution at 500 ms, and 1000 ms, after the onset of image pairs.

The present experiment did not reveal compelling evidence of anxiety-linked impairment in attentional control. Critically, this is inconsistent with the findings of previous experiments in the research programme that have found evidence of this anxiety-linked effect, as well as the findings of a number of studies that have revealed evidence of anxiety-linked impairment in attentional control (Eysenck et al., 2007), including studies that have detected this effect when assessing attention distribution across the durations used in the present task (Chen, Clarke, Watson, Macleod, et al., 2014; Derakshan, Ansari, et al., 2009; Reinholdt-Dunne, Mogg, Benson, et al., 2012). It is noteworthy however, that results of the present experiment provided a suggestion that the degree to which the attentional assessment task was sensitive to anxiety-linked impairment in attentional control was greater when attention was assessed at shorter periods in time after the onset of stimuli.

The present attentional task also failed to obtain evidence of anxiety-linked heightened selective attention to negative information. This anxiety-linked effect was
absent both under conditions that assessed attention under shorter SOA conditions, and longer SOA conditions. These findings are also inconsistent with the findings of previous experiments in the research programme, which have found evidence of this anxiety-linked effect. Likewise, this finding is inconsistent with literature that supports anxiety-linked heightened selective attention to negative information (Bar-Haim et al., 2007), including studies that have detected this anxiety-linked effect when assessing attentional distribution both 500 ms and 1000 ms after the onset of emotional stimuli (Bradley et al., 1997; C. MacLeod et al., 1986; Mogg, Bradley, & Williams, 1995; Rudaizky & MacLeod, 2013).

Medialional analyses in the present experiment revealed no evidence that attentional control mediated the association between anxiety vulnerability and selective attention to negative information, or that selective attention to negative information mediated the association between anxiety vulnerability and attentional control, and thus provided no support for the validity of the *attentional control mediator model* or the *selective attention mediator model*. Additionally, the failure of the present experiment to obtain evidence of both anxiety-linked effects is inconsistent with the predictions of all three models under scrutiny, including the *non-mediational association model*, which predicts that heightened anxiety vulnerability would be characterised by one, or both, of the anxiety-linked effects in any study. Critically however, the failure of the present experiment to obtain evidence of either of the anxiety-linked effects do not support any model, and such findings also do not provide conditions that allow for conceptually meaningful examination of the models under scrutiny. Thus, it would be unreasonable to conclude upon the validity of either of the models under scrutiny from the present findings. It is therefore necessary to consider how subsequent experiments in the research programme may assess these attentional processes in order to more effective observe anxiety-linked differences.
It is possible that anxiety-linked impairment in attentional control may be readily evident through individual differences in the time taken to accomplish attentional objectives. For example, a number of studies have shown high anxious participants, compared to low anxious participants, to be delayed in the time taken to execute attentional shifts away from attentional stimuli (Chen, Clarke, Watson, Macleod, et al., 2014; Derakshan, Ansari, et al., 2009; Reinholdt-Dunne, Mogg, Benson, et al., 2012). Subsequent experiments may therefore yield a greater capacity to obtain evidence of anxiety-linked differences in attentional control by adopting procedures that are able to measure individual differences in the time taken to accomplish attentional objectives.

These individual differences may be sensitively detected if accomplishment of attentional objectives was assessed at even shorter SOAs than the 500 ms SOA employed in the present experiment. However, it is unclear precisely what shorter SOA should be employed. One approach would be to utilise a variety of SOAs, in the hope that these may yield greater capacity to detect anxiety-linked impairment in attentional control. However, this approach would be problematic. For example, for each chosen SOA, if attentional distribution was assessed too late, after the accomplishment of attentional objectives by both high and low anxious individuals, then the attentional assessment task would be insensitive to anxiety-linked differences attentional control. Likewise, for each chosen SOA, if the distribution of attention was assessed too early, prior to accomplishment of attentional objectives by both high and low anxious individuals, then the attentional assessment task would also be insensitive to anxiety-linked differences attentional control. Thus, this particular approach does not present a likely efficacious means of heightening the capacity of the attentional assessment task to detecting this anxiety-linked effect.

An alternative, and likely more effective, approach would be to amend the design of the attentional assessment task so that it can measure the time taken for individuals to...
accomplish attentional objectives after the onset of image pairs. Hence, anxiety-linked impairment in attentional control would be revealed by anxiety-linked delays in the time taken for participants to accomplish their attentional objectives. Importantly, this approach would circumvent the need to choose an arbitrary SOA at which attentional distribution would be assessed to detect anxiety-linked differences in attentional control. Hence, this approach was adopted in subsequent experiments within this research programme. The following section will discuss alternative methods that can be employed to measure individual differences in the time taken to accomplish attentional objectives.

**Consideration of alternate methods to assess individual differences in the time taken to accomplish attentional objectives**

This section will consider two alternative approaches to amending the attentional assessment task, so as to measure the time taken for individuals to accomplish attentional objectives.

One approach would incorporate an amendment to the attentional assessment task that would always present probes *simultaneous* with the presentation of image pairs. This amendment would allow individuals to respond to probes as soon as attention is allocated to the probe location. Hence, variation in probe discrimination latencies will reflect variation in the time taken to allocate attention to the location of probes. When probes are presented in the location participants are instructed to attend to, variation in probe discriminations latencies will reflect variation in the time taken for individuals to accomplish the attentional objective of attending to this location. Importantly however, this amendment alone may not be sufficient to accurately measure the time taken for individuals to accomplish attentional this objective. This is because individual differences in processes other than those involved in moving attention to the specified location may also influence the latency with which probes are discriminated.
Specifically, the latency with which individuals discriminate probes under these presentation conditions will be comprised of two sources of variance. The first source of variance represents variation in the time taken for attention to move to the intended screen locus, and this represents the variance of interest to the attentional assessment task, as it will index individual differences in attentional control. The second source of variance represents variation in the time taken to execute a response to the probe, after attention has moved to the intended locus. Such variance is unrelated to the individual difference in the speed to move attention to the intended location, and so represents variation that ideally should be removed to more clearly index individual differences in attentional control. Thus, in order for the attentional assessment task to be able to accurately reveal anxiety-linked differences in the time taken for participants to accomplish attentional objectives, this approach is required to account for this source of noise variance.

A second amendment to the attentional assessment task was designed to permit this noise variance to be accounted for, by assessing probe discrimination latencies under two assessment conditions. In one condition participants were provided with an attentional control instruction that required the movement of attention to an instructed location, and participants were required to respond to a probe present in this location. Thus, in this experimental condition probe discrimination latencies reflected variation in the time taken for participants to accomplish the attentional objective of moving attention to the intended locus, and as well as noise variation in the time taken to execute a response to the probe after attention was moved to the intended locus. In the second condition, participants were not required to move attention to an intended locus, and were required only respond to a probe presented at a central fixation point. Thus, in this baseline condition probe discrimination latencies reflected the time taken for participants to respond to the probe, when attention was already fixated in the location
of the probe. The degree to which probe discrimination latencies were longer under attentional movement conditions, where an attentional movement to probes was required, compared to baseline conditions, where an attentional movement to probes was not required, revealed the time taken for participants to move attention to their intended locus. As the implementation of this novel assessment approach provided an estimate of the time taken to move attention to the location of the specified image that participants were instructed to attend to, and hence attentional control, Experiment 6 adopted this novel baseline assessment approach.

A quite different approach, that also yields a measure of the time taken for participants to move attention to a specified stimuli location, was employed in Experiment 5. Across a range of studies investigating mental processes, there has been an interest in measuring the speed of cognitive processing, and one common approach has involved “inspection time” procedures (Vickers, Nettelbeck, & Willson, 1972). Inspection time procedures measure the minimum stimulus exposure duration required for individuals to accomplish their specified cognitive objective. For example, if the objective was to discriminate whether two line lengths are equivalent, then the procedure would reduce the exposure duration of the line pair, until the minimum exposure time that permits accurate discrimination is determined. Crucially, the minimum exposure duration that allows for the process to be accomplished reflects the time taken by individuals to accomplish the process. In order to assess attentional control, an inspection time procedure could repeatedly decrease the time available to participants to move attention to the location of a specified image, until the minimum time in which this can be accomplished is determined. Crucially, this would provide an estimate of the time taken to move attention to the location of the specified image that participants were instructed to attend to, and hence attentional control. As noted, this inspection time assessment approach was employed in Experiment 5.
Chapter 6: Experiment 5

In order to assess individual differences in attentional control and selective attention to negative information, Experiment 5 employed an inspection time methodology. To assess individual differences in attentional control, Experiment 5 assessed the time taken for individuals to accomplish attentional objectives. To do so, the methodology identified the minimum time required for individuals to complete the objective of moving attention to the location of an image they were instructed to attend to, by tailoring the time available to participants to do so. Individual differences in the minimum time required for participants to move attention to the location of the image they were instructed to attend to revealed individual differences in attentional control.

To instruct participants as to the image they were instructed to attend to, the methodology employed the same attentional control instructions that were used in Experiment 1, which revealed anxiety-linked difference in attentional control. In order to obtain a measure of the time taken for participants to move attention to the location of the image they were instructed to attend to, the attentional assessment task used a staircasing procedure. This procedure manipulated the duration for which image pairs were exposed, immediately prior to the brief exposure of a probe in the to-be-attended locus which participants were required to identify. Importantly, the brief exposure of the probe ensured that the probe could only be identified when attention was already allocated to its location. Hence, shortening the image presentation duration reduced the time available to participants to move attention to the to-be-attended location to identify the probe. Conversely, lengthening the image presentation duration increased the time available to participants to move attention to the to-be-attended location to identify the probe. By repeatedly adjusting the image presentation duration in response to the accurate, or inaccurate, discrimination of the probe’s identity, the task determined the
minimum time required for participants to move attention to the location of the image they were instructed to attend to, and hence attentional control.

To maintain similarity between the measurement of attentional control and the measurement of selective attending to negative information, in the present experiment, selective attention to negative information was also assessed using an inspection time methodology. This methodology used a staircasing procedure to determine the minimum duration for which probes could be presented, 500 ms after exposure of an image pair, that allowed participants to discriminate the identity of the probes. Probes could be presented in the location of the negatively valenced member of the image pair, or in the location of the positively valenced member. Shorter presentation durations at which probes can be discriminated will reflect greater attention having been allocated to the location of the probe at its onset. Therefore, the degree to which the minimum required probe exposure duration is shorter when probes appeared in the location of negatively valenced images, relative to positively valenced images, provides an index of the degree to which attention was selectively allocated to the location of negative information.

The aim of Experiment 5 remained identical to those of previous experiments in the research programme. As in all previous experiments in the research programme, Experiment 5 examined the capacity of the attentional assessment task to detect anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information. This was followed by an examination of the validity of the three alternative models of interest to the research programme.

**Method**

**Participants**

Seventy-two university undergraduate psychology students were recruited to participate in the experiment. As with previous experiments in the research programme,
the aim of participant selection was to create two groups of participants that would
differ in level of anxiety vulnerability during the experimental session. Participants
were recruited based on scores obtained from the trait scale of the Spielberger State-
Trait Anxiety Inventory (STAI-T) questionnaire completed earlier in the teaching
semester by a large cohort of psychology students (N = 845). Participants were drawn
from the same bottom third (STAI-T score of 36 or below) and top third of scores
(STAI-T score 45 or above) as recruited from in previous experiments in the research
programme. Individuals who had previously participated in an experiment in the
research programme were not recruited.

Participants drawn from the bottom third of STAI-T scores (n = 37, 15
males; M<sub>age</sub> = 18.81, SD<sub>age</sub> = 2.13; M<sub>STAI-T</sub> = 30.92, SD<sub>STAI-T</sub> = 3.56, range = 23 to
36) were labelled the low trait anxiety group. Participants drawn from the top
third of STAI-T scores (n = 35, 13 males; M<sub>age</sub> = 19.09, SD<sub>age</sub> = 2.13; M<sub>STAI-T</sub> =
52.26, SD<sub>STAI-T</sub> = 5.67, range = 45 to 66) were labelled the high trait anxiety
group. This gave rise to a between-groups factor of Trait Anxiety Group (high
trait anxiety, low trait anxiety). Analysis confirmed that the two groups did not
significantly differ in age, t(70) = .55, p = .59, or gender ratio, χ²(1, N = 72) = .09,
p = .77, but did significantly differ in STAI-T scores, t(70) = 19.25, p < .001, as
expected.

Materials

**Spielberger State-Trait Anxiety Inventory.** As in previous experiments in the
research programme, the trait anxiety scale of the Spielberger State-Trait Anxiety
Inventory (STAI-T; Spielberger, 1983) was used to assess anxiety vulnerability.
**Apparatus.** The same apparatus used in previous experiments in the research programme were used for the delivery of the attentional assessment task in the present experiment.

**Attentional assessment task stimuli.** The stimulus image set comprised 192 emotionally valenced representational images, including 96 negatively valenced images and 96 positively valenced images, as well as 64 non-representational abstract images. Images used in the present experiment were drawn from the larger set of images used by previous experiments in the research programme. Negatively valenced representational images used in the present image set comprised the 96 most negatively valenced images used in the previous four experiments in the research programme. Likewise, positively valenced representational images used in the present image set comprised the 96 most positively valenced images used in these four experiments. The abstract images used in the present image set were selected randomly from abstract images used in these previous four experiments. This image set was referred to as the attentional assessment image set.

It was important to confirm that the emotional valence of selected negatively valenced representational images, and selected positively valenced representational images, continued to differ significantly from the neutral midpoint of the IAPS emotional valence rating scale. Negatively valenced representational images had a mean score of 2.09 ($SD = 0.25$; Range: 1.51 to 2.46), which was significantly below the neutral midpoint (5.0) of the IAPS valence scale, $t(95) = 115.17$, $p < .001$, as required. Positively valenced images had a mean scores of 7.53 ($SD = 0.34$; Range: 7.11 to 8.34), which was significantly above the neutral midpoint of the IAPS valence scale, $t(95) = 72.20$, $p < .001$, as required.

**Attentional assessment task.** The attentional assessment task consisted of two subtasks, one designed to measure attentional control, the *attentional control*
assessment subtask, and the other designed to measure selective attention to negative information, the selective attention to negative information assessment subtask. The task was delivered such participants were first assessed on the attentional control assessment subtask, before then being assessed of the selective attention to negative information assessment subtask. Each subtask will now be described.

Attentional control assessment subtask. This task was designed to assess attentional control by measuring the time taken by participants to move attention to a location they were instructed to attend to. The design of the task was closely similar to the design of the attentional control assessment task used in Experiment 1, albeit for two important differences. First, in this task probes were exposed only for a brief duration, individually calibrated for each participant, to ensure that identification of the probe could occur only when the probe appeared in the region where attention was already located. Thus, accurate discrimination of the probe’s identity signified that attention was moved to the location of the probe. Second, in this task the exposure duration of images was tailored via a staircase procedure. This procedure manipulated the duration for which image pairs were exposed immediately prior to the brief exposure of a probe. Shortening the image presentation duration reduced the time available to participants to move attention to the to-be-attended location to identify the probe. Lengthening the image presentation duration increased the time available to participants to move attention to the to-be-attended location to identify the probe. Importantly, shortening the image presentation duration in response to the accurate discrimination of the probe’s identity, and lengthening the image presentation duration in response to the inaccurate discrimination of the probe’s identity, the task determined the minimum time required by participants to move attention to the location of the image they were instructed to attend to.
As noted above, other features of the design of this task were closely similar to the attentional control assessment tasks employed in Experiment 1. Trials in each subtask began with a cue in the centre of the screen. Identical to Experiment 1, the cue always presented participants with an attentional objective instructing them to attend to the representational or abstract image in the image pair. When the space-bar key was pressed the cue was cleared and an image pair was presented. Each image was presented 85 mm x 85 mm in size, and subtended a visual angle of 8° x 8°, at a viewing distance of 60 cm. One image of the image pair was presented on the left side of the screen with its right edge 25 mm from the centre of the screen, and the other image was presented on the right side of the screen with its left edge 25 mm from the centre of the screen. Thus the visual angle between the centres of each image was 12.82° at a viewing distance of 60 cm. The image pair comprised one representational image and one abstract image. Across trials the representational image was negatively valenced or positively valenced with equal frequency, and the representational image appeared in the left or right location with equal frequency. After the image pair was removed from the screen a probe was briefly exposed in the location of the image that participants had been instructed to attend to. Participants were required to discriminate the identity of the presented probe. On each trial the accuracy of probe discrimination was recorded.

As the attentional control assessment task examined the accuracy of probe discrimination in order to signify whether attention was allocated to the location participants were instructed to attend to, it was important to ensure with a high degree of confidence that accurate probe discrimination responses were not simply the result of fortuitous responding. Thus, the task employed probes that could display any of eight possible identities. Each probe identity consisted of a 3x3 grid, with one sector of the grid (excluding the central sector) filled in. Participants discriminated the identity of the probe by pressing the digit on the keyboard’s numeric keypad that corresponded to the
spatial location of the filled sector in the probe. Probe stimuli were 5 mm x 5 mm in size and subtended a visual angle of 0.48° x 0.48° at a viewing distance of 60 cm. An illustration of trials in this task is presented in Figure 6.1.

![Image of trials](image.png)

*Figure 6.1. Example of trials presented in the attentional control assessment subtask.*

Note items in figure not to scale.

In order to tailor the length of time image pairs were exposed during the task, the task used a staircase procedure. This procedure shortened the image presentation duration in response to the accurate discrimination of the probe’s identity, as accurate discrimination of the probe signified that participants had sufficient time to move attention to the image they were instructed to attend to, and lengthened the image presentation duration in response to the inaccurate discrimination of the probe’s identity, as inaccurate discrimination of the probe signified that participants did not have sufficient time to move attention to the image they were instructed to attend to. This occurred until the minimum image presentation duration permitting accurate discrimination of the probe was determined. The staircase procedure was conducted as follows.
At the start of the task, the staircase procedure set the image presentation duration at 720 ms, meaning that participants had 720 ms to move attention to the image they were instructed to attend to, before the probe was presented in that location. Across each set of eight trials, if 75% of probes, or more, were accurately discriminated, this was taken as evidence that the participant was able to reliably move attention to the specified image location within the time provided by the staircase procedure. Thus, the exposure duration of image pairs in subsequent trials was reduced by 60 ms. Conversely, if less than 75% of probes were correctly identified, this was taken as evidence that the participant was not able to reliably move attention to the specified image location within the time provided by the staircase procedure. Thus, the exposure duration of image pairs in subsequent trials was increased by 45 ms.

This continued until a termination criterion was met, at which point the image presentation duration was taken to represent the minimum time required by the participant to reliably move attention to the specified image location. This termination criterion was as follows.

If an initial failure to accurately discriminate 75% of probes, or more, across a set of eight trials was immediately followed by another failure to do so, then the image presentation duration in the next set of trials remained unchanged. If across this set of eight trials the participants again failed to accurately discriminate 75% of probes, or more, then the staircase procedure was terminated. Once the procedure was terminated, the shortest image presentation duration that permitted accurate discrimination of the probe, was recorded by the task. This duration signified the shortest duration in which participants were able to move attention to the location of the image they were instructed to attend to.

Heightened attentional control was revealed by shorter minimum image presentation durations recorded by the task. Hence, this task would detect anxiety-
linked impairment in attentional control by detecting participants with heightened anxiety vulnerability to have longer minimum image presentation durations, as compared to participants with lower anxiety vulnerability. This would be revealed by a main effect of Trait Anxiety Group.

**Selective attention to negative information assessment subtask.** This task was designed to assess attentional distribution between the members of an image pairs comprising of one negatively valenced image, and one positively valenced image, 500 ms after their onset. The task did so by determining the minimum duration for which probes could be presented in the location of each image that also allowed participants to discriminate the identity of the probes.

Trials in the task began with a cue in the centre of the screen that presented two strings of question marks (“??? ???”). When the space-bar key was pressed the cue was cleared and an image pair comprising one negatively valenced representational image and one positively valenced representational image was presented. Each image was presented 85 mm x 85 mm in size, and subtended a visual angle of 8° x 8°, at a viewing distance of 60 cm. One image of the image pair was presented on the left side of the screen with its right edge 25 mm from the centre of the screen, and the other image was presented on the right side of the screen with its left edge 25 mm from the centre of the screen. Thus the visual angle between the centres of each image was 12.82° at a viewing distance of 60 cm. The negative image appeared in the left or right location with equal frequency. The image pair was presented of 500 ms, before then being removed. After the image pair was removed a probe appeared in either the left or right location with equal frequency. This this gave rise to a within-groups factor of Probe Location (negative image, positive image). Participants were required to discriminate the identity of the presented probe. On each trial the accuracy of probe discrimination was recorded. An illustration of trials in the subtask is presented in Figure 6.2.
CHAPTER 6: EXPERIMENT 5

Figure 6.2. Example of a trial presented in the selective attention to negative information subtask. Note items in figure are not to scale.

The task employed a staircase procedure to separately determine the minimum presentation duration that permitted accurate discrimination of probes, when probes were presented in the location of negatively valenced images, and when probes were presented in the location of positively valenced images. The staircase procedure reduced the probe exposure duration when participants accurately discriminated the identity of the probe, but increased the probe exposure duration when participants inaccurately discriminated the identity of the probe. This occurred until the shortest probe exposure duration permitting accurate discrimination of the probe was determined for probes appearing in each location. The staircase procedure was conducted as follows.

At the start of the task, the staircase procedure set the probe exposure duration at 720 ms for probes presented in each image location. This meant that participants had 720 ms, from the time of probe onset, to identify the probe when it was presented in each location. Across each set of sixteen trials, the probe was presented in the location
of the negatively valenced image, or the positively valenced image, with equal frequency. For probes presented in each location across each set of sixteen trials, if 75% of probes, or more, were accurately discriminated, this was taken as evidence that the participant was able to reliably identify probes presented in that image location within the time provided by the staircase procedure. Thus, the presentation duration of the probe in subsequent trials that presented the probe in that same image location was reduced by 60 ms. Conversely, if less than 75% of probes were correctly identified, this was taken as evidence that the participant was not able to reliably identify probes presented in that image location within the time provided by the staircase procedure. Thus, the presentation duration of the probe in subsequent trials that presented the probe in that same image location was increased by 45 ms. Independently for probes presented in each image location, this procedure continued until a termination criterion was met. This termination criterion was as follows.

If an initial failure to accurately discriminate 75% of probes, or more, across a set of sixteen trials was immediately followed by another failure to do so, then the probe exposure duration in the next set of trials remained unchanged. If across this set of trials, the participants again failed to accurately discriminate 75% of probes, or more, then the staircase procedure was terminated. Once the procedure was terminated, the shortest probe exposure duration that permitted accurate discrimination of the probe was recorded by the task. This duration was known as the *probe discrimination threshold*. Upon the staircase procedure terminating for probes presented in one image location, the task continued presenting all trial conditions until the second calibration procedure, for probes presented in the alternate image location, was also terminated.
Importantly, in this subtask shorter exposure durations at which probes could be discriminated reflected greater attention having been allocated to the location of the probe at its onset. Hence, the degree to which participants’ probe discrimination thresholds are shorter when probes appeared in the location of negatively valenced images, relative to when probes appeared in the location of positively valenced images, provides an index of the degree to which attention was selectively allocated to the location of negative information. This task would therefore reveal evidence of anxiety-linked heightened selective attention to negative information via a two-way interaction effect between Trait Anxiety Group and Probe Location. This interaction effect would reflect the fact that the high trait anxious, compared to the low trait anxiety group, displayed disproportionately lower probe discrimination thresholds for probes presented in the location of negatively valenced images, relative to probes presented in the location of positively valenced images.

*Allocation of images to subtasks.* The attentional assessment task employed images from the attentional assessment image set described earlier. For each participant, thirty-two negatively valenced representational images and 32 positively valenced representational images, were randomly selected and paired with 64 abstract images to create 64 images pairs, each comprising one representational image and one abstract image. These image pairs were randomly allocated across trials in the *attentional control assessment subtask*. For each participant, the remaining 64 negatively valenced representational images and 64 positively valenced representational images were randomly paired to create 64 images pairs, each comprising one negatively valenced image and one positively valenced image. These image pairs were randomly allocated across trials in the *selective attention to negative information assessment subtask*.

**Procedure**

The procedure of the present experiment was identical to that followed by
previous experiments in the research programme. Specifically, upon arrival
participants were provided with an information sheet and consent form. Next, to
allow for assessment of whether the required difference in anxiety vulnerability
between participant groups remained at the time of the experimental session
participants completed the STAI-T questionnaire. Participants were then seated at
the computer at a distance 60 cm and verbally instructed by the experimenter
about the requirements of the attentional assessment task. Participants were told
that some trials would present attentional control instructions, while other trials
would not. They were further told that for those trials in which no attentional
control instruction was given probes would appear with equal probability in either
image location, but for those trials in which an attentional control instruction was
given they should comply with this instruction by moving attention to the
specified location as accurately as possible, as probes would appear in the location
they had been instructed to attend to. Participants were told to indicate the identity
of the probe presented on each trial by pressing the appropriate response button on
the numeric keypad. Participants then completed the attentional assessment task,
and were subsequently debriefed.

Results

to confirm that participants allocated to the two trait anxiety groups continued to
differ in trait anxiety at the time of the experimental session, a $t$-test was conducted to
compare trait anxiety scores obtained at the time of the experimental session between
the trait anxiety groups. The analysis revealed that STAI-T scores of participants in the
High Trait Anxiety Group ($M = 52.06, SD = 7.13$) were significantly higher than STAI-
T scores of participants in the Low Trait Anxiety Group ($M = 32.49, SD = 7.14$), $t(70) =
11.63, p < .001$, confirming that the trait anxiety groups continued to differ in level of
trait anxiety at the time of the experiment as intended.
Next, analysis of the data examined whether the current attentional assessment task detected evidence of anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information, before then examining the validity of the hypothesised models.

**Assessment of Anxiety-linked Impairment in Attentional Control**

Analyses first assessed whether the attentional assessment task detected anxiety-linked impairment in attentional control. As described previously, the attentional assessment task assessed attentional control by measuring the time taken for participants to move attention to the location they were instructed to attend to. To enable this assessment an index of attentional control was computed that reflected the mean minimum image presentation duration that was determined during the attentional control assessment subtask. This measure was labelled the Attentional Control Index – Attentional Movement Time (ACI-AMT). Smaller scores on this index represent greater attentional control. A summary of scores on this index, for each anxiety group, can be seen in Table 6.1.

<table>
<thead>
<tr>
<th>Trait Anxiety Group</th>
<th>Low Trait Anxiety</th>
<th>High Trait Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attentional Control Index</strong></td>
<td>830.07 (255.48)</td>
<td>793.07 (280.74)</td>
</tr>
</tbody>
</table>

These indices were subject to a univariate ANOVA with Trait Anxiety Group (high trait anxiety, low trait anxiety) as a between-subjects factor. The presence of anxiety-linked impairment in attentional control would be revealed by a main effect of Trait Anxiety Group in the present analysis. This effect would reflect the fact that the low trait anxiety group had a shorter mean minimum image presentation duration, as
compared to the high trait anxiety group. This main effect was not significant,

\[ F(1, 70) = .34, p = .56, \eta_p^2 = .005, \]

indicating that the trait anxiety groups did not significantly differ in the time taken to accomplish attentional objectives. Thus, the analysis revealed no evidence of an anxiety-linked deficit in attentional control\(^1\).

Correlational analysis of data obtained during the experimental session was also used assess whether trait anxiety was associated with attentional control. The correlation between trait anxiety, and ACI-AMS scores did not approach significance in the present experiment, \( r(70) = -.01, p = .54 \). Consistent with the findings of the ANOVA analysis, this revealed no evidence that heightened levels of anxiety vulnerability were associated with greater time taken to move attention to specified locations.

**Assessment of Anxiety-linked Heightened Selective Attention to Negative Information**

Analyses next assessed whether the attentional assessment task detected anxiety-linked heightened selective attention to negative information. As described previously, the attentional assessment task assessed selective attention to negative information by determining the degree to which the probe discrimination threshold for probes presented in the location of negatively valenced images, was lower, than for probes presented in the location of positively valenced images. A summary of probe discrimination thresholds for each condition in the *selective attention to negative information assessment subtask*, for each trait anxiety group, is provided in Table 6.2.

\(^1\) This ANOVA analysis was repeated to include a factor reflecting the emotional valence of the representational image. The analysis did not reveal any effect of this factor upon effects reported above.

\(^2\) \( r_s(70) = -.07, p = .73 \)
Table 6.2. Mean and standard deviation of probe discrimination thresholds, in milliseconds, under each level of Probe Location in the selective attention to negative information assessment subtask, for each level of Trait Anxiety Group: M(SD).

<table>
<thead>
<tr>
<th>Probe Location</th>
<th>Low Trait Anxiety</th>
<th>High Trait Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative image</td>
<td>454.46 (75.74)</td>
<td>430.29 (61.82)</td>
</tr>
<tr>
<td>Positive image</td>
<td>486.08 (88.56)</td>
<td>458.57 (69.44)</td>
</tr>
</tbody>
</table>

These data were subject to a mixed-design ANOVA that considered the within-groups factor Probe Location (negative image, positive image), and the between-groups factor Trait Anxiety Group (high trait anxiety, low trait anxiety). If the selective attention to negative information assessment task detects the presence of anxiety-linked heightened selective attention to negative information, then this give rise to a two-way interaction involving Probe Location, and Trait Anxiety Group. This two-way interaction effect would reflect the fact that the high trait anxiety group, relative to the low trait anxiety group, would show disproportionately lower probe discrimination thresholds for probes presented in the location of negatively valenced images, relative to probes presented in the location of positively valenced images.

The analysis revealed a main effect of Probe Location, $F(1, 70) = 13.67, p < .001, \eta_p^2 = .16$, reflecting that, in general, probe discrimination thresholds were lower for probes in the location of negatively valenced images ($M = 442.37$) than for probes in the location of positively valenced images ($M = 472.33$). This suggests that, in general, participants tended to allocate greater attention to the locus of negatively valenced images, than to the locus of positively valenced images. However, there was no significant two-way interaction between Probe Location and Trait Anxiety Group, $F(1, 70) = .04, p = .84, \eta_p^2 = .001$, indicating that the trait anxiety groups did not differ in the degree to which the above described main effect was evident. No other effects reached
significance. Thus, the analysis revealed no evidence of anxiety-linked heightened selective attention to negative information.

Correlational analysis of data obtained during the experimental session was also used to assess whether heightened levels of trait anxiety were associated with heightened selective attention to negative information. To achieve this, an index of selective attention to negative information was computed for each participant. This Attention to Negative Information Index (ANII) reflected the degree to which the probe discrimination threshold was lower for probes in the location of negatively valenced images, relative to probes in the location of positively valenced images. Thus, higher scores on this index reflected greater selective attention to negative information. Consistent with the results of the ANOVA, this analysis revealed no significant correlation between STAI-T scores and ANII scores, \( r(70) = .001, p = .50^3 \), providing no evidence of an association between trait anxiety and selective attention to negative information in the present experiment.

**Assessment of Mediation Models**

Statistical analysis next examined the validity of each of the mediational models of interest to the research programme. The mediational analyses first tested the validity of the attentional control mediator model, before then testing the validity of the selective attention mediator model. In each analysis, Attentional Control Index – Attentional Movement Time scores were used as a measure of attentional control, Attention to Negative Information Index scores were used as a measure of selective attention to negative information, and STAI-T scores recorded during the experimental session were used as a measure of anxiety vulnerability.

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\(^3 r_{s}(70) = -.002, \ p = .51\)
The attentional control mediator model proposes that attentional control mediates the relationship between anxiety vulnerability and selective attention to negative information. In order to test this model, the analysis examined whether Attentional Control Index – Attentional Movement Time scores statistically mediated the association between STAI-T scores and Attention to Negative Information Index scores. This was achieved by computing a bias-corrected bootstrapped confidence interval based on 10,000 samples for the effect of the mediating pathway in the model ($ab, b < 0.001$). The computed confidence interval contained zero within its range (95% CI; -0.006 to 0.01), providing no evidence that Attentional Control Index – Attentional Movement Time scores mediated the relationship between STAI-T scores and Attention to Negative Information Index scores. Hence, the results of the mediation analysis provided no support for the attentional control mediator model.

The analysis next tested the validity of the selective attention mediator model. This model proposes that selective attention to negative information mediates the relationship between anxiety vulnerability and attentional control. In order to test the model, the analysis examined whether the association between STAI-T scores and Attentional Control Index – Attentional Movement Time scores was mediated by Attention to Negative Information Index scores by computing a bias-corrected bootstrapped confidence interval based on 10,000 samples for the effect of the mediating pathway in the model ($ab, b < 0.001$). The computed confidence interval contained zero within its range (95% CI; -0.002 to 0.002), providing no evidence that Attention to Negative Information Index scores mediated the association between STAI-T scores and Attentional Control Index – Attentional Movement Time scores. Therefore, the mediation analysis provided no support for the validity of the selective attention mediator model.
Discussion

The present experiment used an inspection time approach to assess attentional control that was intended to measure the time taken for participants to move attention to the location they were instructed to attend to. It was hoped that the methodology may increase the sensitivity of the attentional assessment task to detect anxiety-linked impairment in attentional control. However, this was not found to be the case.

The present experiment revealed no evidence that heightened anxiety vulnerability was associated with differences in the time taken for participants to move attention to instructed locations. Therefore, in contrast to the results of Experiment 1 and Experiment 3 in the research programme, that did detect anxiety-linked impairment in attentional control, and contrary to expectations drawn from the wider literature (Eysenck et al., 2007), the present experiment did not find evidence of such effects. The experiment also found no evidence that high anxious participants allocated disproportionately greater attention to the location of negatively valenced images, relative to positively valenced images. Thus, in contrast to the results of Experiment 2 and Experiment 3 in the research programme, which did detect evidence of anxiety-linked heightened selective attention to negative information, and contrary to the literature supporting such an association (Bar-Haim et al., 2007), the present experiment revealed no evidence of anxiety-linked heightened selective attention to negative information.

The experiment likewise revealed no evidence that attentional control mediated the association between anxiety vulnerability and selective attention to negative information, or that selective attention to negative information mediated the association between anxiety vulnerability and attentional control, and thus provided no support for the validity of the attentional control mediator model or the selective attention mediator model. Additionally, the failure of the present experiment to simultaneously observe
evidence of either anxiety-linked impairment in attentional control or anxiety-linked heightened selective attention to negative information stands inconsistent with all three models under scrutiny, including the non-mediational association model. As was considered in the preceding experiment, the failure of the attentional tasks to detect evidence of anxiety-linked differences in attentional processing does not allow for meaningful conclusions to be drawn from the present findings regarding the models under scrutiny. Hence, it was considered necessary to continue with the next experiment as intended.

As detailed in the previous chapter, the next experiment in the research programme used a novel baseline assessment approach to measure attentional control. As with the present inspection time approach, this approach assessed attentional control by measuring the time taken for participants to move attention to locations they were instructed to attend to. However, this approach employed measures of probe discrimination latency to assess attentional distribution. The next experiment represented the final examination of the validity of the proposed models to be conducted in the research programme.
Chapter 7: Experiment 6

Experiment 6 was the final experiment in the research programme. The experiment assessed attentional control by measuring the time taken for participants to move attention to instructed locations, using the novel baseline assessment approach that was described in Chapter 5.

Previous investigators who have examined anxiety-linked differences in the time taken for individuals to move attention have often done so using stimuli that conveys no emotional tone (Ansari & Derakshan, 2010; Derakshan, Ansari, et al., 2009; Jazbec, McClure, Hardin, Pine, & Ernst, 2005). Hence, in the present experiment stimuli image stimuli used in the assessment of attentional control did not carry an emotional tone.

However, as will be recalled from Chapter 5, the significant characteristic of the present experiment was the presence of a novel baseline attentional assessment condition that allowed for the measurement of the time taken for participants to move attention to the location they were instructed to attend to. Hence, the experiment contained two conditions to assess attentional control. The first condition mirrored the conditions under which attentional control was assessed in Experiments 1 – 4 in the research programme. This condition was designed to elicit the process of interest in the assessment of attentional control, by requiring participants to move attention to the location of an image they were instructed to attend to and examining discrimination latencies for probes in this location. This condition was labelled the experimental condition. The second condition, labelled the baseline condition, was designed to assess probe discrimination latencies under conditions that were similar, but that did not elicit the process of interest, by not requiring participants to move attention to discriminate the probe. The assessment of probe discrimination latencies under these two conditions provided the capacity to distinguish the variation in the time taken for participants to move attention to the location they were instructed to attend to and discriminate the
probe in that locus, from variation in the time taken for participants to discriminate a
probe when attention had already been in the location of the probe. Hence, the degree to
which probe discrimination latencies were relatively longer under the experimental
condition, compared to the baseline condition, revealed the time taken for participants
to move attention to the location they were instructed to attend, and hence, attentional
control.

In order to allow for the ability to measure the time taken for participants to move
attention to instructed locations, no matter how fast they are able, a further refinement in
the present experiment was to present image stimuli and probes simultaneously.
Importantly, this feature allowed participants to discriminate probes as soon as attention
was moved to their location.

The assessment of probe discrimination latencies under a baseline condition, as
well as a condition that elicits selective attention processes, could allow for a more
sensitive measure of selective attention to negative information. Specifically, this
measure could reveal variation in probe discrimination latencies reflecting selective
attention, once variation in latencies to respond to probes generally, has been accounted
for. Hence, the present experiment also assessed selective attention to negative
information by comparing probe discrimination latencies under experimental and
baseline conditions. In this case, the experimental condition was designed to elicit the
process of interest in the assessment of attentional control, by presenting an image pair
consisting of negatively valenced image and positively valenced image for 500 ms and
examining discrimination latencies for probes presented in the location of each image.
The baseline condition was designed to assess probe discrimination latencies under
conditions that were similar but did not elicit selective attention to emotional
information, by presenting only a single emotional image for 500 ms that was always
replaced by the probe. The assessment of probe discrimination latencies under these two
conditions provided the capacity to distinguish variation in probe discrimination latencies resulting from selective attention to negative information, from variation in probe discrimination latencies when selective attention was not elicited. Hence, the degree to which probe discrimination latencies were shorter under the experimental condition, compared to the baseline condition, when probes were presented in the location of negatively valenced images, relative to positively valenced images, revealed the degree to which individuals selectively attended to negative information during the experimental condition.

The aim of Experiment 6 was to again discriminate the validity of alternative models describing the relationship between attentional control, selective attention to negative information, and anxiety vulnerability. As detailed above, the present experiment employed a novel approach to measure of the time taken for participants to accomplish attentional objectives in order to assess attentional control, and to measure selective attention to negative information. As in previous experiments in the programme, two issues were addressed in statistical analysis. First, analyses determined whether an anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information were evident. Second, the validity of the three alternative models of interest to the research programme were examined through mediational analyses.

**Method**

**Participants**

One hundred and twenty-three university undergraduate psychology students were recruited to participate in the experiment. As in to previous experiments in the research programme the aim of participant selection was to create two groups of participants that differed in level of anxiety vulnerability during the experimental session. Participants were recruited based on scores obtained from the trait scale of the Spielberger State-
Trait Anxiety Inventory (STAI-T) questionnaire completed earlier in the teaching semester by a large cohort of psychology students (N = 1,033). Participants were drawn from the bottom half of STAI-T scores (STAI-T score of 42 or below), and the top half of STAI-T scores (STAI-T score 43 or above). Individuals who had previously participated in an experiment in the research programme were not recruited.

Participants that were drawn from the bottom half of STAI-T scores (n = 62, 18 males; M_age = 18.40, SD_age = 2.13; M_STAI-T = 34.69, SD_STAI-T = 4.38, range = 21 to 42) were labelled the low trait anxiety group. Participants drawn from the top half of STAI-T scores (n = 61, 19 males; M_age = 18.31, SD_age = 1.91; M_STAI-T = 51.30, SD_STAI-T = 5.46, range = 44 to 68) were labelled the high trait anxiety group. This gave rise to a between-groups factor of Trait Anxiety Group (low trait anxiety, high trait anxiety). The two groups did not significantly differ in age, t(121) = 0.25, p = .80, or gender ratio, \( \chi^2(1, N = 123) = 0.07, p = .80 \), but did significantly differ in STAI-T, t(121) = 18.62, p < .001, scores as required.

**Materials**

**Spielberger State-Trait Anxiety Inventory.** As in previous experiments in the research programme, the trait anxiety scale of the Spielberger State-Trait Anxiety Inventory (STAI-T; Spielberger, 1983) was used to assess anxiety vulnerability.

**Apparatus.** The computer apparatus used in the present experiment were identical to that of previous experiments in the research programme. The task was delivered on a monitor with a resolution of 1920 x 1080 pixels.

**Attentional assessment task stimuli.** The objective of stimuli selection was to create a set of images to be used for the assessment of selective attention to negative information, the emotional image set, as well as to create two images that were devoid
of emotional content and easily discriminable, to be used for the assessment of attentional control.

The two stimuli used in the assessment of attentional control were comprised of easily discriminable shapes, a circle and a diamond. Each of these shapes was depicted as a white outline 5 mm in width on a black background. The two shape images are shown in Figure 7.1.

![Circle and diamond shapes](image)

*Figure 7.1. Circle and diamond shapes used in the assessment of attentional control.*

The emotional image set comprised 144 negatively valenced representational images, and 144 positively valenced representational images. These included the set of 256 emotionally valenced representational images used in previous experiments in the research programme as well as an additional 32 emotionally valenced images. The additional images were also drawn from the International Affective Pictures System, using the same procedure to source emotional images as was employed by Experiment 1. It was important to confirm that the emotional valence of the 144 negatively valenced images, and 144 positively valenced images in the emotional image set continued to differ significantly from the neutral midpoint of the IAPS emotional valence rating scale. Negatively valenced representational images included in the subset had a mean score of 2.27 ($SD = 0.34$; Range: 1.51 - 2.87), which was significantly more negative
than the midpoint (5.0) of the IAPS valence scale, \( t(143) = 97.36, p < .001 \). Positively valenced representational images included in the subset had a mean score of 7.28 (\( SD = 0.46 \); Range: 6.46 – 8.34), which was significantly more positive than the midpoint of the IAPS valence scale, \( t(143) = 59.20, p < .001 \). Hence, the selected images satisfied this requirement.

**Attentional assessment task.** The attentional assessment task contained 768 trials. These trials were divided equally among two subtasks. One subtask was designed to assess attentional control, the *attentional control assessment subtask*. The other subtask was designed to assess selective attention to negative information, the *selective attention to negative information assessment subtask*. The task was delivered across 12 trial blocks of 64 trials each. Trial blocks were delivered in a manner that alternated between subtasks, and were counterbalanced across participants such that half of participants were first assessed on the *attentional control assessment subtask*, and half of participants were first assessed on the *selective attention to negative information assessment subtask*.

Subtasks were similar in many aspects but differed in important ways that enabled the assessment of attentional control or selective attention to negative information. Each subtask will now be described.

**Attentional control assessment subtask.** This task was designed to assess attentional control by measuring the time taken for participants to move attention to a location they were instructed to attend to. To allow this measurement the task assessed probe discrimination latencies under two key trial conditions. Trials in the *experimental condition* required participants to execute an attentional movement towards an image they were instructed to attend to, and then to discriminate the identity of a probe presented in that location. Alternately, trials in the *baseline condition* required participants to fix attention to a single image presented in a central location, thus
requiring no attentional movement to be executed, and then to discriminate the identity
of a probe presented in that location. The presence of these conditions gave rise to a
within-groups factor of Experimental-Baseline Condition (experimental condition, 
baseline condition) in this task. Crucially, the time taken for participants to move
attention to locations they were instructed to attend to, hence attentional control, was
estimated by comparing the probe discrimination latencies under the experimental 
condition and the baseline condition. The subtask presented an equal number of trials
from the experimental condition, and the baseline condition, in a randomised mixed
order. These two key conditions will now be described further.

In this task, each trial in the experimental condition began with a cue in the centre
of the screen. This cue instructed participants to move attention to the location of the
diamond image, or circle image, in an upcoming image pair. The instructions presented
on screen were, “ATT CIR” (meaning attend to the circle), “AVD CIR” (meaning avoid
the circle), “ATT DIA” (meaning attend to the diamond), and “AVD DIA” (meaning
avoid the diamond). Each variation was presented an equal number of times across
trials. When the space-bar key was pressed the cue was cleared and an image pair was
presented. Each image was 85 mm x 85 mm in size, and subtended a visual angle of 8°
x 8° at a viewing distance of 60 cm. One image of the image pair was presented on the
left side of the screen with its right edge 25 mm from the centre of the screen, and the
other image was presented on the right side of the screen with its left edge 25 mm from
the centre of the screen. This provided a visual angle between the centres of each
stimulus image of 12.82° at a viewing distance of 60 cm. The image pair contained a
diamond image and circle image drawn from the image set described earlier. The circle
image was presented in the left and right image location with equal frequency. When
the image pair was presented, a probe simultaneously appeared in the centre of the
image participants were instructed to attend to. The probe consisted of two vertically
aligned grey dots, with the top dot offset slightly to the left or right of the bottom dot. Participants were required to quickly indicate the identity of the probe by pressing the left mouse button if the top dot was offset to the left, or the right mouse button if the top dot was offset to the right. An illustration of trials in this condition is presented in Figure 7.2 below.

![Figure 7.2](image)

**Figure 7.2.** Example trial presented in the experimental condition of the attentional control assessment subtask. Not items in figure not to scale.

As participants were required to move attention in order to discriminate probes under this condition, probe discrimination latencies reflected the time taken for participants to move attention to the location of the probe, and to discriminate the identity of the probe once attention was moved to its location. Hence, this condition contained the attentional process of interest, attentional movement time, for the assessment of attentional control in the present experiment.

Each trial in the baseline condition also began with a cue in the centre of the screen. In this subtask, the cue did not instruct participants to make an attentional
movement, but instead instructed participants to fix attention to the location of the cue. The instruction presented on screen was, “ATT HERE” (meaning attend here). When the space-bar key was pressed the cue was cleared and a single image was presented in the centre of the screen. The presented image was a circle image or diamond image, drawn from the image set described earlier, with equal frequency. This image was presented 85 mm x 85 mm in size and subtended a visual angle of $8^\circ \times 8^\circ$ at a viewing distance of 60 cm. When the image appeared, a probe simultaneously appeared in the centre of the image. Identical to the experimental condition, the probe consisted of two vertically aligned grey dots, with the top dot offset slightly to the left or right of the bottom dot. Participants were required to quickly indicate the identity of the probe by pressing the left mouse button if the top dot was offset to the left, or the right mouse button if the top dot was offset to the right. An illustration of trials in this condition is presented in Figure 7.3 below.

![Image of trial](image)

*Figure 7.3. Example trial presented in the baseline condition of the attentional control assessment subtask. Note items in figure not to scale.*
Importantly, as participants were not required to move attention in order to identify probes under this condition, probe discrimination latencies recorded under this condition reflected the latency to discriminate the identity of the probe once attention was moved to its location.

Under both conditions, if participants correctly discriminated the identity of the probe the screen was cleared and the next trial commenced after a 1000 ms inter-trial interval. However, if participants made an incorrect response to the probe by pressing the wrong mouse button an on-screen message ("ERROR TRIGGERED DELAY") was presented for five seconds prior to the next trial commencing after a 1000 ms delay. For each trial, the latency to discriminate the probe (as well as the accuracy of probe discrimination) was recorded.

In this subtask the time taken for participants to move attention to locations they were instructed to attend to, hence attentional control, was estimated by comparing probe discrimination latencies under the experimental condition and the baseline condition. The degree to which probe discrimination latencies were longer under the experimental condition as compared to the baseline condition, revealed the degree to which participants took longer to move attention to the location of the images they were instructed to attend to in the experimental condition. This would be revealed by a main effect of Experimental-Baseline Condition. Crucially, longer durations to move attention to instructed locations would reflect poorer attentional control. Hence, if anxiety vulnerability moderated attentional control, this would be revealed by a two-way interaction effect involving Experimental-Baseline Condition and Trait Anxiety. This effect would reveal that the main effect of Experimental-Baseline Condition was more greatly evidenced in the high trait anxious participants, compare to the low trait anxious participants.
**Selective attention to negative information assessment subtask.** This task was designed to assess selective attention to negative information by measuring attentional distribution 500 ms after the presentation of an emotional image pair. However, in order to increase the sensitivity of the task to selective attentional responding, the task was designed to account for variation in the time taken for participants to discriminate the identity of probes, once attention had been allocated to their location. To allow this the task assessed probe discrimination latencies under two key trial conditions. Trials in the *experimental condition* presented pairs of images that differed in emotional tone and then presented a probe in the location of one of the images. Hence, this condition permitted assessment of selective attentional responding to images in the image pair. Alternately, trials in the *baseline condition* presented only a single image in a central location and then presented a probe in that location. Hence, this condition allowed for the assessment of the latency for participants to discriminate probes when attention had been fixed to their location. These conditions gave rise to a within-groups factor of Experimental-Baseline Condition (*experimental condition, baseline condition*) in this task. Crucially, in this subtask selective attention to negative information, was estimated by comparing the probe discrimination latencies under the *experimental condition* and the *baseline condition*. The subtask presented an equal number of trials from the *experimental condition*, and the *baseline condition*, in a randomised mixed order. These two key conditions will now be described further.

In this task, each *trial in the experimental condition* began with a cue in the centre of the screen. This cue was a white cross. When the space-bar key was pressed the cue was cleared and an image pair was presented for 500 ms. Each image was 85 mm x 85 mm in size, and subtended a visual angle of 8° x 8° at a viewing distance of 60 cm. One image of the image pair was presented on the left side of the screen with its right edge 25 mm from the centre of the screen, and the other image was presented on the right
side of the screen with its left edge 25 mm from the centre of the screen. This provided a visual angle between the centres of each stimulus image of 12.82° at a viewing distance of 60 cm. Image pairs presented on these trial contained one negatively valenced image and one positively valenced image, drawn from the emotional image set described earlier. The negatively valenced image was presented in the left or right location with equal frequency. Immediately after the image pair was removed a probe was presented in the location of the negatively valenced image or positively valenced image with equal frequency. This gave rise to a within-groups factor of Probe Location (negative image, positive image). The probe consisted of two vertically aligned grey dots, with the top dot offset slightly to the left or right of the bottom dot. Participants were required to quickly indicate the identity of the probe by pressing the left mouse button if the top dot was offset to the left, or the right mouse button if the top dot was offset to the right. An example illustration of trials in this condition can be seen in Figure 7.4.

Figure 7.4. Example of a trial presented in the experimental condition of the selective attention to negative information assessment subtask. Note items in figure not to scale.
Importantly, as this condition presented an image pair containing negatively valenced and non-negatively valenced images, this condition permitted the expression of selective attention to negative information by participants. Hence, probe discrimination latencies under this condition would reflect the degree to which participants had selectively allocated attention to each image location when the probe appeared.

Each trial in the baseline condition also began with a cue in the centre of the screen that comprised a single white cross. When the space-bar key was pressed the cue was cleared and a single image, drawn from the emotional image set described earlier, was presented in the centre of the screen for 500 ms. This image was presented 85 mm x 85 mm in size and subtended a visual angle of 8° x 8° at a viewing distance of 60 cm. The image was negatively valenced or positively valenced with equal frequency. Immediately after the image was removed a probe was presented in the same location as the image. Identical to the experimental condition, the probe consisted of two vertically aligned grey dots, with the top dot offset slightly to the left or right of the bottom dot. Participants were required to quickly indicate the identity of the probe by pressing the left mouse button if the top dot was offset to the left, or the right mouse button if the top dot was offset to the right. An example illustration of trials in this condition can be seen in Figure 7.5.
Importantly, as this condition presented only a single image, this condition did not permit the expression of selective attention to negative information. Hence, probe discrimination latencies under this condition reflected the latency for participants to discriminate probes, when attention was already allocated to the location that the probe appeared.

Under both conditions, if participants correctly discriminated the identity of the probe the screen was cleared and the next trial commenced after a 1000 ms inter-trial interval. If participants made an incorrect response to the probe by pressing the wrong mouse button an on-screen message (“ERROR TRIGGERED DELAY”) was presented for five seconds prior to the next trial commencing after a 1000 ms delay. On each trial, the latency to discriminate the probe (as well as the accuracy of probe discrimination) was recorded.

In this subtask selective attention to negative information was estimated by comparing the degree to which probe discrimination latencies were slowed under the
experimental condition, compared to the baseline condition, when probes were presented in the location of negatively valenced images, compared positively valenced images. For probes presented in the location of negatively valenced images, reduced slowing of discrimination latencies under the experimental condition, relative to the baseline condition, would reflect greater attention allocation to the location of negatively valenced images, during the experimental condition. Likewise, for probes presented in the location of positively valenced images, reduced slowing of discrimination latencies under the experimental condition, relative to the baseline condition, would reflect greater attention allocation to the location of positively valenced images, during the experimental condition. Hence, if this slowing was disproportionately reduced when probes replaced negatively valenced images, compared to positively valenced images, this would reflect selective attention to negative information under the experimental condition. This would be revealed by a two-way interaction effect of Probe Location and Experimental-Baseline Condition. Crucially, if trait anxiety moderated selective attention to negative information then this would be revealed by a three-way interaction effect involving Probe Location, Experimental-Baseline Condition, and Trait Anxiety. This effect would reveal that the two-way interaction effect was more greatly evidenced in the high trait anxious participants, compared to the low trait anxious participants.

Allocation of images to subtasks. As described earlier, the selective attention to negative information assessment subtask employed images from the emotional image set. For each participant the subtask randomly allocated 48 negatively valenced images and 48 positively valenced images for use in the baseline condition. The subtask then generated 192 unique image pairs from the remaining images in the subset for use in the experimental condition.
**Procedure**

The procedure of the present experiment closely matched that followed in previous experiments. Upon arrival participants were provided with an information sheet and consent form. To allow for assessment of whether the required difference in anxiety vulnerability between participant groups remained at the time of the experimental session participants completed the STAI-T questionnaire. Participants were then seated at the computer at a distance 60 cm and verbally instructed by the experimenter about the requirements of the attentional assessment task. Participants were told that some trials would present attentional control instructions, while other trials would not. They told that for those trials in which no attentional control instruction was given probes would appear with equal probability in either image location, but for those trials in which an attentional control instruction was given they should move attention as quickly as possible to the instructed location, as this was the location that probes would appear. Participants were told to indicate the orientation of each probe by pressing the appropriate response button as quickly as possible, whilst maintaining a high level of accuracy. Participants then completed the attentional assessment task, and were subsequently debriefed.

**Results**

To confirm that participants allocated to the two trait anxiety groups continued to differ in trait anxiety at the time of the experimental session, a *t*-test was carried out on trait anxiety scores obtained during the experimental session between trait anxiety groups. This test revealed STAI-T scores of participants in the High Trait Anxiety Group (*M* = 49.61, *SD* = 7.18) were higher than STAI-T scores of participants in the Low Trait Anxiety Group (*M* = 33.26, *SD* = 6.72), *t*(70) = 13.03, *p* < .001, confirming that the trait anxiety groups continued to differ in level of trait anxiety at the time of the experiment as intended.
Statistical analyses next examined whether the current attentional assessment task detected evidence of anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information, before then examining the validity of the models.

**Preparation of probe discrimination latency data**

As in experiments 1 – 4, only probe discrimination latencies resulting from accurate discrimination of probes were employed to compute mean latencies. Additionally, a participant inclusion criterion was adopted that required 90% accuracy, or greater, on probe discrimination judgements in the attentional assessment task, for a participant’s mean response latencies to be included in analyses.

One participant from the high trait anxiety group failed to meet the 90% probe discrimination accuracy criterion and thus was excluded from subsequent analyses. The mean accuracy of remaining participants was high at 97.33% ($SD = 1.66\%$, range = 91.80% – 99.74%). Accuracy did not differ between trait anxiety groups, $t(120) = 0.79$, $p = .43$.

Probe discrimination latencies were filtered to exclude outlying latencies using the same approach used in Experiments 1 – 4. This approach first eliminated all latencies that exceeded 2000 ms, then eliminated any remaining latencies that, for each participant, fell more than 1.96 standard deviations from their mean latency under each experimental condition. This resulted in 2.77% of probe discrimination latencies being excluded.

**Assessment of Anxiety-linked Impairment in Attentional Control**

Analysis next assessed whether the attentional assessment task detected anxiety-linked impairment in attentional control. A summary of probe discrimination latencies for each condition in the attentional control assessment subtask, for each trait anxiety group, can be seen in Table 7.1.
Table 7.1. Mean and standard deviation of probe discrimination latencies, in milliseconds, under level of Experimental-Baseline Condition in the attentional control assessment subtask, for each level of Trait Anxiety Group; M (SD).

<table>
<thead>
<tr>
<th>Experimental-Baseline Condition</th>
<th>Trait Anxiety Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Trait Anxiety</td>
</tr>
<tr>
<td>Experimental condition</td>
<td>792.33 (96.45)</td>
</tr>
<tr>
<td>Baseline condition</td>
<td>542.03 (58.99)</td>
</tr>
</tbody>
</table>

These data were subject to a mixed-design ANOVA that considered the within-groups factor Experimental-Baseline Condition (experimental condition, baseline condition) and the between-groups factor Trait Anxiety Group (high trait anxiety, low trait anxiety). In the present experiment the existence of anxiety-linked impairment in attentional control would be revealed by the presence of a two-way interaction involving Experimental-Baseline Condition and Trait Anxiety Group. This two-way interaction effect would reveal that high trait anxious participants showed disproportionate slowing of probe discrimination latencies for probes presented in the experimental condition, relative to probes presented in the baseline condition, as compared to low trait anxious participants.

The analysis revealed a main effect of Experimental-Baseline, $F(1, 120) = 1971.35, p < .001, \eta_p^2 = .94$, demonstrating that participants in general took longer to discriminate to probes in the experimental condition ($M = 795.92$) as compared to probes in the baseline condition ($M = 544.15$). This revealed that participants took longer to discriminate probes on trials that required the execution of an attentional movement, compared to trials that did not require the execution of an attentional movement, as would be expected. However, the interaction involving Experimental-Baseline Condition and Trait Anxiety Group was not significant, $F(1, 120) = 0.07, p = .80, \eta_p^2 < .01$. Thus, the degree to which participants showed slower probe
discrimination latencies in the *experimental condition*, than in the *baseline condition*, did not differ as a function of trait anxiety. This result provided no evidence that the time taken for individuals to move attention to the location they were instructed to attend to was moderated by anxiety. Thus, this result was inconsistent with the results prediction by an anxiety-linked impairment in attentional control. No other effects in this analysis reached significance.

Correlational analysis of data obtained during the experimental session was also carried out to assess whether heightened levels of anxiety vulnerability were associated with impaired attentional control. To enable this assessment an index of attentional control was computed, labelled the Attentional Control Index – Attentional Movement Time (ACI-AMT). This index reflected the degree to which participants took longer to discriminate probes in the *experimental condition* compared to the *baseline condition*. Thus, decreasing values on this index score reflected shorter time taken to move attention to instructed locations, and so represents greater attentional control. In contrast to the results of the ANOVA analysis, this correlational analysis did reveal a trend towards a significant positive correlation between attentional control and trait anxiety, \( r(121) = .12, p = .089^1 \). This was consistent with an anxiety-linked impairment in attentional control in the present experiment.

It is important to recognise that this correlation did not reach conventional levels of significance. When considered along with the absence of evidence of an association between trait anxiety and measures of attentional control from the ANOVA analysis, it is clear that this trend must be interpreted with caution. Thus, while this correlational analysis does provide some tentative suggestion of an association between trait anxiety

\[ r(120) = .11, p = .11 \]
and attentional control, it does not provide compelling support of the conclusion that the task detected anxiety-linked impairment in attentional control.

**Assessment of Anxiety-linked Heightened Selective Attention to Negative Information**

Analysis next assessed whether the attentional assessment task detected anxiety-linked heightened selective attention to negative information. A summary of probe discrimination latencies for each condition in the *selective attention to negative information assessment subtask*, for each trait anxiety group, can be seen in Table 7.2.

Table 7.2. *Mean and standard deviation of probe discrimination latencies, in milliseconds, under each level of Trial Condition and Probe Location in the selective attention to negative information assessment subtask, for each level of Trait Anxiety Group; M (SD).*

<table>
<thead>
<tr>
<th>Trial Condition</th>
<th>Probe Location</th>
<th>Low Trait Anxiety</th>
<th>High Trait Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline condition</td>
<td>Negative Image</td>
<td>591.47 (77.32)</td>
<td>594.67 (73.44)</td>
</tr>
<tr>
<td></td>
<td>Positive Image</td>
<td>563.49 (74.69)</td>
<td>561.42 (63.18)</td>
</tr>
<tr>
<td>Experimental condition</td>
<td>Negative Image</td>
<td>863.23 (103.60)</td>
<td>759.59 (90.93)</td>
</tr>
<tr>
<td></td>
<td>Positive Image</td>
<td>759.67 (106.13)</td>
<td>769.03 (89.91)</td>
</tr>
</tbody>
</table>

These data were subject to a mixed-design ANOVA that included the within groups factors of Probe Location (negative image, positive image), and Experimental-Baseline Condition (Baseline condition, Experimental condition), and the between-groups factor Trait Anxiety Group (high trait anxiety, low trait anxiety). This analysis revealed a main effect of Experimental-Baseline Condition, $F(1, 120) = 2457.48, p < .001, \eta^2_p = .95$, indicating that, in general, participants were slower to discriminate to
probes under the *experimental condition* \((M = 762.88)\) compared to *baseline condition* \((M = 577.76)\). The analysis also revealed a main effect of Probe Location, \(F(1, 120) = 54.01, p < .001, \eta^2_p = .31\), indicating that, in general, participants were slower to respond to probes presented in the location of negatively valenced images \((M = 677.24)\) compared to positively valenced images \((M = 663.40)\), under both conditions. The analysis also revealed a significant two-way interaction effect involving Experimental-Baseline Condition and Probe Location, \(F(1, 120) = 95.42, p < .001, \eta^2_p = .44\). This effect reflected the fact that the degree to which participants were slower to respond to probes under *experimental condition*, relative to the *baseline condition*, differed depending upon whether the probe appeared in the location of a negatively valenced image or a positively valenced image. Specifically, when probes were presented in the location of negatively valenced images, it took participants on average 168.34 ms longer to discriminate the probe under the *experimental condition*, as compared to the under the *baseline condition*. However, when probes were presented in the location of positively valenced images, it took participants on average 201.90 ms longer to discriminate the probe under the *experimental condition*, as compared to the under the *baseline condition*. Thus these results suggest that, in general, under the *experimental condition* participants allocated greater attention to the location of negatively valenced images, relative to the location of positively valenced images.

As will be recalled, in the present experiment anxiety-linked selective attention to negative information would predict the presence of a three-way interaction effect between Experimental-Baseline Condition, Probe Location, and Trait Anxiety Group. This interaction would reveal that the above described two-way interaction, involving Experimental-Baseline Condition and Probe Location, would be more greatly evidenced by the high trait anxiety group, compared to the low trait anxiety group. This interaction
effect was found to be significant, $F(2, 120) = 7.07, p < .01, \eta_p^2 = .06$. No other significant effects were observed in the analysis.

In order to determine whether the nature of this three-way interaction was consistent with anxiety-linked heightened selective attention to negative information, an index was computed using probe discrimination latencies, for probes presented in the location of negatively valenced images, and for probes presented in the location of positively valenced images. In each case, this index reflected the degree to which participants were slower to respond to probes under *experimental condition*, relative to the *baseline condition*. Thus, smaller values (reduced slowing) on this index reflected greater attentional allocation to the location that probes appeared in under the *experimental condition*. These indices, for each trait anxiety group, are shown in Figure 7.6.

![Figure 7.6](image)

*Figure 7.6.* Index of slowing to discriminate probes in the *experimental condition* compared to the *baseline condition*, for probes in the location of negative images, and positive images, for each trait anxiety group. Bars represent standard error.

The nature of the interaction indicated that, when relative to the *baseline condition*, under the *experimental condition* high anxious participants took disproportionately little time discriminate probes that appeared in the location of
negatively valenced images, compared to positively valenced images, compared to low anxious participants. This is consistent with the prediction that high trait anxious participants, compared to low trait anxious participants, allocated disproportionately greater attention to negatively valenced images, compared to positively valenced images, during the experimental condition, reflecting the presence of anxiety-linked heightened selective attention to negative information.

Correlational analysis of data obtained during the experimental session was also used assess whether heightened levels of trait anxiety were associated with heightened selective attention to negative information. To enable this assessment an index of selective attention to negative information was computed. This Attention to Negative Information Index (ANII) reflected the degree to which participants demonstrated smaller values on the previously computed index when probes were presented in the location of negatively valenced images compared to when probes were presented in the location of positively valenced images. Thus, higher values on this Attention to Negative Information Index represented greater selective attention to negative information.

Confirming the effect revealed by the ANOVA analysis, there was a significant positive correlation between STAI-T scores and ANII scores, \( r(121) = .17, p = .033\), indicating that heightened anxiety vulnerability was related to heightened selective attention to negative information in the present experiment.

Assessment of Mediation Models

The present attentional assessment task demonstrated the capacity to detect anxiety-linked heightened selective attention to negative information. While evidence of the capacity of the present attentional assessment task to detect anxiety-linked

\[ r^2(121) = .17, p = .028 \]
impairment in attentional control and reached only marginal levels of significance, the present results provide relatively encouraging conditions for testing the validity of the models of interest to the research programme. The mediational analyses first tested the validity of the *attentional control mediator model*, before then testing the validity of the *selective attention mediator model*. Each analysis used Attentional Control Index (ACI) scores as a measure of attentional control, Attention to Negative Information Index (ANII) scores as a measure of selective attention to negative information, and STAI-T scores recorded during the experimental session as a measure of anxiety vulnerability.

The *attentional control mediator model* proposes that attentional control mediates the relationship between anxiety vulnerability and selective attention to negative information. In order to test this model, the analysis examined whether the association between STAI-T scores and Attention to Negative Information Index scores was mediated by Attentional Control Index scores. This was achieved by computing a bias-corrected bootstrapped confidence interval based on 10,000 samples for the effect of the mediating pathway in the model ($ab, b = 0.003$). The computed confidence interval for the mediating pathway contained zero within its range (95% CI; -0.001 to 0.02), providing no evidence that Attentional Control Index scores mediated the relationship between STAI-T scores and Attention to Negative Information Index scores. Hence, the result of this mediation analysis provided no support for the validity of the *attentional control mediator model*.

Analysis next tested the validity of the *selective attention mediator model*. This model proposes that selective attention to negative information mediates the relationship between anxiety vulnerability and attentional control. To test this model, the analysis examined whether the association between STAI-T scores and Attentional Control Index scores was statistically mediated by Attention to Negative Information Index scores by computing a bias-corrected bootstrapped confidence interval based on
10,000 samples for the effect of the mediating pathway in the model ($ab, b = 0.003$).

This interval contained zero within its range (95% CI; -0.001 to 0.01), providing no
evidence that Attention to Negative Information Index scores mediated the association
between STAI-T scores and Attentional Control Index scores. Therefore, the mediation
analysis provided no support for the validity of the *selective attention mediator model*.

**Discussion**

Experiment 6 used a novel methodology designed to reveal the time taken for
participants to move attention to locations they were instructed to attend to. This
methodology was adopted with the intention of potential enhancing the capacity of the
attentional assessment task to detect anxiety-linked impairment in attentional control,
and anxiety-linked heightened selective attention to negative information.

The experiment revealed trend level evidence that anxiety vulnerability was
associated with longer time taken for participants to move attention as instructed,
though this evidence came only from correlational analyses. The experiment did find
significant evidence that heightened anxiety vulnerability was associated with
heightened selective attention to negative information.

The present experiment has revealed evidence of anxiety-linked impairment in
attentional control, and anxiety-linked heightened selective attention to negative
information. Thus, the present results provided encouraging conditions to test the
validity of the mediational models. Nevertheless, the experiment revealed no evidence
that either attentional control mediated the association between anxiety vulnerability
and selective attention to negative information, or that selective attention to negative
information mediated the association between anxiety vulnerability and attentional
control. Hence, this final experiment in the research programme did not support the
validity of the *attentional control mediator model* or the *selective attention mediator
model*, which each predict the existence of a mediational relationship between the
attentional processes and anxiety vulnerability. In contrast, the findings of the present experiment do not challenge the validity of the non-mediational associations model, according to which attentional control, selective attention to negative information, and anxiety vulnerability do not share a mediational relationship.

Although this was the final experiment in the research programme, it is useful to consider ways in which the present findings may inform the development of future tasks that may have still greater capacity to detect anxiety-linked impairment in attentional control. One possibility relates to anxiety-linked differences in the speed to identify images used to assess attentional control. During assessment of attentional control, it was necessary for participants to evaluate the identities of presented images in order to move attention in accordance with the attentional objective on each trial. Although the use of shape images ensured that the identification of images was relatively easy, it is possible that individual differences in the processing of their identities may have impacted upon probe discrimination latencies. For example, if it were the case that high anxious participants were much faster to process the identity of the shape images relative to low anxious participants, this may have offset their delay in moving attention to the instructed location relative to low anxious participants, resulting in roughly equivalent probe discrimination latencies. Although this situation could logically obscure anxiety-linked impairment in attentional control, it seems unlikely that anxiety would moderate the ability to identify shapes, and so this possibility may be regarded as improbable.

A second possibility concerns the possibility that the presentation of a diamond shape and circle shape may have led to attention being preferentially initially shifted to diamond shapes, during the assessment of attentional control. Research into attention to shapes has revealed that individuals may often attend to more angular shapes over less angular shapes, even when told not to do so (Kaufman & Richards, 1969; Tsal & Lavie,
If this was the case in the present experiment, then when image pairs were presented during the assessment of attentional control, participants may have often have initially attended to the diamond shape, over the circle shape, prior to the execution of the required attentional movement. This would add erroneous variance to probe discrimination latencies on top of variance due to the execution of attentional movements, thereby reducing the sensitivity of the attentional task to individual’s differences in attentional control.

The present attentional assessment task detected evidence of anxiety-linked heightened selective attention to negative information, while accounting for individual differences in speed to respond to probes when selective attention was not elicited. This raises the interesting possibility that the incorporation of a baseline condition was beneficial to observing this effect. Conversely, attentional assessment tasks used in previous experiments in the research programme, as well as those used in attentional-probe literature, do not employ such conditions to account for variation in the time taken for participants to respond to probes when selective attention is not elicited. It is interesting therefore to test whether the present methodology would have been capable of detecting anxiety-linked heightened selective attention to negative information, if the baseline condition was not employed.

To assess this possibility a post-hoc examination was conducted. This examination employed a mixed-design ANOVA to compare the degree to which probe discrimination latencies in the experimental condition only were faster when the probes appeared in the locus of negatively valenced images, compared to positively valenced images, across anxiety groups. This 2 x 2 ANOVA design included Probe Location (negative image, positive image) as a within-groups factor, and Trait Anxiety Group (high trait anxiety, low trait anxiety) as a between-groups factor. The analysis revealed a significant interaction effect of Probe Location and Trait Anxiety Group, $F(1, 120) =$
4.16, \( p < .044, \eta_p^2 = .03 \). An examination of the nature of this effect revealed that high anxious participants were disproportionately speeded to respond to probes in presented in the location of negatively valenced images compared to positively valenced images \((M = 9.44 \text{ ms})\), compared to low anxious participants \((M = 3.56 \text{ ms})\). This finding was consistent with an anxiety-linked selective attention to negative information. Hence, while the observed size of this effect \((\eta_p^2 = .03)\) was markedly smaller than the size of the effect observed by the experimental analysis, which incorporated probe discrimination latencies of the baseline condition \((\eta_p^2 = .06)\), these findings show that the baseline condition was not necessary for the detection of anxiety-linked heightened selective attention to negative information in the present experiment.

Interestingly, this finding sits in contrast to the findings of Experiment 4, in which selective attention to negative information was assessed in a manner identical to the experimental condition in the present experiment, but which failed to detect anxiety-linked differences in selective attention to negative information. It is possible that simply the presence of the baseline condition in the present attentional task made anxiety-linked differences in selective attention to negative information more detectable in some way. For example, the addition of these trials meant that participants were exposed to greater numbers of emotional images across the attentional task, as compared to the attentional task used in Experiment 4. This may have resulted in a greater potential for participants to encode the emotional content of images during the task. Future research seeking to design novel methodologies may investigate this possibility. A second possibility considers that differences in the evidence of anxiety-linked heightened selective attention to negative information obtained by this experiment and Experiment 4 may not in fact be reflective of the methodological differences between their methodologies. Instead it may reflect some feature of anxiety-
linked heightened selective attention to negative information. This possibility will be considered in the following chapter.

Experiment 6 served as the final experiment in the research programme. The experiment found solid evidence of anxiety-linked heightened selective attention to negative information, and some evidence of anxiety-linked impairment in attentional control. There was however, no evidence to support the validity of either of the mediation models of interest to the research programme. The absence of strong evidence of both anxiety-linked effects in this experiment, as well as the absence of evidence supporting the validity of each mediational model, echoes the findings of previous experiments in the research programme. A concluding discussion of the entire research programme will be presented in the following chapter.
Chapter 8: General Discussion

This final chapter of the thesis will first provide a review of experimental findings in the research programme. Next, conclusions concerning the validity of the *attentional control mediator model*, *selective attention mediator model*, and *non-mediational associations model* that can be drawn from these findings will be described. Following this, implications of these conclusions on understanding anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information, and the relationship between these attentional phenomena, will be considered. Finally, potential avenues for future research will be discussed.

**Review of Experimental Findings**

The central purpose of the present research programme was to examine the validity of alternative models describing the relationship between selective attention to negative information, in attentional control, and anxiety vulnerability. The *attentional control mediator model* contends that attentional control mediates the relationship between selective attention to negative information and anxiety vulnerability. Alternatively, the *selective attention to negative information model* contends that selective attention to negative information mediate the relationship between attentional control and anxiety vulnerability. Lastly, the *non-mediational associations model* contends that there is no mediational relationship between the variable of attentional control, selective attention to negative information, and anxiety vulnerability. The series of experiments in the research programme employed a number of task variants designed to investigate that validity of these alternate models. In each experiment this investigation involved assessment of anxiety-linked heightened selective attention to negative information, assessment of anxiety-linked impairment in attentional control, and statistical tests examining the validity of the hypothesised mediational models. The findings obtained from these experiments will now be reviewed in turn.
Evidence that heightened anxiety vulnerability is characterised by heightened selective attention to negative information. Of the six experiments reported in this research programme, Experiment 2 and Experiment 6 revealed significant evidence of anxiety-linked heightened selective attention to negative information, while Experiment 3 revealed a trend towards this effect.

Experiment 2 assessed selective attention to negative information through a procedure that indexed the allocation of attention to negative information, relative to non-negative information, 1000 ms after the onset of negative information. Analyses conducted in Experiment 2 demonstrated that high trait anxious participants, compared to low trait anxious participants, allocated disproportionately great attention to the location of representational images compared to abstract images, when these representational images were negatively valenced rather than positively valenced in emotional tone. This is consistent with the presence of anxiety-linked heightened selective attention to negative information.

Experiment 3 assessed selective attention to negative information in a manner identical to Experiment 2. Analyses conducted on the data collected in Experiment 3 also provided evidence that high trait anxious participants, compared to low trait anxious participants, allocated disproportionately great attention to the location of representational images compared to abstract images, when these representational images were negatively valenced rather than positively valenced in emotional tone. Once again, this result is consistent with the presence of anxiety-linked heightened selective attention to negative information.

Experiment 6 adopted a novel approach to assessing selective attention to negative information. This approach measured probe discrimination latencies under two conditions. These conditions allowed for a measure of selective attention to negative information that controlled for variation in the time taken for participants to
discriminate probes when attention was already in their location. Analyses revealed high
trait anxious participants, compared to low trait anxious participants, allocated
disproportionately great attention to the locus of negatively valenced images compared
to the locus of non-negatively valenced images, once again consistent with anxiety-
linked heightened selective attention to negative information.

While these three experiments revealed evidence of anxiety-linked heightened
selective attention to negative information, three experiments in the research
programme did not obtain evidence of this attentional effect. Experiment 1 assessed
selective attention to negative information in a manner identical to that of Experiment 2
and Experiment 3. However, this experiment did not provide evidence of anxiety-linked
selective attention to negative information across participants. Experiment 4 measured
selective attention to negative information under conditions that indexed attentional
distribution either 500 ms or 1000 ms after the onset of negative information. Under
each of these conditions, the experiment revealed no evidence of anxiety-linked
selective attention to negative information. Lastly, Experiment 5 measured selective
attention to negative information using an inspection time approach that assessed the
speed at which probes could be presented, to allow their identification, when they were
presented in the location of negative and positive information. This experiment also did
not reveal evidence of anxiety-linked selective attention to negative information.

As can be seen, the present programme of research was inconsistent with respect
to the demonstration of anxiety-linked heightened selective attention to negative
information. To investigate whether, across the full set of experiments in the research
programme, there was significant evidence of this effect overall, a meta-analytic
procedure was conducted. This procedure derived an estimate of the anxiety-linked
heightened selective attention to negative information effect across the research
programme. This analysis resulted in a significant effect ($Z = 2.93, p = .002$, Hedges’ $g$
= 0.27). Therefore, while the results of individual experiments within the present research programme varied in the degree to which they individually demonstrated significant anxiety-linked heightened selective attention to negative information, the presently estimated effect provides reassurance that heightened selective attention to negative information was characteristic of anxiety vulnerability across the research programme.

**Evidence that heightened anxiety vulnerability is characterised by impairment in attentional control.** Of the six experiments reported in this research programme, Experiment 1 and Experiment 3 revealed significant evidence of anxiety-linked impairment in attentional control, while Experiment 6 revealed a trend toward this effect.

Experiment 1 assessed attentional control using a procedure that instructed participants to attend to a particular stimulus location, and indexed the degree to which attention was allocated to this location, relative to a location that participants were not instructed to attend to, 1000 ms after the onset the stimuli. In this experiment instructions specified the location participants were required to attend to with respect to representational or abstract qualities of the presented stimuli. Analyses conducted in Experiment 1 demonstrated that high trait anxious participants, compared to low trait anxious participants, showed less selective allocation of attention to the location they were instructed to attend to. Thus the findings of the experiment were consistent with the detection of anxiety-linked impairment in attentional control.

Experiment 3 also assessed attentional control through a procedure that instructed participants to attend to a particular stimulus location, and indexed the degree to which attention was allocated to this location, relative to a location participants were not instructed to attend to, 1000 ms after the onset of negative information. However, Experiment 3 incorporated two instruction conditions. One condition specified the
location participants were required to attend to with respect to representational or abstract qualities of the presented images. The second condition specified the location participants were required to attend to with respect to emotional valence of the presented images. The data collected from Experiment 3 revealed that anxiety-linked impairment in attentional control was evident, but was more greatly evident under the latter condition. The effect observed under this condition was consistent that observed under Experiment 1. Specifically, high trait anxious participants, compared to low trait anxious participants, exhibited reduced selective allocation of attention to the location they were instructed to attend to. Thus, Experiment 3 provided the second instance of evidence of anxiety-linked impairment in attentional control.

Experiment 6 adopted a novel approach to assessing attentional control by developing a procedure that measured the time taken for participants to move attention to a location they were instructed to attend to. This experiment revealed evidence that higher levels of anxiety vulnerability were associated with greater time taken to move attention to the location participants were instructed to attend to. Hence, the findings of supported the presence of anxiety-linked impairment in attentional control in this experiment.

While these experiments revealed evidence of anxiety-linked impairment in attentional control, the remaining three experiments in the research programme did not obtain significant evidence of this attentional effect. Experiment 2 assessed attentional control through a procedure that was similar to that employed in Experiment 1. In this experiment however, attentional control instructions specified the location participants were required to attend to with respect to emotional valence of the presented stimuli, rather than in terms of whether the image depicted representational or abstract content. Unlike Experiment 1, analyses conducted in Experiment 2 did not find significant differences between high trait anxious participants and low trait anxious participants, in
the degree to which they exhibited less selective allocation of attention to the location
they were instructed to attend to. Hence, Experiment 2 did not reveal evidence of
anxiety-linked impairment in attentional control. Experiment 4 also measured
attentional control by indexing attentional distribution following instructions that
required participants to selectively attend to one of two images. However, unlike
previous experiments in the research programme Experiment 4 incorporated conditions
that indexed attentional distribution 500 ms or 1000 ms after the onset of image pairs.
Analyses computed under each conditions revealed no evidence of anxiety-linked
impairment in attentional control. Lastly, like Experiment 6, Experiment 5 developed a
procedure that measured the time taken for attention to be shifted to the location
participants were instructed to attend to, in a manner uninfluenced by variation in the
speed for participants to respond to probes. However, unlike Experiment 6, Experiment
5 utilised a novel inspection time approach to obtain this measure. Thus, this experiment
did not reveal evidence of anxiety-linked impairment in attentional control.

As can be seen, evidence of anxiety-linked impairment in attentional control was
inconsistent across experiments conducted in the research programme. Once again, to
assess whether there was significant evidence of anxiety-linked impairment in
attentional control across the research programme a meta-analytic procedure was
conducted. This procedure resulted in a trend towards a statistically significant effect (Z
= 1.38, p = .085, Hedges’ g = 0.13). Thus, although individual experiments in the
research programme did not consistently reveal evidence of anxiety-linked impairment
in attentional control, this estimate does provide trend level evidence of that impaired
attentional control was characteristic of anxiety vulnerability across the research
programme effect.

Evidence for the validity of hypothesised models of interest to the research
programme. As described earlier in this chapter, the central purpose of the present
research programme was to examine the validity of alternative models that describe the relationship between selective attention to negative information, attentional control, and anxiety vulnerability. In each experiment, statistical tests were employed to examine the validity of the attentional control mediator model, the selective attention mediator model, and the non-mediational associations model.

Prior to considering how the findings bear upon the validity of the three alternative models proposed by the research programme, it is important to recognise that no experiment in the research programme simultaneously detected significant associations between anxiety vulnerability, and selective attention to negative information and attentional control. Hence, one cannot completely discount the possibility that the failure to find evidence of mediational effects in any experiment may have stemmed from a failure of any individual experiment to adequately measure both of the attentional processes of interest. The effect sizes computed from the meta-analytic analyses above allowed for examination of the power of experiments in the research programme to detect anxiety-linked differences in attentional control and selective attention. Potentially, this may reflect power limitations associated with these studies. The meta-analytic computation of anxiety-linked selective attention to negative information demonstrates that the sample size necessary in each study to detect the effect (of size $g = 0.27$), with power of .80 and alpha error probability of 0.05, is 171 participants per group. Likewise, the meta-analytic computation of anxiety-linked impairment in attentional control demonstrates that the sample size necessary in each study to detect the effect (of size $g = 0.13$), with power of .80 and alpha error probability of 0.05, is 180 participants per group. The participant numbers in the present experiments fall below the cohort sizes ideally suited to the detection of the anticipated effects. Hence, though the conclusions drawn from the present programme of research
must be dictated by the statistical significance of effects tested using the presently collected data, this limitation should be borne in mind.

In the **attentional control mediator model** the relationship between anxiety vulnerability and selective attention to negative information occurs indirectly through variation in attentional control. Crucially, this model predicts that attentional control would be found to mediate the association between anxiety vulnerability and selective attention to negative information when examined through statistical mediation analyses. However, no experiment in the research programme revealed evidence of statistical mediation consistent with this prediction. Hence, present programme of research provided no support for the validity of this particular model.

In the **selective attention to negative information model** the relationship between anxiety vulnerability and attentional control occurs indirectly through variation in selective attention to negative information. Hence, this model predicts that selective attention to negative information would be found to mediate the association between anxiety vulnerability and attentional control. However, in no experiment in the research programme revealed did statistical examination of this mediation effect demonstrate evidence for this statistical mediation effect. Thus, the present programme provided no support for the validity of this particular model also.

Lastly, the **non-mediational associations model** describes associations between anxiety vulnerability and attentional control, and between anxiety vulnerability and selective attention to negative information, as independent of one another, and hence does not predict the existence of either of the mediational relationships described by the other two models. Importantly therefore, the absence of evidence supporting either of the two mediation models in the present programme is consistent with this model.

The observation that experiments in the present research programme typically did not demonstrate simultaneous evidence of associations between anxiety vulnerability
and selective attention to negative information, and anxiety vulnerability and attentional control can also inform the validity of the three models under examination. Each of the mediational models describe that each anxiety-linked effect will co-occur, and thus predict the simultaneous demonstration of associations between anxiety vulnerability, and selective attention to negative information and attentional control. The pattern of findings across the research programme do not support this prediction, and hence do not support the validity of either of these two models. Conversely, the non-mediational associations model does not predict that associations between anxiety vulnerability, and selective attention to negative information and attentional control, will necessarily co-occur. Hence, the pattern of findings across the research programme are not inconsistent with this model, and so do not challenge the validity of this model.

In summary, the findings of the present research programme are inconsistent with the predictions of either of the attentional control mediator model, which describes attentional control as mediating the relationship between anxiety vulnerability and selective attention to negative information, or for the selective attention mediator model, which describes selective attention to negative information as mediating the relationship between anxiety vulnerability and attentional control. Hence, the present findings do not demonstrate support for the validity of either of the two mediations models under test in the present programme. Rather, the findings of the present research programme are not inconsistent with the non-mediational associations model, which describes heightened selective attention to negative information and impairment in attentional control as independently characterising heightened anxiety vulnerability. Hence, of those models under test, the present findings demonstrate greatest support for the validity of this model. These findings clearly hold implications for the understanding of the relationships between anxiety vulnerability, selective attention to negative information, and attentional control. The implications of these findings will now be considered.
Implications of the Current Research Findings

The present research programme most strongly supports the view that anxiety-linked heightened selective attention to negative information, and anxiety-linked impairment in attentional control are independent characteristics of anxiety vulnerability. If future research were to confirm this present finding, then this will have important theoretical and applied implications. However, it is also relevant to consider that the present research programme did not observe consistent evidence of anxiety-linked heightened selective attention to negative information, and anxiety-linked impairment in attentional control. This holds important methodological implications concerning the assessment of these anxiety-linked effects. The following sections will consider these three categories of implications.

Methodological implications of the research findings. It has been an assumption of the present research programme that anxiety-linked differences in attentional control and selective attention to negative information are anxiety-linked effects that operate persistently. Hence, it has been an aim across experiments in the present programme to develop methodological variants that are more highly sensitive to these anxiety-linked effects. However, it is important to recognise that methodological variation, even if intended to increase sensitivity to an operating effect, may instead result in conditions under which no such effect operates.

For example, there are several methodological variations to the assessment of anxiety-linked heightened selective attention to negative information that have been demonstrated to result in the absence of the effect. These variations have not commonly been interpreted as variations that result in a diminished sensitivity of the methodology to detect anxiety-linked heightened selective attention to negative information, but rather have been interpreted as variations that result in conditions under which anxiety-linked heightened selective attention to negative information does not operate. One such
methodological variation reflects the variation in the intensity of negative information that is employed during the assessment of selective attention. Investigators have concluded that the use of mild intensity negative information results in the operation of anxiety-linked heightened selective attention to negative information, whereas the use of high intensity negative stimuli does not (Koster, Crombez, et al., 2006; Koster et al., 2005; Wilson & MacLeod, 2003). Other investigators have demonstrated that the relevance of negative information to the source of individual’s anxiety also modifies the occurrence of anxiety-linked heightened selective attention to negative information. Asmundson and Stein (1994) assessed selective attention to negative information amongst individuals who varied in social anxiety. It was found that anxiety-linked heightened selective attention to negative information was observed only for information that was relevant to social threats, and not to negative information that was relevant to physical threats.

Likewise, investigators have also proposed methodological variations that influence the observation of anxiety-linked impairment in attentional control. In their review of such methodological variations, Berggren and Derakshan (2012) proposed that cognitive load influences the presence or absence of anxiety-linked impairment in attentional control. In support of this proposition, Berggren, Richards, Taylor, and Derakshan (2013) assessed attentional control under conditions that provided high cognitive load, or did not provide a cognitive load. It was observed that anxiety-linked impairment in attention control resulted from the addition of the cognitive load, but was not present under conditions of no cognitive load.

Hence, for any methodological variation that is shown to influence observation of anxiety-linked heightened selective attention to negative information, or anxiety-linked impairment in attention control, it is important to determine whether the variation diminished the capacity of the methodology to detect the effect as it continued to
operate, or whether the variation modified methodological conditions such that the effect was no longer in operation. Crucially therefore, as future research continues to develop novel methodological variations for the observation of anxiety-linked differences in attentional control and selective attention to negative information, it will be critically important to differentiate which variations result in each of these alternative possibilities.

It will be important to examine the internal reliability of new methodological variants, which could influence the likelihood that such new variant will demonstrate greater, or reduced, capacity to detect the effect of interest. A programme of research that systematically manipulates methodologies, and examines internal reliability of the resulting tasks would give rise to useful information for researchers seeking to develop strengthen assessment procedures. Unfortunately, the design of the present tasks do not lend themselves to accurate assessment of statistical reliability. Such a programme of future research would require the development of attentional tasks in precise manner that made them amenable the detection of the attentional process, as well as to examination of their reliability. For example, analysis of internal reliability of a dot-probe task would require the allocation of stimulus pairs to conditions, and the presentation order of trials and conditions, to be identical across participants. These requirements could readily be satisfied in future studies, making this a potentially valuable avenue for further research.

An assessment of attentional processing that uses only one measure is unable to differentiate which variations result in the alternative possibilities. For example, if it is the case that a methodological variation does not result in observation of the intended anxiety-linked effect, it remains that such a result may be due to diminished sensitivity to the effect, or the elimination of the effect. Alternately, one means of differentiating these possibilities would be to employ multiple assessment measures of the attentional
process of interest when introducing a methodological variation. Investigators could determine whether a methodological variation that no longer observes the attentional effect of interest, under one measurement approach, did observe the effect under alternative measurement approaches. In such a case it could be proposed that the variation resulted in diminished sensitivity of the methodology under particular assessment approaches. Conversely, investigators could determine whether a methodological variation that no longer observed the attentional effect of interest, under one measurement approach, in fact continued to no longer observe the effect under alternative measurement approaches also. In this case, it could be more confidently proposed that the variation resulted the elimination of the attentional effect altogether.

The employment of concurrent assessment measures would similarly allow for the delineation of these alternatives in the case that a methodological variation resulted in the heightened evidence of anxiety-linked differences in the attentional process of interest. The concurrent measures would allow for greater confidence in concluding whether heightened evidence resulted from heightened sensitivity of the methodology to the anxiety-linked effect, or from amplified operation of the effect itself.

A programme of research that employed multiple assessment measures of an anxiety-linked effect of interest would be able to conclude upon whether a particular methodological variation modified sensitivity to the anxiety-linked effect, or modified the operation of the anxiety-linked effect. Such a programme could enhance understanding of anxiety-linked differences in attentional processing in two ways. First, the programme could inform the design of methodologies that would most sensitively detect anxiety-linked differences in attentional processing. Second, the programme could lead to a greater understanding of the conditions under which anxiety-linked differences in attentional processing operate. For these key reasons, the delineation of these two possibilities when developing novel methodological variants for the
assessment of anxiety-linked differences in attentional control and selective attention to negative information is an important prospect for future research.

**Theoretical implications of the research findings.** Although evidence of anxiety-linked heightened selective attention to negative information and anxiety-linked impairment in attentional control was not constant across the research programme, multiple observations of each effect across the research programme, as well as results of post-hoc analyses, support the existence of these anxiety-linked effects across the research programme generally.

The present finding supporting the existence of anxiety-linked heightened selective attention to negative information across the present program is consistent with theoretical models that implicate heightened selective attention to negative information in heightened anxiety vulnerability. For example, Mathews and Mackintosh (1998) described anxiety vulnerability as being characterised by a strengthened cognitive threat evaluation system that overrides attention to task demands in favour of the processing of negative information. Similarly, other theoretical accounts of anxiety vulnerability have incorporated heightened selective attention to negative information as an attentional pattern characteristic of heightened anxiety (Beck & Clark, 1997; Rapee & Heimberg, 1997; Wells & Matthews, 1996). More recently, Bar-Haim and colleagues (2007) presented a multidimensional model whereby heightened anxiety vulnerability is linked to dysfunction in a range of attentional mechanisms that selectively increases the influence of negative information to draw attention, resulting in anxiety-linked heightened selective attention to negative information.

However, the failure of the present research programme to find support for mediational accounts of the relationship between attentional control, selective attention to negative information, and anxiety vulnerability presents a challenge for theories that construe impaired control of attentional resources as a precursor to heightened selective
attention to negative information. In some instances, this contention has been central proposition of a proposed model, and therefore the validity of the model is challenged by the present findings. In other instances, this contention has been made by theorists when describing a model though does not reflect a central proposition of the model and hence the invalidity of this contention is less problematic for the function of the model itself.

When proposing key attentional mechanisms that lead to selective attention to negative information, and subsequent heightened anxiety vulnerability, Mathews and Mackintosh (1998) propose that an individual’s capacity to control the allocation of attention resources influences the degree to which negative information selectively captures attention. Specifically, they propose individuals high in anxiety vulnerability may experience a limited capacity to exert control over the allocation of attention, resulting in the more likely occurrence that attentional resources will become captured by distracting negative information. This, in turn, results in heightened anxiety dysfunction. On the other hand, individuals low in anxiety vulnerability hold sufficient attentional control such that negative information does not excessively capture attention. Crucially however, the present research programme found no evidence to suggest that heightened selective attention to negative information leads to heightened anxiety vulnerability as a result of impaired attentional control. Hence, the present findings challenge this key proposition, and hence present a challenge to the validity of the model proposed by Mathews and Mackintosh (1998).

Other theorists have made similar proposition, concerning the influence of attention control on the selective attention to negative information, when describing their own models of the cognitive underpinnings of heightened anxiety vulnerability, though such contentions have been far less paramount in the models themselves. For example, Bar-Haim et al. (2007) proposed that anxiety-linked heightened selective
attention to negative information, and in turn heightened anxiety vulnerability, may result from one of several anxiety-linked differences in the processing of stimuli, including a diminished ability to override attention to negative information in order to continue pursuit of task relevant goals. Once again, the absence of evidence of mediational relationships between attentional control and selective attention to negative information in the present research programme do not support this contention. Hence this proposed possibility is challenged by the present findings. However, as the proposition does not reflect a stringent proposition within the model, these present findings do not deeply challenge the validity of the model itself.

Similarly, in their integrative account of attentional mechanisms in anxiety vulnerability Cisler and Koster (2010) also contend that heightened selective attention to negative information may likely result from an underactivity of attentional control processes. However, the authors note that the precise relationships between candidate mediating mechanisms remains unclear, and requires further investigation. Hence, the present findings can inform the refinement of this integrative account, by proposing that impaired attentional control is unlikely to operate as a mechanism leading to heightened selective attention to negative information.

Ultimately, in the light of the present findings, it would be prudent for the development of specific theoretical models that aim to describe mechanisms of selective attention that underpin anxiety vulnerability, to not include the now challenged contention that heightened selective attention to negative information is resultant from impairment in attentional control.

The present finding supporting the existence of anxiety-linked impairment in attentional control across the research program is consistent with theoretical models that implicate impaired attentional control in heightened anxiety vulnerability. For example, processing efficiency theory (Eysenck & Calvo, 1992) describes heightened anxiety
vulnerability as being characterised by impairment in cognitive systems related to processes that allow for control of the allocation and maintenance of attention as a characteristic of anxiety vulnerability.

A more recent theory, attentional control theory (Eysenck et al., 2007), also describes heightened anxiety vulnerability as being characterised by a range of processing difference that impair the control of attentional resources. However, the failure of the present research programme to find support for mediational accounts of the relationship between attentional control, selective attention to negative information and anxiety vulnerability presents a challenge for specific predictions of this model. In their description of the relationship between attentional control and anxiety vulnerability, Eysenck et al. make the key prediction that anxiety-linked impairment in attentional control arises as a result of anxiety-linked heightened selective attention to negative information. Critically however, the present findings do not reveal support for this prediction, by demonstrating no evidence for models that proposed selective attention to negative information influenced attentional control. Hence, the current findings challenge this key prediction of attentional control theory. Conversely, the present findings suggest that specific theoretical models that aim to describe mechanisms of attentional control that underpin anxiety vulnerability, should avoid the incorporating proposal that heightened selective attention to negative information leads to impairment in attentional control.

**Applied implications of the research findings.** The present support for the suggestion that heightened anxiety vulnerability is characterised by heightened selective attention to negative information and impairment in attentional control is consistent with the nomination of the modification of these anxiety-linked differences as potential avenues for changing anxiety vulnerability (Hakamata et al., 2010; Sari et al., 2015; Wells, White, & Carter, 1997). Of importance however, the absence of evidence for the
mediational models proposed in the present research programme holds specific implications for the development of procedures that aim to modify these cognitive processes in order to ameliorate heightened anxiety vulnerability and anxious dysfunction. Implications concerning procedures intended to modify anxiety vulnerability through the modification of selective attention to negative information will now be discussed, followed by implications concerning procedures intended to modify anxiety vulnerability through the modification of attentional control.

There currently exists a range of literature indicating that the reduction of heightened selective attention to negative information contributes to amelioration of heightened anxiety vulnerability (Hakamata et al., 2010; Mathews & MacLeod, 2002). However, as yet there has been little investigation of the potential mechanisms by which this causal relation operates. Some investigators have proposed that procedures that operate to reduce selective attention to negative information may result in decreased anxiety vulnerability due to intermediary change in attentional control (Chen, Clarke, Watson, MacLeod, & Guastella, 2014; Heeren, Mogoasă, McNally, Schmitz, & Philippot, 2014). If such a proposal were supported, this would invite the conclusion that procedures seeking to reduce the impact of heightened selective attention to negative information on anxiety vulnerability could do so via procedures that operated to increase attentional control. However, the absence of evidence supporting the proposal that selective attention to negative information characterises anxiety vulnerability through attentional control does not support this possibility. Rather, the present findings are consistent with the conclusion that procedures seeking to reduce the anxiogenic consequence of heightened selective attention to negative information must directly modify selective attention to negative information itself.

It is important to note in addition that this conclusion does not completely preclude the possibility that variation in attentional control may not be relevant to the
efficacy of procedures designed to modify selective attention to negative information. For example, it may be that individuals with heightened attentional control may be more capable of engaging with the attentional requirements of the procedures themselves. However, specifically, the present findings indicate that such a pattern would not emerge as a result of variation in attentional control mediating the causal impact of selective attention to negative information on anxiety vulnerability.

As noted above, there also exist applied implications that arise concerning the understanding of procedures designed to train attentional control as a means to ameliorate heightened anxiety vulnerability. Such training procedures include therapy-based attentional training procedures that aim to increase the capacity of cognitive factors involved in the regulation of cognition and attention (Wells et al., 1997), as well as more recent procedures that employ computerised training to improve working memory and associated attentional processes (Owens, Koster, & Derakshan, 2013; Sari et al., 2015). These findings permit the conclusion that impaired attentional control plays a causal role in the expression of heightened anxiety vulnerability. However, there has been no rigorous investigation of the potential mechanisms by which this causal relation operates. Importantly, the present findings can inform upon the potential nature of this causal relation.

Specifically, the present absence of evidence supporting the possibility that attention control influences selective attention to negative information provides no indication that the impact of impaired attentional control on anxiety vulnerability may be attenuated through the modification of selective attention to negative information. Once again, the present findings are instead consistent with the conclusion that procedures that seek to reduce the negative impact of impaired attentional control on anxiety vulnerability must do so via the direct modification of attentional control. However, it is once again important to note in that this conclusion does not completely preclude the
possibility that variation in selective attention to negative information may not be pertinent to the efficacy of procedures designed to modify attentional control. However, the present findings indicate that such an observation would not emerge as a result of variation in selective attention to negative information having an intermediary effect upon the causal impact of attentional control on anxiety vulnerability.

The present findings therefore hold the important implication that the amelioration of heightened anxiety vulnerability through modification of each attentional process must occur through the modification of the specific attention processes themselves. Crucially therefore, the modification of each attentional process represents an independent avenue for the amelioration of anxiety vulnerability. Thus, training schemes that combine procedures that independently modify each attentional process may be most likely to result in the greatest amelioration of anxiety vulnerability. Importantly however, the present literature is currently unable to confirm or disconfirm the validity of this proposal, and thus its investigation provides another important avenue for future research.

Researchers have noted the need for attentional training procedures that are more capable of ameliorating heightened anxiety vulnerability (Cristea, Kok, & Cuijpers, 2015; Kuckertz & Amir, 2015; Mogoase, David, & Koster, 2014). Importantly, if the above conclusions are accurate then this would propose that attentional training procedures that incorporate methods to independently attenuate anxiety-linked differences in each attentional process will likely be the most capable ameliorating anxiety vulnerability. The present findings alone however are unable to confirm or disconfirm the validity of this proposal, and thus this provides an important avenue for future research.

In order to investigate this proposal, an experimental design could allocate individuals who are high in anxiety vulnerability to one of three conditions. These
conditions would each involve the completion of an attentional training procedure designed to ameliorate heightened anxiety vulnerability. Crucially, the conditions would differ with respect to the nature of the attentional training procedure. One condition would involve a procedure that operates to attenuate heightened selective attention to negative information, while a second condition would involve a procedure that operates to increase attentional control. A third, and critical, condition would involve a procedure that integrates both prior procedures. Each condition would examine the degree to which individuals showed a reduction in anxiety vulnerably after completion of the attentional training procedure. Crucially, if it were the case that the procedure operating to modify both attentional processes resulted in the greatest amelioration of heightened anxiety vulnerability, this would propose that attempts to increase the effectiveness of attentional training procedures to ameliorate heightened anxiety vulnerability would benefit by adopting an approach that operates to modify both attentional processes.

**Avenues for Future Research Regarding Further Investigation of the Proposed Mediation Models**

The findings of the present research programme provide a range of avenues of investigation that can serve as the focus of future research. One category of these avenues includes those that have been nominated earlier in this chapter, arising from the implications of the present research findings. It would be inappropriate to completely dismiss the validity of these proposed models purely on the basis of the current null findings. Thus, a second category of avenues includes research that will allow for the continued examination of the validity of the mediational, and non-mediational, models proposed by the present research programme. This chapter will now move to describe the second category of research by moving to discuss avenues for research concerning continued investigation of the presently proposed models.
Three potential research avenues fall within this category. The first involves the incorporation of alternative methods of assessing selective attention to negative information and attentional control, into the methodological framework presented in the present research programme. It is possible that eye-tracking measures, and elector-cortical measures of attentional processes may enhance the capacity of the presently utilised methodological framework to simultaneously observe anxiety-linked differences in each attentional process, and provide desirably robust conditions for the examination of the mediational models. A second avenues involves the assessment of particular facets of selective attention to negative information and attentional control within the present methodological framework. It is possible that the presently examined mediational relationships between selective attention to negative information, attentional control, and anxiety vulnerability, may be differentially evident when considering specific facets of selective attention to negative information or attentional control. A final avenue of research involves the consideration and assessment of specific dimensions of anxiety vulnerability, and clinical manifestations of anxiety vulnerability. It is possible that the presently proposed mediational relationships may be differentially evident when considering specific dimensions of anxiety vulnerability, or when considering specific clinical manifestations of heightened anxiety vulnerability. Each of these avenues of research, and the way in which they may be investigated, will now be described.

**Alternative methods of assessing selective attention to negative information and attentional control.** As noted above, the integration of alternative methods of assessing selective attention to negative information and attentional control within the present methodological framework may enhance its capacity to simultaneously detect
anxiety-linked differences in these attentional processes. Candidate methods include the measurement of eye-movements and the measurement of electro-cortical activity.

Assessment of selective attention to negative information and attentional control using measures of eye-movement. One method of assessing attentional distribution that has proven capable of providing measures of selective attention to negative information and attentional control is the assessment of eye-movements. This method involves tracking the movements of an individual’s eye-gaze while they view visual stimuli. Research has shown that eye movements can correspond to shifts in the focus of attention (Posner, 1980; Shepherd, Findlay, & Hockey, 1986). Thus, experiments that adopt eye-movement methodologies that allow for the assessment of attentional distribution offer a potential means of simultaneously observing anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information.

Indeed researchers have demonstrated that eye-movements can reveal differences in the allocation of attention negative information between individuals with higher, compared to lower, levels of anxiety vulnerability (Cisler & Koster, 2010; Mogg, Millar, & Bradley, 2000). For example, Mogg, Millar, and Bradley (2000) assessed selective attention to negative information in individuals with generalised anxiety disorder, and a control group, by assessing eye-movement during an attentional-probe task. Consistent with expectation of anxiety-linked heightened selective attention to negative information, it was revealed that individuals with generalised anxiety were more likely to initially execute eye-movements that directed attention to the location of negative information relative to non-negative information, as compared to the control group, and individuals with generalised anxiety were generally quicker to execute eye-movements that shifted attention towards negative information when compared to the control group. In other studies, individuals diagnosed with clinical levels of anxiety
vulnerability have been found to preferentially execute eye-movements that allocate attention to the location of a negative stimulus presented in an array of non-negative stimuli, as compared to non-anxious control groups (Bryant, Harvey, Gordon, & Barry, 1995; Felmingham, Rennie, Manor, & Bryant, 2011).

Investigators have also noted particular methodological benefits that arise from the use of eye-movement measures, as compared to measures of response time, when assessing selective attention. For example Waechter et al. (2014) assessed selective attention to negative information across a sample of participants using both response time measures and eye-movement measures. An analysis of the internal consistency of each measure revealed that response time measures held a very low level of consistency across the procedure. In contrast however, eye-movement measures specifically reflecting eye-movements to negative as compared to non-negative information were highly consistent. Thus, the capacity of eye-movement measures to detect anxiety-linked heightened selective attention to negative information, as well as evidence supporting the consistency of these measures, supports the potential for these measures to serve as complementary means of assessing selective attention to negative information.

Researchers have also demonstrated the capacity for eye-movement measures to detect anxiety-linked impairment in the capacity to move attention to instructed locations (Ansari & Derakshan, 2010; Ansari et al., 2008; Derakshan, Ansari, et al., 2009; Garner, Ainsworth, Gould, Gardner, & Baldwin, 2009). For example, Garner et al. (2009) found that individuals with relatively high levels of anxiety vulnerability exhibited a greater number errors in the direction of eye movements when attempting to follow instructions requiring the execution eye-movements away from a peripheral stimulus, as compared to individuals with lower levels of anxiety vulnerability. Likewise, investigators have observed this pattern of impairment in attentional control
amongst individuals with heightened levels of anxiety (Wieser et al., 2009). Finally, researchers have found heightened impairment in attentional control, as reflected by greater slowing amongst high anxious individuals to execute eye-movements in line with instructions that require shifting attention away from peripheral stimuli, as compared to low anxious individuals (Ansari & Derakshan, 2011; Derakshan, Ansari, et al., 2009).

Additionally, some investigators have noted the potential for eye-movement measures to detect anxiety-linked differences in attentional control that may not be reflected by variation in probe discrimination response latencies. For example, Ansari et al. (2008) measured eye-movements and probe discrimination latencies to assess attention across a task repeatedly altered the requirements for participants to attend towards, or away from, a peripheral stimulus. Analysis revealed that high anxious individuals, as compared to low anxious individuals, demonstrated impaired accomplishment of attentional requirements on measures of eye-movement, but demonstrated no anxiety-linked differences on measures of probe discrimination. This research highlights the potential for eye-movement assessment to serve as a complementary means of assessing attentional control.

It must be recognised that attentional allocation can occur in the absence of eye-movement and conversely that under particular circumstances eye-movements can occur whilst the focus of attention remains fixed (Beauchamp, Petit, Ellmore, Ingeholm, & Haxby, 2001; Groner & Groner, 1989; Hoffman, 1998; Shepherd et al., 1986). Nonetheless, the research involving anxiety-linked differences in eye-movement described above supported to possibility that the incorporation of eye-movement measures in the assessment of selective attention to negative information and attentional control, within the current methodological framework, could allow for an effective complementary means of examining the validity of the models proposed by the research programme.
Crucially, it is possible that such measures would also heightened the capacity of the attentional tasks to detect evidence of both anxiety-linked effects, thereby allowing for robust examination of the proposed models. The findings of such experiments would deliver valuable insight into these models, by providing convergent or divergent evidence for the present findings concerning the relationship between attentional control, selective attention to negative information, and anxiety vulnerability.

*Assessment of selective attention to negative information and attentional control using electro-cortical measures.* Another method that has proven capable of providing measures of selective attention to negative information and attentional control is an electroencephalographic procedure known as steady-state visual evoked potentiation (SSVEP). This technique presents individuals with visual stimuli that each flicker at a different, but constant, frequency. When stimuli are attended to, a resultant oscillatory electro-cortical response occurs in the visual cortex which matches in frequency to the attended stimulus. This response is detected via measurement of electro-cortical activity. SSVEP has certain advantages for studying spatial attention in that it provides a continuous measure of attentional distribution across stimuli presented in a visual display. Importantly, this technique has been shown to be capable of revealing the relative degree of attentional distribution across concurrently presented stimuli (Luck, Woodman, & Vogel, 2000; Müller & Hillyard, 2000).

Researchers have been able to demonstrate selective attention to particular emotional stimuli using this technique across individuals (Müller & Hillyard, 2000). Importantly, this technique has also demonstrated the capacity to detect anxiety-linked differences in attentional distribution across emotional information. McTeague et al. (2011) measured SSVEPs among individuals who varied in social anxiety in response to the presentation of images of negative and non-negative faces. It was revealed that heightened anxiety vulnerability was strongly related to enhanced distribution of
attention to face images when images depicted emotional compared to non-emotional facial expressions. Perhaps most compellingly, investigators have employed SSVEP procedures during attentional tasks very similar in design to attentional-probe tasks typically used to assess selective attention to negative information (Wieser, McTeague, & Keil, 2011). In this experiment, high and low socially anxious individuals were exposed to two emotionally discrepant facial expressions that were simultaneously flickered at different frequencies and spatial locations and were instructed to maintain eye-gaze fixation in the centre of the visual display throughout. Consistent with expectations of anxiety-linked heightened selective attention to negative information, analysis of electro-cortical responses revealed that faces depicting negative emotional expressions were allocated a relatively greater proportion of attentional distribution, compared to positive and neutral expressions, in high socially anxious individuals, but not low socially anxious individuals. Similarly, (Wieser, McTeague, & Keil, 2012) demonstrated evidence consistent with anxiety-linked heightened selective attention to negative information by revealing angry face distractor stimuli, relative to a neutral or happy face distractor stimuli, elicited heightened SSVEP amplitudes in individuals with heightened social anxiety.

The use of SSVEP techniques may also provide a complementary means of assessing individual differences in attentional control. For example, Toffanin et al. (2009) used the technique to assess participants performance on a visual detection task that required participants to identify the presence of a single digit embedded in a stream of characters. Two stimulus streams were displayed simultaneously to the left and right of fixation, and each stream flickered at a different frequency. At the beginning of each trial a cue indicated whether targets presented on the left, or right, should be attended to. Importantly, SSVEP responses were able to determine the relative distribution of attention across streams, and revealed evidence of greater attentional distribution to
streams that participants were instructed to attend to, compared to streams that participants were not instructed to attend to. Thus, SSVEP could also plausibly provide a means of assessing anxiety-linked differences in the degree to which individuals are able to control the allocation of attention in correspondence with attentional objectives.

The measurement of SSVEP provide an additional means of assessing attentional control and selective attention to negative information that would serve to complement measures of response time and inspection time, and eye-movement. The adaption of the attentional assessment tasks employed by the present research programme to include SSVEP assessment of each attentional process would allow a valuable means of further of examining the validity of the models proposed by the research programme. Crucially, it is possible that such measures would also heightened the capacity of the attentional task to observe evidence of both anxiety-linked effects, thereby allowing for robust examination of the proposed models. Never-the-less such experiments would deliver valuable insight into the validity of the proposed models, by providing an alternative approach to the assessment of the relationships between attentional control, selective attention to negative information, and anxiety vulnerability.

Importantly, these use of eye-movement and SSVEP measures potentially allows for future experiments to assess selective attention to negative information and attentional control in closely matching ways when further examining the validity of the findings of the present research programme. Ultimately, the pursuit of both of the above described lines of investigation would allow for a highly informed understanding of the validity of the relationships between attentional control, selective attention to negative information, and anxiety vulnerability, that are proposed by the research programme. Thus, the pursuit of these avenues of research reflects an important means of continuing the assessment of the validity of these models.
Assessment of alternative facets of selective attention to negative information and attentional control. When assessing selective attention to negative information and attentional control the present programme did not discriminate between alternative attentional mechanisms that may underpin these attentional processes. Importantly, the validity of the presently proposed mediational models may be differentially evidenced when considering alternative facets of selective attention to negative information or attentional control. Tests of specific hypotheses that arise from the consideration of these alternative facets, utilising the same methodological framework employed in the present research programme, would allow for a markedly nuanced examination of the currently proposed models describing the relationship between attentional control and selective attention to negative information, and anxiety vulnerability. Candidate facets of selective attention to negative information, and attentional control, will now be discussed.

Assessment of alternative facets of selective attention to negative information. Research has long recognised that visual attention is comprised of numerous underlying mechanisms. Two distinct mechanisms that have received consideration in the investigation of visual attention are processes of attentional engagement and attentional disengagement (Posner, 1980; Posner, Walker, Friedrich, & Rafal, 1984). Attentional engagement refers to the shifting of attentional focus to a stimulus that is distal to the initial locus of attention. Attentional disengagement on the other hand refers to the shifting of attention away from a stimulus that was the initial focus of attention. More recently, investigators have examined the relative role these mechanisms hold in the expression of anxiety-linked heightened selective attention to negative information. In this case, anxiety-linked heightened selective attention to negative information would be demonstrated by either anxiety-linked enhanced attentional engagement with negative
information, or anxiety-linked delayed attentional disengagement from negative information.

To do so researchers have developed novel attentional-probe methodologies that allow for the independent assessment of engagement and disengagement facets of selective attention to negative information (see Clarke, Macleod, & Guastella, 2013). These paradigms have not only demonstrated evidence of heightened attentional engagement with negative information and delayed attentional disengagement from negative information in individuals with heightened levels of anxiety vulnerability, but have also revealed that these facets independently characterise heightened anxiety vulnerability (Grafton & MacLeod, 2014; Rudaizky et al., 2014). Thus, for some individuals, anxiety-linked heightened selective attention to negative information may occur as a result of heightened attentional engagement with negative information, while for other individuals, anxiety-linked heightened selective attention to negative information may arise from delayed attentional disengagement from negative information.

This raises the interesting possibility that attentional control may be differentially associated with attentional engagement with negative information and attentional disengagement from negative information. For example, while anxiety-linked impairment in attentional control and anxiety-linked heightened selective attention to negative information may not be functionally related among individuals whose anxiety vulnerability is associated with heightened attentional engagement with negative information, these processes may be functionally related among individuals whose anxiety vulnerability is associated with delayed attentional disengagement from negative information. As experiments in the present research programme did not differentiate between these facets of selective attention to negative information, this proposal cannot be examined from the present data. Crucially however, future research
could pursue these possibilities by incorporating independent assessments of attentional engagement with, and attentional disengagement from, negative information into the presently employed methodological framework. This would allow precise hypotheses to be tested concerning the relationship between specific facets of selective attention to negative information, attentional control, and anxiety vulnerability.

**Assessment of alternative facets of attentional control.** A number of attentional mechanisms have been found to underlie the capacity of individuals to control the allocation of attention. Miyake et al. (2000) identified distinct facets that provide separable contributions to the effective control of attention, including mental set shifting, information updating and monitoring, and the inhibition of pre-potent attentional responses. Some accounts of the relationship between anxiety vulnerability and attentional control have sought to identify particular mechanisms that underpin anxiety-linked impairment in attentional control. These investigations have revealed anxiety-linked impairment in multiple facets of attentional control, including inhibition of pre-potent attentional responding, attentional distractibility, and attentional task switching.

Heightened anxiety has been associated with impaired performance in the inhibition of pre-potent attentional responses. For example, Pallak et al. (1975) found high anxious participants, compared to low anxious participants, showed greater difficulty in inhibiting the pre-potent response of colour naming colour incongruent words during a Stroop task. More recently, investigator have demonstrated that high anxious individuals, compared to low anxious individuals, make greater errors when required to the focus of attention away from an attention capturing stimulus (Wieser et al., 2009), and are slower to make attentional shifts away from such stimuli (Ansari & Derakshan, 2010; Derakshan, Ansari, et al., 2009).
A number of studies have also identified heightened anxiety vulnerability to be associated with increased distractibility by task irrelevant stimuli. Calvo and Eysenck (Calvo & Eysenck, 1996) investigated effects of distraction on text comprehension performance and found that distracting stimuli had a significantly greater negative effect on performance among high anxious individuals, as compared to low anxious individuals. Similarly, Eysenck and Graydon (1989) identified that the performance of high trait anxious individuals on a letter-transformation task was impaired by distracting stimuli to a greater degree as compared to low trait anxious individuals.

Further research has also revealed anxiety-linked impairment in the capacity to switch attentional objectives. Derakshan, Smyth, and Eysenck (2009) required low and high anxious individuals to complete simple arithmetic operations under conditions that frequently switched the presented mathematical operators, or kept the operators constant. Latencies to complete the operations under each condition revealed that low anxious participants performed equivalently under each condition, however, high anxious individuals displayed significant delay in performing the completing operations in the task switching condition relative to the non-task-switching condition. Supporting evidence for anxiety-linked impairment in attentional switching has been observed through the assessment of eye-movements. Ansari, Derakshan, and Richards (2008) assessed performance in an antisaccade task that either consistently required pro-saccades or anti-saccades in response to a presented stimulus, or inconsistently required pro-saccades or anti-saccades in response to a presented stimulus. It was found that high anxious participants, relative to low anxious participants, were disproportionately delayed to perform correct saccades under task-switching conditions compared to non-task-switching conditions.

Additionally, some theorist have promoted a distinction between explicit attentional control, which involves the voluntary control of attention in accordance with
voluntary attentional goals, and implicit attentional control, which involves the control of attentional allocation without awareness (Schmidt, Crump, Cheesman, & Besner, 2007). Hence, there arises the interesting possibility that experimental tasks that can dissociate these two putative forms of attentional control may demonstrate that variation in each is differentially associated with variation in selective attention to negative information.

The research above raises the interesting possibility that discrete facets of attentional control may be differentially associated with selective attention to negative information. As experiments in the present research programme did not differentiate between these facets of attentional control, this possibility cannot be examined here. However, future research could investigate these possibilities by assessing each facet of attentional control within the present methodological framework. Such designs would again allow for the examination of more precise hypotheses concerning the relationship between facets of attentional control, selective attention to negative information, and anxiety vulnerability, thereby allowing for a more precise understanding of the attentional underpinnings of anxiety vulnerability.

Of course, future research need not only limit itself to the incorporation of alternate facets of selective attention to negative information, or alternate facets of attentional control, but may incorporate examination of both avenues of research. Ultimately, the combined pursuit of both of the above described lines of investigation would generate an impressive matrix of potential hypotheses, whose examination would allow for a greatly detailed understanding of the validity of the relationships between attentional control, selective attention to negative information, and anxiety vulnerability, that have been proposed by the present research programme.

If the examination of any of these combinations of hypotheses were to result in findings that supported the validity of the presently proposed meditational models, this
would hold a range of important implications for the conceptualisation of anxiety vulnerability, as well as for the development attentional tasks intended to ameliorate heightened anxiety vulnerability. Hence, these lines of research, as well as their integration, reflects an important avenue for continuing the assessment of these models.

**Assessment of alternative dimensions and clinical manifestations of anxiety vulnerability.** A final category of research concerns the consideration of alternative dimensions of anxiety vulnerability, including anxiety-reactivity and anxiety-perseveration, and clinical manifestations of heightened anxiety vulnerability. This section will now discuss these potential avenues of research.

**Assessment of alternative dimensions of anxiety vulnerability.** An important avenue for future research involves the consideration of distinct dimensions of anxiety vulnerability. In their examination of variation in trait-anxiety Rudaizky et al. (2013) independently assessed two conceptual dimensions of anxiety vulnerability which they argued could make independent contributions to heightened anxiety vulnerability. These dimensions were labelled anxiety-reactivity, the probability of experiencing an anxious reaction to a stress inducing event, and anxiety-perseveration, the persistence of anxiety symptoms once they are elicited. Examination of participants’ responses across scales designed to assess each dimension of anxiety vulnerability determined that anxiety-reactivity and anxiety-perseveration scores accounted for independent variance in trait-anxiety scores, thus revealing that anxiety-reactivity and anxiety-perseveration reflected dissociable dimensions of anxiety vulnerability. In their deliberation of this finding the authors invited speculation concerning the distinction between the patterns of attentional processing that may differentially contribute to elevated anxiety-reactivity, and to elevated anxiety-perseveration.

When assessing anxiety vulnerability, the present programme did not distinguish between these specific dimensions of anxiety vulnerability. Thus, the present
programme is unable to conclude as to whether the validity of the proposed mediational relationships differs when these dimensions of anxiety vulnerability are considered specifically. For example, it may be the case that heightened selective attention to negative information results in impaired attentional control only for individuals who experience heightened anxiety perseveration, whereas attentional control plays no part in the relationship between selective attention to negative information and anxiety vulnerability amongst individuals with heightened anxiety reactivity.

Future research could examine these possibilities by modifying the presently employed methodologies to substitute the presently adopted measures of anxiety vulnerability with measures capable of revealing variation in anxiety-reactivity or anxiety-perseveration specifically. Interestingly, previous research has demonstrated the assessment of these dimensions of anxiety vulnerability using questionnaire and in-vivo procedures (Rudaizky & MacLeod, 2014; Rudaizky, Page, & MacLeod, 2012). Thus, research could incorporate these complementary means of assessing anxiety reactivity and anxiety perseveration within the current methodological framework, in order to further investigate the relationship between selective attention to negative information, attentional control, and these dimensions of anxiety vulnerability.

Until now, potential avenues for research have considered ways in which the validity of the models proposed by the present research programme may tested further. However, if it is the case that continued investigation of the proposed models continues to find evidence in support of the functional independence of anxiety-linked heightened selective attention to negative information, and anxiety-linked impairment in attentional control, within anxiety vulnerability, then this will also raise interesting avenues for future research.

If it is established that heightened selective attention to negative information, and impairment in attentional control reflect functionally independent characteristics of
heightened anxiety vulnerability, then future research could investigate whether each anxiety-linked attentional process differentially contributes to distinct aspects of anxiety phenomenology. Once again, the distinction made by Rudaizky et al. (2014; Rudaizky et al., 2012), which identifies alternative dimensions of anxiety vulnerability, serves as an interesting target for investigation. Specifically, it is may be the case that anxiety-linked differences in selective attention to negative information and attentional control differentially characterise anxiety-reactivity and anxiety-perseveration dimensions. An experimental design could utilise an attentional task capable of measuring selective attention to negative information and assessing attentional control, as well as measures of undifferentiated anxiety vulnerability, anxiety-reactivity, and anxiety-perseveration. If it were found that either attentional process was differentially associated with each dimension of anxiety vulnerability, or was shown to specifically contribute to a dimension of anxiety vulnerability, as compared to then to anxiety vulnerability generally, then it could be concluded that these attentional process independently characterise specific phenomenology of anxiety vulnerability, rather than simply being characteristic of anxiety vulnerability generally. Additionally, such findings would suggest that the assessment of anxiety-linked differences in an attentional process may be enhanced by specifically considering the specific dimension of anxiety vulnerability it was found to be most greatly associated with.

**Consideration of clinical manifestations of anxiety vulnerability.** As mentioned prior, it is also possible that relationships between attentional control, selective attention to negative information, and anxiety vulnerability differ when considering specific forms of clinical symptomatology. As well as characterising individuals with heightened levels of trait anxiety, heightened selective attention to negative information has been found to characterise individuals with a range of clinical diagnoses relating to heightened anxiety vulnerability (Bar-Haim et al., 2007). Similarly, impairment in
attentional control has been observed to characterise anxiety disorder symptomatology amongst patients diagnosed with obsessive-compulsive disorder and generalised anxiety disorder (Armstrong, Zald, & Olatunji, 2011; Pacheco-Unguetti et al., 2011), and post-traumatic stress disorder (Schoorl, Putman, Van Der Werff, Van Der Does, & Van Der Does, 2013; Sippel & Marshall, 2013). While it is possible that the pattern of findings presently obtained across high trait anxious, but non-clinical, individuals in the research programme may also reflect the pattern of effects within clinically anxious individuals, it is nevertheless possible that features that distinguish individuals with clinical diagnoses of anxiety vulnerability, from individuals who do not meet clinical criteria, includes differences in the relationship between attentional control and selective attention to negative information. For example, while highly anxious, but non-clinical, individuals may typically be characterised by anxiety-linked heightened selective attention to negative information, or anxiety linked impairment in attentional control, individuals with clinical diagnoses may typically be characterised by both anxiety-linked effects. Such information would be helpful in the development of effective attentional training methodologies that seek to ameliorate clinical levels of anxious dysfunction through the modification of selective attention to negative information and attentional control (Mogoase et al., 2014; Owens et al., 2013).

Critically, as the present research programme did not recruit individuals on the basis of clinical diagnoses, the validity of alternate mediating relationships between attentional control and selective attention to negative information, within specific types of clinical anxiety symptomatology, cannot be determined by the present research programme. Thus, a clear avenue for future research is to examine the models proposed by the present programme across populations that have clinical presentations of anxiety vulnerability. This could be achieved by simply substituting the assessment of trait anxiety used in the present methodology, with assessment of specific clinical anxious
symptomatology, while continuing to utilise an attentional task capable of measuring selective attention to negative information and attentional control in manner that conforms to the methodological criteria employed by the present research programme.

Mirroring the consideration of alternative dimensions of anxiety vulnerability described prior, if future research demonstrates that heightened selective attention to negative information, and impairment in attentional control, reflect functionally independent characteristics of clinical manifestations of anxiety vulnerability, then future research could investigate whether each anxiety-linked attentional process differentially contributes to specific clinical anxiety symptoms.

Some evidence for this proposal has been observed through the assessment of attentional control across groups of individuals with different clinical diagnoses. For example, Armstrong, Zald, and Olatunji (2011) compared the relationship between attentional control and disorder specific symptomatology in patients with obsessive-compulsive disorder and generalised anxiety disorder. Interestingly, impairment in attentional control was found to be associated only with disorder specific symptoms of obsessive-compulsive disorder, with greater impairment in attentional control revealed to be associated with greater severity of obsessional thoughts. Conversely, no association revealed was between attentional control and disorder specific symptoms of generalised anxiety disorder. However, limited exploration of this possibility at the present time means that further investigation of the association between impairment in attentional control and specific symptomatology of anxiety related clinical disorders is needed.

An experimental design capable of assessing selective attention to negative information and attentional control, as well as specific anxious symptomatology associated with an anxiety disorder of interest, would allow for such investigation. Importantly, if it were found to be the case that an attentional process was differentially
associated with specific symptomatology, this would suggest that the attentional process may contribute to only specific manifestations of anxiety vulnerability, and may even suggest that the modification of either attentional process would serve to attenuate specific aspects of a clinical disorder symptomology. Such information would be especially helpful in the development of current attentional training methodologies that seek to ameliorate clinical levels of anxious dysfunction through the modification of selective attention to negative information and attentional control (Hakamata et al., 2010; Owens et al., 2013).

Concluding Comments

The present research programme was designed to examine the validity of three models concerning the relationship between anxiety vulnerability, anxiety-linked heightened selective attention to negative information, and anxiety-linked impairment in attentional control. The present research programme provided no support for the validity of the model that proposed a mediating role of attentional control in the relationship between anxiety vulnerability and selective attention to negative information, and no support for the model that proposed a mediating role of selective attention to negative information on the relationship between anxiety vulnerability and attentional control. Rather, the results of the research programme provided greatest support for the validity of a model that describes the two attentional process as independent characteristics of anxiety vulnerability. The findings of the present programme hold methodological, theoretical and applied implications concerning each anxiety-linked attentional process. Future avenues of research will be able to build upon these implications in a number of ways. This research would further strengthen understanding of the relationship between attentional control, selective attention to negative information, and anxiety vulnerability, by adopting novel methods of assessing anxiety-linked differences in each attentional process, and by assessing specific facets of attentional control, selective
attention to negative information, and anxiety vulnerability. Which of these various candidate lines of future research are most important to pursue? This will depend upon the specific objectives of the researcher. For example, for researchers seeking to understand the role of cognitive processing in clinical manifestations of anxiety it would perhaps be of greatest utility to pursue examination of the present research question in cohorts of participants with clinical diagnoses of anxiety pathology. However, for researchers seeking to understand the neurological mechanisms underpinning anxious disposition, it may be more useful to examine SSVEP or ERP correlates of the presently observed attentional effects. Regardless of the specific questions asked, and research approach adopted, enhanced understanding of the relationship between attentional control, selective attention to negative information, and anxiety vulnerability is likely to hold implications for our understanding of heightened anxiety vulnerability, and for our ability to ameliorate such vulnerability. Thus, these facets of research all can serve a complementary role in the ultimate understanding of anxiety vulnerability, and so the importance of utility of each facet of research alone cannot be segregated. Ultimately, it is hoped that the present research programme has provided some insight of, and will stimulate further investigation into, the nature of the relationships between attentional control, selective attention to negative information, and anxiety vulnerability.
References


Parametric fMRI Study of Overt and Covert Shifts of Visuospatial Attention.  


http://doi.org/10.1016/j.biopsycho.2012.03.007

http://doi.org/10.3389/fnhum.2013.00188

http://doi.org/10.1016/j.tics.2007.05.008


http://doi.org/10.1016/0167-8760(95)00036-4

Burgess, I. S., Jones, L. M., Robertson, S. A., Radcliffe, W. N., & Emerson, E. (1981). The degree of control exerted by phobic and non-phobic verbal stimuli over the


performance using a task-switching paradigm: an investigation of attentional
http://doi.org/10.3758/PBR.16.6.1112

Derryberry, D., & Reed, M. a. (2002). Anxiety-related attentional biases and their
regulation by attentional control. *Journal of Abnormal Psychology, 111*(2), 225–

attentional biases: Effects of feature-specific attention allocation. *Cognition &

http://doi.org/10.1080/0269939208409696

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and
http://doi.org/10.1037/1528-3542.7.2.336

Eysenck, M. W., & Graydon, J. (1989). Susceptibility to distraction as a function of
http://doi.org/10.1016/0191-8869(89)90227-4

Felmingham, K. L., Rennie, C., Manor, B., & Bryant, R. a. (2011). Eye tracking and
physiological reactivity to threatening stimuli in posttraumatic stress disorder.
*Journal of Anxiety Disorders, 25*(5), 668–73.
http://doi.org/10.1016/j.janxdis.2011.02.010

Foa, E. B., & McNally, R. J. (1986). Sensitivity to feared stimuli in obsessive-
compulsives: A dichotic listening analysis. *Cognitive Therapy and Research,

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or
hold visual attention in subclinical anxiety? *Journal of Experimental Psychology:

attentional control in high and low anxious healthy volunteers: evidence from the
antisaccade task. *European Neuropsychopharmacology, 19*, S599.
http://doi.org/10.1016/S0924-977X(09)70960-5

Grafton, B., & MacLeod, C. (2014). Enhanced probing of attentional bias: The
independence of anxiety-linked selectivity in attentional engagement with and
disengagement from negative information. *Cognition and Emotion, 28*(7), 1287–


MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, G., & Holker, L. (2002). Selective attention and emotional vulnerability: Assessing the causal basis of their


Reinholdt-Dunne, M. L., Mogg, K., & Bradley, B. P. (2009). Effects of anxiety and
REFERENCES

attention control on processing pictorial and linguistic emotional information. 
*Behaviour Research and Therapy, 47*(5), 410–7.
http://doi.org/10.1016/j.brat.2009.01.012

Reinholdt-Dunne, M. L., Mogg, K., & Bradley, B. P. (2012). Attention control: 
Relationships between self-report and behavioural measures, and symptoms of 
http://doi.org/10.1080/02699931.2012.715081

Richards, A., French, C. C., Johnson, W., Naparstek, J., & Williams, J. (1992). Effects 
of mood manipulation and anxiety on performance of an emotional Stroop task. 
8295.1992.tb02454.x

people with social, emotional and behavioural difficulties. *Learning and Individual 

*Social and Personality Psychology Compass, 5*(6), 359–371.

Rudaizky, D., Basanovic, J., & MacLeod, C. (2014). Biased attentional engagement 
with, and disengagement from, negative information: Independent cognitive 
http://doi.org/10.1080/02699931.2013.815154

Rudaizky, D., & MacLeod, C. (2013). Anxiety reactivity and anxiety perseveration 
represent dissociable dimensions of anxiety vulnerability: A replication and 
http://doi.org/10.1111/ajpy.12024

Rudaizky, D., & MacLeod, C. (2014). Anxiety reactivity and anxiety perseveration 
represent independent dimensions of anxiety vulnerability: an in vivo study. 
http://doi.org/10.1080/10615806.2013.853047

Rudaizky, D., Page, A. C., & MacLeod, C. (2012). Anxiety reactivity and anxiety 
perseveration represent dissociable dimensions of trait anxiety. *Emotion, 12*(5), 

Rutherford, E., MacLeod, C., & Campbell, L. W. (2004). Negative selectivity effects 
and emotional selectivity effects in anxiety: Differential attentional correlates of
http://doi.org/10.1080/02699930341000121

http://doi.org/10.1016/j.biopsycho.2015.09.008


http://doi.org/10.1016/j.janxdis.2013.10.001

http://doi.org/10.1080/14640748608401609

http://doi.org/10.1037//1082-989x.7.4.422


Spielberger, C. D., & Sydeman, S. J. (1994). State-Trait Anxiety Inventory and State-Trait Anger Expression Inventory. In M. E. Maruish (Ed.), *The use of*


REFERENCES


