EMOTIONAL PROCESSING IN ANXIETY: DISPROPORTIONATE ACTIVATION OR AN INABILITY TO INHIBIT?

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ABSTRACT

Experiment 1 investigated the cognitive biases which have been demonstrated when anxious subjects process threatening material (e.g., MacLeod & Rutherford, 1992; MacLeod & Locke, 1994). The design of Experiment 1 was modelled closely on the study carried out by MacLeod and Locke. Undergraduate students divided into high and low trait anxiety groups completed an attentional deployment task under conditions of elevated (exam proximal) and lowered (exam distal) state anxiety. Two issues were of central interest. The first was whether high trait anxious subjects with elevated state anxiety would be disproportionately activated to respond to threatening stimuli. This pattern of results has been found by researchers using attentional deployment tasks and expressed in terms of anxious individuals having a selective encoding bias towards threatening material (e.g. Broadbent & Broadbent, 1988; MacLeod & Locke, 1994; Mogg, Mathews & Eysenck, 1992). For the purposes of this thesis this theoretical position was termed the disproportionate activation hypothesis. The second issue was whether anxious subjects, instead of being disproportionately activated to respond to threatening stimuli, are unable to inhibit threatening information from entering selective attention. This would normally occur through cognitive inhibition, a process identified in research using the negative priming paradigm (Tipper, 1985). This new theoretical position was termed the inability to inhibit hypothesis.

In Experiment 1, on each trial, subjects were presented with a prime phase then a probe phase. The prime phase consisted of a target word (printed in green) and a distractor word (printed in red). The subject's task was to focus on the green word. In the probe phase, a word printed in white was presented, which the subject named. Naming latencies on the probe phase were recorded. On some trials an attention check phase occurred which was designed to test whether the subject had been attending to the target word in the prime phase. The stimulus materials consisted of several categories of threat and nonthreat words. The results failed to support the disproportionate activation hypothesis and could not be used to evaluate the inability to inhibit hypothesis because an effect of negative priming was not obtained.

The aim of Experiment 2 was to investigate the possible reasons for the failure to obtain negative priming in Experiment 1. A review of the literature identified several factors thought to affect the occurrence of negative priming: the presence or absence of a probe distractor, the degree of angular separation between the stimuli on the prime phase and the degree of angular separation between the stimuli on the probe phase. These factors were then manipulated using a design which closely resembled Experiment 1, excluding the factor based on trait anxiety. The attention check phase was also made more difficult. However, these manipulations and the tightening of the attention check phase failed to produce a negative priming effect. Further factors which may affect negative priming are identified and discussed in the general discussion. Reasons are also considered for the failure to find support in Experiment 1 for the disproportionate activation hypothesis.

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CHAPTER 1

GENERAL INTRODUCTION

1.1 Scope of this review

This review covers the literature relevant to the cognitive processing of anxious individuals. The first section provides a conceptualisation of what anxiety is, the variables that relate to anxiety and the incidence of anxiety disorders in the community. The second section considers the issue of whether the experience of emotion involves cognitive processes. This is followed by a review and evaluation of the prominent cognitive models of emotional processing. Research supporting these cognitive models is then reviewed. At this point the concept of cognitive inhibition is introduced and it is suggested that cognitive inhibition may provide an alternative explanation of the findings supporting the prominent cognitive models. However, before this possibility is discussed, experiments which have measured cognitive inhibition in normal and clinical populations are reviewed to provide the reader with an understanding of the paradigm used to measure cognitive inhibition. This leads on to a discussion of the possibility that inhibitory processes may differ between anxious and non-anxious individuals.

1.2 Defining the issue of anxiety

Spielberger (1972) states that anxiety is elicited by the perception that a particular stimulus is potentially harmful, dangerous or threatening, facilitating the awareness and the avoidance of danger. Spielberger put forward that anxiety consists of both a transient mood state which is triggered whenever an individual interprets a particular stimulus or situation to be potentially harmful, dangerous or threatening and a relatively stable trait characteristic which accounts for individual differences in the propensity to experience elevations in state anxiety. Elevations in state anxiety help individuals prepare themselves to effectively deal with situations which are potentially dangerous or threatening by preparing the individual's physiological system for action, and focussing that individual's cognitive resources towards the sources of threat. However, some researchers (e.g., Zajonc, 1980) state that anxiety can be experienced without cognition. This possibility will be discussed in the next section.

1.3 Does emotion require cognition?

In some individual's anxiety becomes maladaptive when it occurs at an intensity and/or frequency which impedes those individuals functioning. According to Weissman (1985) the reported annual incidence of anxiety disorders is between 4% and 8% of the population. Given this high incidence much research has focussed on understanding anxiety disorders with one major stream investigating cognitive dysfunction.

This issue of whether emotion requires cognition is of central importance in considering whether a cognitive approach to understanding emotion is viable and has been the subject of some debate. The controversy was initiated by Zajonc (1980) who put forward that emotion was a very basic process which can occur independently of cognition. Zajonc performed several studies which he claimed provided support for his theoretical position. He presented melodies and pictures either very briefly at a subliminal level or while the subject was involved in a secondary task. Zajonc found that subjects could not recall having seen or heard the stimuli that had been presented, but were more likely to choose previously presented stimuli than equivalent new stimuli when asked to select the ones they preferred. Therefore, he observed a positive emotional reaction to previously presented stimuli without evidence of cognitive processing.

Lazarus (1982) put forward a theoretical position which opposed Zajonc (1980) by stating that cognitive appraisal underlies and is an integral feature of all emotional states. He divided cognitive appraisal into three specific stages which occur sequentially. These are: (1) primary appraisal where an appraisal is made of the environmental situation as being positive, stressful or irrelevant to wellbeing; (2) secondary appraisal where an account is taken of the resources the individual can call on to cope with the situation; and (3) reappraisal which involves the monitoring of coping strategies and the modification of primary and secondary appraisals if necessary. Lazarus investigated his theoretical position by performing studies in which subjects were shown an anxiety provoking film under several conditions where he manipulated cognitive appraisal by varying the accompanying soundtrack. Lazarus found that when the soundtrack emphasised denial or intellectualisation subjects showed substantial reductions in stress on psychophysiological measures.

Eysenck and Keane (1990) state that the available empirical evidence does not provide a convincing answer to the question. However, they point out that Lazarus's studies have far more direct relevance to everyday emotional experience than do those of Zajonc, providing grounds for assuming that emotional experience is generally preceded by cognitive processes. Mathews and MacLeod (1994) state that the view that cognitive processes are closely related to emotion has been steadily gaining ground. However, disagreement continues about the extent and nature of this relationship. Cognitive theorists have put forward that the critical processes involved in emotion are automatic (Bower, 1992) and Lazarus (1982) states that cognitive appraisal does not have to involve conscious processes. Mathews and MacLeod state that if it is assumed that automatic and nonconscious processes may be involved in emotion, then many of the objections to cognitive models appear less compelling. The prominent cognitive models of emotional processing will now be discussed.

1.4 Cognitive models of emotional processing

1.4.1 Bower's network model of emotional processing

Bower (1981) proposed a theory concerned with the relationship between mood and memory. This theory was subsequently extended by Bower and Cohen (1982), and Bower (1987). The starting point for Bower's theoretical approach is the notion that long term memory can be regarded as a semantic associative network in which concepts are represented as nodes. Emotions are also represented as nodes within the semantic framework. Bower (1981) put forward that when any node is activated by external or internal stimuli, activation from that node spreads in a selective fashion to other related nodes. In the case of an individual who is in an anxious state, the node for that emotion is activated and activation spreads to associated nodes. Although Bower does not discuss the specific content of the information contained in the nodes, he states that the associated nodes will typically contain information which is congruent in mood with the experienced emotion. Thus, in the case of anxiety, concepts such as "danger" and "failure" would become activated when the person was feeling anxious. This would render the cognitive system to be disproportionately activated towards stimuli associated with "danger" and "failure" resulting in increased attention, faster perception and more extensive processing of these stimuli in relation to non mood related stimuli. In other words, a mood-congruent processing bias is created because of increased activation of mood-congruent information.

The basic network theory was extended by Bower and Cohen (1982) to include the notion of automatic processing. These researchers argued that the activation of any emotion node would automatically lead to the experience of that emotion. However, it is easy to think about anxiety without becoming anxious. In order to explain this situation, Bower and Cohen introduced the notion of a "blackboard" which closely modelled the concept of "working memory" described by Baddeley and Hitch (1974). According to Bower and Cohen, in order to re-experience an emotion associated with a particular event, it is necessary to recreate the state of the "blackboard" or working memory as well as activating the appropriate emotion node.

Although Bower has been mainly concerned with providing a theoretical account of the effects of current mood state on information processing, and his research has been typically carried out on groups of normal subjects, his research is relevant to clinical populations for several reasons. First, induced mood in normal individuals may have the same effects on cognition as current mood state in anxious and depressed patients. Second, it has been put forward by Ingram (1984) that individuals differ in the degree to which the associative connections surrounding each emotion node are developed. Specifically, it has been suggested that anxious patients tend to have more nodes strongly associated with the anxiety node than normals. It is hypothesised by Ingram that such differences in the semantic network could account for the differences in cognitive functioning between normal and clinical populations.

1.4.2 Beck's schema model

Beck and his colleagues (Beck & Emery, 1985; Beck & Clark, 1988) have proposed an influential account of cognitive processing in anxiety which makes almost identical predictions to Bower's network model of emotional processing. However, Beck's model was developed through clinical observations while Bower followed an experimental approach.

A central component of Beck's model is the notion of schemas. Beck and Clark (1988) proposed that schemas form an integrated body of knowledge that reside in long term memory and are built upon by life experience. Schemas serve a central function in information processing as they guide the screening, encoding, organising, storing and retrieval of information. However, Beck and Clark (1988) put forward that some schemas are maladaptive and cause an individual to become vulnerable to developing an anxiety disorder. These schemas are hypothesised to contain perceived physical or psychological threat to one's personal domain as well as an exaggerated sense of vulnerability to this type of threat. In depression, these schemas are hypothesised to contain negative cognitions to do with loss and failure. For anxious individuals these schemas contain an overestimation of the degree of danger associated with situations and an underestimation of the individual's ability to cope with the perceived danger. These maladaptive schema are most likely to become activated with the occurrence of life stressors resulting in changes of cognitive functioning which Beck and Clark identify as the major features of anxiety disorders.

The changes in cognitive functioning brought about by maladaptive schemas becoming a prominent part of an individuals information processing system are as follows. First, anxious individuals will be hypersensitive to any aspects of a situation that are interpreted as being potentially harmful but will not respond to its positive aspects. In some cases, the number of stimuli which can evoke anxiety will increase due to the individual's information processing framework being geared to detect and process such stimuli. For example, Beck and Emery (1985) suggested that in generalised anxiety disorder the range of stimuli perceived as dangerous may increase until almost any stimulus is perceived as dangerous. Second, ambiguous stimuli will be interpreted in a threatening fashion. Third, threatening information will be readily retrieved from memory. Fourth, Beck and Emery make the prediction that anxious individuals will have a reduced processing capacity due to a large part of the individual's cognitive capacity being used up by scanning for threatening stimuli. Fifth, Beck and Emery and Beck and Clark (1988) proposed that cognitive processing guided by the maladaptive cognitive schemas is automatic and therefore can occur without attention or awareness.

1.4.3 Evaluation of Bower's network model and Beck's schema model

MacLeod (1990) points out that although the hypothetical mechanisms underlying the predicted relationship between emotion and cognition are very different in the network and schema models, the two models share highly similar central predictions. First, both models suggest that mood-congruent information will be disproportionately available to the cognitive system during encoding and recall. Second, both suggest that the interpretation of ambiguous information will be biased towards mood-congruent interpretations. Third, both models provide roles for trait and state variables. Although Bower's model emphasises the role played by current mood state in mediating the occurrence of mood-congruent processing, the model can also accommodate more stable individual differences associated with trait vulnerability. This is because individuals who have high trait vulnerability to a particular emotion will have experienced this emotion more frequently and under a wider range of circumstances, than would be the case for low trait individuals. Therefore, the strength and richness of associative connections between emotion nodes and related affect-congruent information will be more highly developed in high trait individuals. In this way, the affect-congruent processing biases predicted by Bower's model will be a result of an interaction between state and trait variables. Beck's model emphasises the role of trait variables by describing the development of maladaptive schemas but also implicates state variables by identifying current life stressors as a precursor to the development of mood disorders. Finally, both models suggest that cognitive biases can occur without intention and awareness.

Experiments were conducted to test the predictions advanced by Bower and Beck, and were designed to examine whether memory biases for negative stimuli distinguished clinically anxious and clinically depressed individuals from normal controls. Memory biases for negative stimuli were found in clinically depressed subjects (Bradley & Mathews, 1983; Clark & Teasdale 1982; Derry & Kuiper, 1981). However, memory biases for negative stimuli were not found for clinically anxious subjects (Mogg, Mathews & Weinman, 1987). Therefore, the prediction of Bower and Beck of a memory bias in the processing of emotional stimuli was only supported in the case of depressed subjects. In anxious subjects, a specific attentional bias for emotionally threatening stimuli, relative to nonthreat stimuli was detected and was shown to differentiate clinically anxious subjects from control subjects (e.g. Eysenck, MacLeod & Mathews, 1987; MacLeod, Mathews & Tata, 1986; Mogg, Mathews & Weinman, 1989). A theory which accounts for the dissociation between attentional biases in anxiety and memory biases in depression was developed by Williams, Watts, MacLeod & Mathews (1988) and is presented in the next section.

Beck and Bower predicted that the processing of ambiguous information would be biased by mood-congruent interpretations. There is strong experimental evidence that clinically anxious subjects impose threatening interpretations on ambiguous stimuli (Eysenck, Mogg, May, Richards & Mathews, 1991; Mathews, Richards & Eysenck, 1989; McNally & Foa, 1987). According to MacLeod (1990) less research has utilised information processing methodologies to investigate interpretative biases in depression. Instead, these studies have employed self-report measures which are associated with methodological problems. Nevertheless, these studies have found evidence that depressed subjects display a disproportionate tendency to select the more negative interpretation offered in ambiguous scenarios (Butler & Mathews, 1983; Krantz & Hammen, 1984, cited in MacLeod, 1990).

1.4.4 The theoretical model of Williams et. al. (1988)

The central finding that clinically anxious subjects show biases associated with attentional processes while clinically depressed subjects show memory biases is explained by the model put forward by Williams et. al. (1988). Williams et. al. begin their explanation by distinguishing priming and elaboration. This distinction is based on the work of Graf and Mandler (1984). According to Graf and Mandler, priming (or in their terminology integration) is an automatic and effortless process in which a stimulus produces activation of the components that comprise its internal representation. This automatic activation results in a strengthening of the organisation of the internal representation rendering it more accessible when only a fraction of its stimulus features are presented. In contrast, elaboration is described as a strategic process which requires conscious effort in which the activation of the internal representation of a stimulus leads to the activation of other associated internal representations. This activation either strengthens existing inter-connections among the stimuli or forms new inter-connections. As in the case of priming, elaboration has the effect of making the previously presented stimulus subsequently easier to retrieve.

The distinction between priming and elaboration provided Williams et. al. (1988) with an important advantage over the other theories. As discussed previously, Bower's (1981) semantic network theory and the schema theory put forward by Beck and his colleagues (Beck & Emery, 1985; Beck & Clark, 1988) both predict that biases involving mood-congruent effects should be pervasive throughout the cognitive processing system. In contrast, the theoretical framework of Williams et. al. allows for the postulation of more specific mood-congruent biases by distinguishing between priming which involves automatic processing and elaboration which involves strategic processing. Williams et. al. made use of this type of distinction in arguing that anxiety affects the passive, automatic aspect of encoding and retrieval, while depression affects the more active, effortful aspects of encoding and retrieval. In other words, Williams et. al. state that anxiety makes certain items more accessible, whereas depression makes certain items more retrievable.

The model put forward by Williams et. al. (1988) also explains the operation of state and trait variables in anxiety and depression. However, for the purpose of this review, only anxiety will be discussed. The model indicates the circumstances under which anxiety is associated with a bias in processing threatening information. At the pre-attentive stage, stimulus input is processed by an affective decision mechanism (ADM). This mechanism makes an assessment of the threat value of the stimulus. This information is then passed to the resource allocation mechanism. This mechanism directs attention towards or away from threatening information. Williams et. al. put forward that state anxiety influences the output of the ADM by increasing the subjective threat value of the presented stimuli. It is suggested that differences in trait anxiety may represent permanent tendencies to react to input from the ADM by directing attention towards or away from the location of the threat.

This model provides a framework for understanding the role state and trait variables play in anxiety. In essence, high trait anxiety provides a constant tendency to direct attention towards threat while low trait anxiety is associated with a tendency to direct attention away from threat. These directional biases are amplified as the level of state anxiety increases. Therefore, the model of Williams et. al. (1988) predicts that an elevation in state anxiety results in an attentional pattern towards threatening stimuli in high trait anxious individuals, and an attentional pattern away from threatening stimuli in low trait anxious individuals.

In terms of vulnerability to developing anxiety disorders, Williams et. al. (1988) predict that those high in trait anxiety are more likely to develop anxiety disorders than those low in trait anxiety because of their tendency to selectively attend to threatening stimuli. However, it is suggested that psychopathology will typically only occur when the individual's level of state anxiety is elevated which results in an increase in the magnitude of the individual's attentional bias towards threat. In this way, the model of Williams et. al. is a diathesis-stress model which is similar to Beck's schema model (Beck & Emery, 1985; Beck & Clark, 1988).

1.4.5 Evaluation of the theoretical model of Williams et. al. (1988)

The model of Williams et. al. (1988) has been most useful in providing a theoretical framework to explain the empirical finding that anxiety is associated with biases in attention while depression results in biases in memory. In this regard, the model provides a better fit to the data than Bower's (1981) network model and Beck's schema model (Beck & Emery, 1985; Beck & Clark, 1988) where it is predicted that the effects of anxiety and depression would be similar. The model of Williams et. al. (1988) also provides a plausible explanation of the development of anxiety disorders through the interaction of trait and state variables. However, Eysenck (1992) has presented several criticisms of the model.

Eysenck (1992) states that Williams et. al.'s (1988) account of anxiety and attention is too limited. He argues that Williams et. al. stress the notion that anxious individuals have an attentional bias towards threat, but de-emphasise other attentional phenomena associated with anxiety such as attentional scanning and distractibility. Second, Eysenck suggests that the theory is more explicit at the descriptive level of identifying differences in cognitive processing between anxious patients and normal controls than at the explanatory level. A theoretical account at the explanatory level would require pinpointing the differences which account for a cognitive vulnerability factor. Eysenck notes that this deficiency is due to lack of empirical evidence available to Williams et. al., but states that accounting for differences between anxious patients and normals which relate to cognitive vulnerability are of greater significance than explaining the consequences of being in a clinically anxious state. Third, Eysenck states that it is often difficult to disentangle the relative contribution of priming and elaboration in cognitive experiments making the model of Williams et. al. difficult to test.

Despite these criticisms, the central prediction put forward by Williams et. al. (1988) that clinically anxious patients and normal individuals with high trait and elevated levels of state anxiety will show an attentional bias towards threatening stimuli remains an important prediction for empirical investigation. If an attentional bias in the form predicted by Williams et. al. is identified it could explain the mechanisms by which state anxiety often becomes elevated in individuals with high levels of trait anxiety and subsequently their increased vulnerability to developing anxiety disorders. A review of research into threat-directed attentional biases will now be presented.

1.5 Review of research into attentional processing in anxiety

From considering the cognitive models of anxiety, researchers have identified several different ways in which anxiety might bias attentional processing leading anxious individuals to be more geared to processing threatening information than non-anxious individuals. First, Eysenck and Keane (1990) put forward that it may be the content of the information to which attention is directed. If anxious individuals are sensitive to danger, then it is entirely possible that they are more likely than non-anxious individuals to attend to threat related stimuli. Second, Eysenck and Keane state that anxious individuals may have loose systems of attentional control which causes them to become more easily distracted by threatening information. The experimental evidence for each of these hypotheses will now be considered.

Experiments investigating the content of information have evaluated the prediction that anxious individuals are more likely than non-anxious individuals to attend to, and process threat related stimuli (e.g. words related to social and physical threat). This research involved presenting one word at a time of threatening or nonthreatening content to individuals high and low in trait anxiety. Eysenck and Keane (1990) state that most of this research returned nonsignificant results indicating that subjects high and low in trait anxiety did not differ in their processing of threatening stimuli.

However, these nonsignificant results led researchers to hypothesise that individuals high and low in trait anxiety may differ in terms of a selective attentional bias. It was predicted that if a threat related and a neutral stimulus are presented together, then individuals high in anxiety will selectively attend to the threat related stimulus, whereas those low in anxiety will selectively attend to the neutral stimulus. This selective attentional bias has been tested using a number of experimental paradigms. Two of the most common paradigms are attentional interference paradigms and attentional deployment paradigms.

Attentional interference paradigms provide measures of the distractibility of a subject's attentional processes. Therefore, attentional interference tasks provide data concerning the hypothesis of Eysenck and Keane (1990) regarding anxious subjects being distracted by threatening stimuli. In a typical attentional interference task, subjects are required to perform some central task (such as naming the ink colours in which words are written), while attempting to ignore emotionally valanced distractor information (such as the content of the coloured words). Hence in this case two pieces of information are being presented together - the ink colour of the stimulus and the content of the word. The degree to which the subjects process the distractor information will be indicated by disrupted performance on the central task.

Mathews and MacLeod (1985) compared the performance of patients with generalised anxiety disorder (GAD) on a task where subjects were required to colour name emotionally valanced words. They found that GAD patients took longer to name colours for the threatening words compared to the non-threatening words, but normal controls did not. Many researchers have replicated this finding (e.g. Ehlers, Margraf, Davies &

Roth, 1988; Mogg et. al., 1989; Hope, Rapee, Heimberg & Dombeck, 1990). In addition, Mathews and MacLeod found that there was some evidence of more specific interference effects as only anxious patients with predominant physical worries had slowed colour naming with physical threat words. Many researchers have found content specific effects regarding threat stimuli. For example, social phobics show disproportionate colour-naming interference on social threat words (Hope et. al., 1990), post traumatic stress disorder (PTSD) rape victims show interference only on words related to rape (Foa, Feske, Murdoch, Kozak & McCarthy, 1991), and panic disorder patients show greater interference only on words related to physical threat (Ehlers et. al., 1988; Hope et. al., 1990; McNally, Riemann & Kim, 1990b).

In addition, Mathews and MacLeod found that subjects were unable to report the semantic content of the words that they had colour named. This finding indicated that the anxiety-linked encoding bias was mediated by automatic processes (which occurred rapidly and without conscious mediation; Hasher & Zacks 1979). However, Holender (1986) in his review on semantic activation without awareness, put forward an argument that was relevant to the findings of Mathews and MacLeod (1985) regarding the automaticity of the encoding bias. He identified several methodological problems which left open the possibility that the measure of awareness employed by Mathews and MacLeod was subjective. In response to this possibility, studies were performed which replicated the findings of Mathews and MacLeod regarding the automaticity of the encoding bias using measures which satisfied Holender's criteria regarding an absence of conscious awareness (see Mathews, 1988).

Non-clinical studies have also produced reasonable evidence that subjects high in trait anxiety have slower colour naming with threat related words than with neutral words compared to subjects low in trait anxiety (e.g. Mogg & Marsden, 1990; Mogg, Mathews, Bird & MacGregor-Morris, 1990; MacLeod, 1990). However, there is some concern over whether this relationship is mediated solely by state anxiety levels (Mogg et. al., 1990) or is jointly determined by trait and state variables (MacLeod, 1990).

Of particular interest is a study performed by Martin, Williams and Clark (1991) using GAD patients and normal controls. These researchers replicated the finding that GAD patients were slower to colour name threatening words. However, an additional finding of the research of Martin et. al. was that GAD patients also showed significant slowing of colour naming with emotionally positive words (e.g., joyful, affectionate). This finding indicates that anxious patients engage in increased processing of all emotional stimuli regardless of their emotional valence. Eysenck (1992) points out that if this finding where to be repeated in other paradigms, it would have far reaching theoretical implications.

However, results from interference tasks have been the subject of some criticism. MacLeod et. al. (1986) put forward that it may be the case that anxious subjects are selectively allocating their attention away from threatening stimuli resulting in an increase in response time. In order to overcome these interpretive difficulties, MacLeod et. al. developed an attentional deployment task. This task was designed to measure the deployment of attentional resources in the processing of threatening, relative to neutral stimuli. In this task, subjects were presented with a word pair which contained a threat and neutral word. This word pair remained on the computer screen for 500 milliseconds (ms) and then was replaced by a dot probe which could occur in the spatial location of either the threat or the neutral word. The subject's task was to press a button as soon as they saw the probe. Consistent with the hypothesis that elevated anxiety should be associated with allocation of attention to emotionally threatening stimuli, GAD patients alone exhibited speeded detection latencies for probes occurring in the spatial location of threat words. In contrast, non-anxious control subjects tended to demonstrate relatively slower detection latencies for those probes occurring in the location of the threat words, suggesting that these subjects selectively allocated attention away from threatening stimuli. These findings have been replicated by Broadbent and Broadbent (1988), MacLeod and Mathews (1988) and Mogg, Mathews, and Eysenck (1992), providing further support for the hypothesis that anxious individuals selectively attend to emotionally threatening information and are therefore disproportionately activated to respond to it.

MacLeod and Locke (1994) developed a design which permitted an even more direct assessment of selective encoding. In their experiment, MacLeod and Locke presented subjects with a threat/neutral word pair which was displayed briefly on the prime phase. The prime phase was followed by a probe phase in which the subject was required to name a word displayed on the computer screen (the probe word). The occurrence of the prime and probe phase consisted of a single experimental trial. On half the trials, the probe word was a repetition of either the threat or neutral word from the preceding prime pair. Otherwise, it was a threat or neutral word that had not previously been exposed within the prime pair. The dependent measure was the naming latency for the probe word.

Using this paradigm MacLeod and Locke (1994) examined issues regarding the automaticity of the anxiety-linked encoding bias, the personal relevance of the threatening information and the role of state and trait variables on this relationship. To address the automaticity issue, MacLeod and Locke altered the stimulus onset asynchrony (SOA) occurring between the prime phase and the probe phase. This manipulation was based on the work of Neely (1977) who presented evidence that a 500 ms SOA would reflect automatic processes while a 2000 ms SOA would allow time for strategic processes to operate. Therefore, in MacLeod and Locke's experiment, half the trials contained an SOA of 500 ms while on the other half the SOA was set at 2000 ms. To address the personal relevance hypothesis, half the threat word content was associated with examination-related concerns (e.g. failure, expelled) while half were unrelated to this topic (e.g. injury, lonely). Finally, to address trait versus state involvement, high and low trait anxious subjects were tested once when state anxiety was low (distal to exams) and once when state anxiety was high (proximal to exams).

When the SOA was 500 ms, MacLeod and Locke (1994) found that under conditions of high state anxiety, trait anxious subjects were primed to respond to threat stimuli while low trait anxious subjects responded to the state anxiety elevation with a decrease in the magnitude of priming on trials where the probe word was a threat word. However, these effects were found to be equivalent for both exam-related stimuli and exam-unrelated stimuli. From these results, MacLeod and Locke concluded that state and trait anxiety mediate an automatic encoding bias which is sensitive only to the valence of the stimuli and not to its specific personal relevance.

When the SOA was 2000 ms, MacLeod and Locke (1994) found that the patterns of priming under the condition of high state anxiety differed for exam-related and exam-unrelated stimuli. However, these patterns were equivalent for both low and high trait anxious subjects. All subjects responded to the state anxiety elevation by showing a relative decrease in priming on threat word stimuli, but only when the threat words were exam-related. From these findings it was concluded that state anxiety elicits a strategically mediated reduction in the encoding of threat stimuli that are personally relevant to the individual, which is equivalent in both low and high trait anxious subjects.

1.5.1 Summary of experimental findings

The central finding of experimental research is that anxious subjects compared to non-anxious subjects show a selective encoding bias favouring emotionally threatening stimuli. In interference tasks this finding was apparent as anxious subjects were significantly slower in naming the colour of threat words (Mathews & MacLeod, 1985; Watts, McKenna, Sharrock & Trezise, 1986; Hope et. al., 1990; MacLeod & Rutherford, 1992). In attentional deployment tasks this effect was shown in terms of anxious subjects eliciting significantly faster responses to threat stimuli (Broadbent & Broadbent, 1988; MacLeod & Locke, 1994; MacLeod et. al., 1986; Mogg et. al., 1992). These experimental findings specifically support the model put forward by Williams et. al. (1988) which predicted that elevated anxiety should be associated with a selective encoding bias towards emotionally threatening information. The findings also provide support for the more general predictions of Bower (1981) and Beck and Emery (1985) and Beck and Clark (1988) who predicted that mood-congruent information will be disproportionately available to the cognitive system.

Experimental findings show that enhanced processing is more pronounced when it corresponds to the anxious individual's domain of major concern (Ehlers et. al. 1988; MacLeod & Mathews, 1985; Mogg et. al., 1989; Hope et. al., 1990). It is also reported that processing biases for threat stimuli in anxious individuals are characterised by automatic processing (Mathews & MacLeod, 1985; Mathews, 1988). Research by MacLeod and Locke (1994) further examined issues regarding the automaticity of the anxiety-linked encoding bias, the personal relevance of threatening information, and the role of state and trait variables on this relationship. When the SOA reflected automatic processes, MacLeod and Locke found that state and trait anxiety mediated an automatic encoding bias which was only sensitive to the valence of the stimuli and not to their specific personal relevance. However, when the SOA reflected strategic processes, the researchers reported that elevated levels of state anxiety elicited a reduction in the encoding of personally relevant threat stimuli in both low and high trait anxious subjects.

1.6 A possible alternative explanation of experimental findings

As stated previously, the central finding from research investigating the cognitive processing of anxious individuals is that anxiety is associated with a selective encoding bias for threatening information. This selective encoding bias has been expressed by researchers using attentional deployment tasks in terms of anxious individuals being disproportionately activated to respond to emotionally threatening material (e.g. Broadbent & Broadbent, 1988; MacLeod & Locke, 1994; MacLeod et. al. 1986; Mogg et. al., 1992). However, it may be the case that anxious subjects are unable to inhibit threatening information from entering their selective attention. This would normally occur through the process of cognitive inhibition. In order to investigate this possibility, the concept of cognitive inhibition will now be explained followed by a review of studies investigating cognitive inhibition in clinical populations and extreme normal groups.

1.6.1 The concept of cognitive inhibition

The concept of cognitive inhibition comes from research using the negative priming paradigm (Tipper, 1985). According to the logic of this paradigm, if the internal representations of a to-be-ignored stimulus are associated with inhibition during the selection and execution of the responses to a target object, the processing of a subsequent stimulus requiring the inhibited representations should be impaired (Houghton & Tipper, 1994). The first-known demonstration of negative priming was by Dalrymple-Alford and Budayr (1966) cited in Neill, Valdes, and Terry (1995). These researchers used the Stroop colour-word task. In this task, subjects try to quickly name the ink colours in which words are written. It has been found that colour naming is greatly slowed if the words denote incompatible ink colours, for example, GREEN written in red ink. This is described as the "Stroop-Effect". Dalrymple-Alford and Budayr manipulated the Stroop task so that each word to be ignored was the next colour in the list. For example, GREEN written in red ink, followed by YELLOW written in green ink, followed by BLUE written in yellow ink and so on. These researchers found that colour naming was even slower when the stimuli were presented in this order and reasoned that the effect was two-fold. First, subjects had to suppress their response to each word in order to name the ink colour - the standard Stroop effect. Second, if the suppressed response was required to name the next ink colour, that response would be further slowed.

Since the initial demonstrations of negative priming in the Stroop task, similar effects have been demonstrated in a great variety of other selective attention tasks. Some of the most common tasks are picture naming, letter identification and lexical decision. Although these tasks use different categories of stimuli, the basic design is the same. Subjects are presented with a stimulus consisting of two simultaneously presented stimuli - typically a target stimulus and a distractor stimulus. The task of the subject is to identify the target stimulus and ignore the distractor stimulus. The critical trials occur when the previously ignored distractor stimulus is presented as the next target for selective responding. If reaction time is consistently increased on these trials then negative priming is said to have occurred.

Allport, Tipper and Chmiel (1985) used a picture naming task to investigate the nature of negative priming. Subjects were shown superimposed line drawings of objects (e.g. a house and a cat), one (the target) drawn in red and the other (the distractor) drawn in green. These stimuli were shown in two separate phases which together comprised a single experimental trial. The first phase was the prime phase in which the subject's task was to remember the word drawn in red (the prime target) while ignoring the superimposed word drawn in green (the prime distractor). On the probe phase which followed, the subject's task was to name as quickly as they could the word drawn in red (the probe target) while ignoring the superimposed word drawn in green (the probe distractor). The critical variable was the relation of the probe target and the prime distractor. On phases where the probe target and the prime distractor were identical (except for colour) naming latencies were significantly slower than when the prime and probe phases were unrelated. In a further experiment, Tipper (1985) found that subjects were slower to name the probe target when it was nonidentical, but semantically related to the prime distractor, for example, a picture of a dog with a to-be-ignored picture of a cat, compared to when there was no semantic relationship. Therefore, Tipper found that negative priming generalises to semantic associations of ignored stimuli. Tipper, Weaver, Cameron, Brehaut, and Bastedo (1991) distinguished targets and distractors by spatial location rather than ink colour. Targets were presented at a centrally fixed location, while distractor pictures appeared randomly to the left or the right. Despite the spatial separation, identical to-be-ignored stimuli and semantically related distractor stimuli produced negative priming.

Tipper and Cranston (1985) replicated the findings of Allport et. al. (1985) using a letter identification task. Tipper and Cranston required subjects to vocally name target letters written in red ink while ignoring overlapping green distractor letters. These researchers found that letter naming was slower if the probe target letter was identical to the recently ignored prime distractor.

Negative priming experiments have also been carried out using lexical decision tasks. In a lexical decision task, subjects must judge whether each string of letters is a word (e.g.

NURSE) or a nonword (e.g. NERSE). Neill et. al. (1995) notes that this task has been perhaps the most commonly used tool for investigating (positive) associative priming effects. The typical result is that the stimulus is categorised more quickly as a word or nonword if it follows a semantically related word, for example, NURSE followed by DOCTOR. In these experiments the priming word is deliberately attended to. From this research the question arises whether a deliberately ignored word produces a negative priming effect. Yee (1991) carried out an experiment where subjects were required to classify geometric figures (e.g. square, triangle etc). The figures were presented with irrelevant distractor words either above or below the geometric figure or both. After classifying the geometric figure, the probe phase required subjects to make a word/nonword judgement for a string of letters. Yee found that lexical decisions were significantly slower for words related to the prime phase distractor, for example, making a lexical decision regarding the word DOG after ignoring the word CAT.

In summary, the concept of cognitive inhibition stems from the negative priming paradigm. Negative priming occurs when subjects' responses are inhibited (slowed) by subjects being required to recall information which they were previously attempting to ignore. Negative priming has been shown in varied experimental tasks. The next section will review research which has used the negative priming paradigm to investigate clinical problems.

1.6.2 Applying the negative priming paradigm to the investigation of clinical problems

Houghton and Tipper (1994) proposed that the function of inhibitory mechanisms is to assist in the efficient foregrounding of target information and reduce interference from competing distractors. If this proposition is correct, it follows that the degree of negative priming found in individuals is an indication of the strength of their inhibitory processes. This reasoning led Houghton and Tipper to predict an inverse relationship between interference and negative priming. Specifically, these researchers predicted that less negative priming should indicate weaker inhibitory processes and hence greater interference. Evidence for such a relationship has been observed in several clinical populations in experiments that have investigated differences in selective attention by using the negative priming paradigm.

Beech, Baylis, Smithson, and Claridge (1989) investigated cognitive inhibition in schizophrenic subjects in order to provide a test of Frith's (1979) hypothesis which states that the cognitive symptoms of schizophrenia may be due to a failure to inhibit the output of preconscious processes. The control group consisted of age-matched psychiatric subjects who had not been diagnosed with a major psychotic illness. The experimental task was to name the ink colour of the stimuli presented. The experimental design included two important conditions: first, the priming distractor condition where a colour name predicted the colour of the following word (e.g. YELLOW written in red followed by GREEN written in yellow); second, the neutral condition where subjects were required to name the colour in which a row of Xs was displayed. The researchers found that the psychiatric control group subjects showed a significant effect of negative priming when their mean reaction times in the priming distractor condition and the neutral condition were compared. However, schizophrenic subjects did not produce a significant effect of negative priming, indicative of weaker inhibitory processes. These results were replicated by Beech, Baylis, Tipper, McManus and Agar (1991) and Laplante and Everett (1992) using similar experimental designs.

The hypothesis of reduced cognitive inhibition has also been tested in patients with obsessive compulsive disorder (OCD). Enright and Beech (1993) hypothesised that there may be a deficit of inhibition in OCD which renders the suppression of unwanted or irrelevant information less effective. The researchers suggest that this may account for the comparatively high frequency of intrusive thoughts found in OCD sufferers. Enright and Beech reasoned that since information is not being inhibited effectively at the pre-conscious level, the patient is forced to resort to conscious strategies of thought suppression. In order to test the hypothesis of reduced cognitive inhibition in OCD patients, Enright and Beech compared them to patients with other anxiety disorders (agoraphobia, simple phobia, panic disorder, general anxiety disorder, social phobia and post traumatic stress disorder). The researchers presented subjects with target and distractor stimuli. The target stimuli were single letters of the alphabet written in red. The distractor stimuli were the same letters written in green. A red and green letter were presented simultaneously, slightly overlapping in the centre of the computer screen. The subject's task was to ignore the green letter and name the red letter. The experiment had two conditions which were used to calculate negative priming. These were the priming distractor condition in which the red letter in the trial was the same as the preceding green letter and the control condition in which the red letter was different from the preceding green letter. The priming effect was calculated by subtracting the mean reaction time for the control condition from the mean reaction time for the prime distractor condition. A positive value would indicate negative priming while a negative value would indicate facilitation. Enright and Beech found that both patients diagnosed with OCD and those diagnosed with post-traumatic stress disorder (PTSD) failed to exhibit significant levels of negative priming. Patients diagnosed with agoraphobia, general anxiety disorder or social phobia exhibited negative priming, with those diagnosed with simple phobia and panic disorder obtaining results where priming tended towards negative, but failed to reach significance at the five percent level.

Downes, Sharp and Sagar (1995) investigated the time course of negative priming in Parkinson's Disease patients using a letter detection task similar to Enright and Beech (1993). These researchers found that normal control subjects exhibited a significant level of negative priming. That is, they were slowest when the ignored letter of trial n became the target letter on trial n+1. In contrast, Parkinson's Disease patients failed to show this effect of negative priming. From these findings the researchers argued that the basal ganglia which is damaged in Parkinson's Disease may play an inhibitory/suppression role.

Reduced levels of inhibition of irrelevant stimuli have been shown in extreme groups of normal subjects. De La Casa and Lubow (1994) designated introductory psychology students as low or high psychotic-prone on the basis of the abbreviated version of the MMPI subscales (Hathaway & McKinley, 1985, cited in De La Casa & Lubow, 1994). De La Casa and Lubow presented subjects with two superimposed figures (one in red and the other in green). Half the subjects were instructed to attend to the green figures while the other half were instructed to attend to the red figures. The figures were a closed, meaningless shape. The subjects task was to make an aesthetic judgement of the attended figure on a five-point scale. Each subject was exposed to six pairs of figures and then required to complete a recognition test. The recognition test consisted of 18 figures printed in black. Six figures were the same as the figures presented in red, six were the same as the figures presented in green and six were new figures. The order of the figures was randomised. The subjects task was to write 'yes' or 'no' next to each figure to indicate whether or not the figure had been seen in the previous stage of the experiment. The researchers found that high-psychotic prone subjects reported seeing the unattended stimuli more often than low-psychotic prone subjects. De La Casa and Lubow concluded that high-psychotic prone subjects have weaker inhibitory processes than low psychotic-prone subjects.

In summary, evidence of weaker inhibitory processes has been evidenced through reduced negative priming in schizophrenic patients (Beech et. al., 1989, 1991; Laplante et. al., 1992), patients with obsessive compulsive disorder and post-traumatic stress disorder (Enright & Beech, 1993) and in patients with Parkinson's Disease (Downes et. al., 1995). High-psychotic prone normal subjects have also been shown to have weak inhibitory processes (De La Casa & Lubow, 1994). From these experimental findings stems the possibility that anxious subjects may have an inability to inhibit threatening information. This possibility will be discussed in the next section.

1.6.3 Do anxious individuals have an inability to inhibit threatening information?

The prominent information-processing models of emotion (Bower, 1981; Beck & Emery, 1985; Beck & Clark, 1988; Williams et. al., 1988) have led many theorists to the central prediction that elevated anxiety should be associated with an encoding bias which operates to selectively favour emotionally threatening information. As reviewed earlier, this hypothesis has received substantial experimental support from interference tasks and attentional deployment tasks. Attentional deployment tasks which have been shown to provide a more direct measure of subject's cognitive processing have found that subjects with high levels of state and trait anxiety are disproportionately primed to respond to threat stimuli compared to low trait anxious subjects with elevated levels of state anxiety (MacLeod & Locke, 1994).

An alternative explanation of these findings is that high trait anxious individuals with an elevated level of state anxiety may have difficulty inhibiting emotionally threatening stimuli from entering their attention and are therefore able to respond to these stimuli (or other stimuli that occur in the same vicinity) more rapidly. The possibility that this may be the case comes from research using the negative priming paradigm (Tipper, 1985). As discussed earlier, negative priming describes the sequence whereby a distractor on a given trial becomes a target on a subsequent trial and the response latency on the second trial is prolonged due to inhibition. The effect of negative priming has been extensively demonstrated in normal populations and has been found to be reduced in some clinical populations as well as some extreme groups in normal populations indicating that these subjects have difficulty inhibiting distractor stimuli.

Enright and Beech (1993) tested clinically anxious subjects (those diagnosed with agoraphobia, panic disorder, simple phobia, post traumatic stress disorder, generalised anxiety disorder, social phobia, and obsessive compulsive disorder) and only found reduced negative priming in subjects diagnosed with obsessive compulsive disorder and post traumatic stress disorder. However, these researchers did not present subjects with emotionally threatening distractor stimuli, rather Enright and Beech used single letter stimuli. Therefore, it is possible that the many categories of anxious patients who participated in the study conducted by Enright and Beech did not show reduced effects of negative priming as the stimuli which they were presented with were not emotionally threatening. This leaves open the possibility that anxious subjects may show reduced levels of negative priming when distractor stimuli of threatening content are displayed. This possibility is tested in the current study which provides a manipulation of the subject's selective attention and contains conditions which allow both positive (activation) and negative (inhibition) priming to be measured.

CHAPTER TWO

EXPERIMENT ONE

2.1 INTRODUCTION

2.1.1 Overview

The current study will consist of trials containing a prime phase and a probe phase. Some trials will also include an attention check phase. In the prime phase, two words will be presented on a computer screen for 500 ms. One word will be printed in green and the other in red and each pair will contain one threat word (either exam-related or general) and one neutral word (either exam-related or general). The subject will be instructed to attend to the green word. On each trial, the prime phase will be followed by the probe phase in which a probe word displayed in white will be presented. The probe word may be either the word printed in green, the word printed in red or a new word (one which was not present during the prime phase). When the probe word is the word that had been green this will provide a measure of positive priming. When the probe word is the word that had been red this will provide a measure of negative priming. In the case where the probe word is a new word this will provide a baseline reaction time against which to compare positive and negative priming. The subject's task will be to name aloud the probe word and naming latency will be the critical dependent measure. To check that the subject is attending to the green word, an attention check trial will occur on some of the trials and consist of a semi-completed word string which could either be completed to spell the green word or not. The subject's task will be to indicate whether or not the letter string could be used to complete the green word by pressing one of the two mouse buttons labelled "yes" and "no". The conditions in this Experiment are illustrated in Table 1. In these examples, the threat words are "failure" and "injured" and the neutral words are "bicycle" and "picture".

Table 1. Illustration of each condition in Experiment 1.

Condition	Prime	Probe	Priming Expected
1) Repeated prime; attended threat; probe threat.	FAILURE BICYCLE	FAILURE	Positive
2) Repeated prime; attended neutral; probe threat.	BICYCLE FAILURE	FAILURE	Negative
3) Repeated prime; attended threat; probe neutral.	FAILURE BICYCLE	BICYCLE	Negative
4) Repeated prime; attended neutral; probe neutral.	FAILURE BICYCLE	BICYCLE	Positive
5) Prime not repeated; attended threat; probe threat.	FAILURE BICYCLE	INJURED	Nil
6) Prime not repeated; attended neutral; probe threat.	FAILURE BICYCLE	INJURED	Nil
7) Prime not repeated; attended neutral; probe neutral.	BICYCLE FAILURE	PICTURE	Nil
8) Prime not repeated; attended threat; probe neutral.	FAILURE BICYCLE	PICTURE	Nil

2.1.2 Theoretical predictions

From the conditions shown in Table 1, several predictions can be made. These predictions evolve from two theoretical positions in respect of dysfunctional cognition associated with anxiety - disproportionate activation and an inability to inhibit. The disproportionate activation hypothesis stems from experimental work which has shown that anxious subjects compared to non-anxious subjects show a selective encoding bias towards emotionally threatening material, rendering them to be disproportionately activated to respond to threatening material. This effect was shown in experiments performed by MacLeod and his colleagues and other researchers in terms of anxious subjects compared to non-anxious subjects recording faster reaction times to threat stimuli (Broadbent & Broadbent, 1988; MacLeod et. al. 1986; MacLeod & Locke, 1994; Mogg et. al., 1992). If the disproportionate activation hypothesis is supported the following patterns of results are predicted.

I Positive priming is predicted for threat and neutral words. For threat words reaction times (RTs) are expected to be shorter in the repeated prime; attended treat; probe threat condition (condition 1, Table 1) compared to its control condition - prime not repeated; attended threat; probe threat (condition 5, Table 1). For neutral words, RTs are expected to be shorter in the repeated prime; attended neutral; probe neutral condition (condition 4, Table 1) compared to its control condition - prime not repeated; attended neutral; probe neutral (condition 7, Table 1).

II Positive priming for threat words (RT for condition 5 - RT for condition 1) should be more pronounced than positive priming for neutral words (RT for condition 7 - RT for condition 4).

III The predictions stated in II will be mediated by the variables of trait and state anxiety as follows: State anxiety elevations will result in an increase in the selective encoding of threat stimuli for the high trait anxious subjects (i.e. the magnitude of the threat priming effect relative to the non-threat priming effect, as expressed in prediction II, will be increased). By contrast, elevation in state anxiety will result in a decrease in the selective processing of threat stimuli for the low trait anxious subjects (i.e. the magnitude of the threat priming effect relative to the non-threat priming effect will be decreased).

IV The effects predicted in II and III will occur to an equivalent degree regardless of whether or not the stimuli are related to examinations. That is, the effect of personal relevance will not be significant, as a 500 ms SOA was found by MacLeod and Rutherford (1992) and MacLeod and Locke (1994) to be governed by automatic processing.

The inability to inhibit hypothesis stems from research investigating cognitive inhibition which has used the negative priming paradigm. Negative priming is said to occur when the internal representations of a to-be-ignored stimulus are inhibited due to the selection of a target stimulus. This inhibition causes reaction times to become slowed when the previously inhibited stimulus becomes the target stimulus. The inability to inhibit hypothesis predicts that anxious subjects compared with non-anxious subjects may be unable to inhibit threatening information from entering their selective attention. If the inability to inhibit hypothesis is supported the following pattern of results is predicted.

V There should be an effect of negative priming for threat and neutral words. For threat words, RTs should be lengthened in the repeated prime; attended neutral; probe threat condition (condition 2, Table 1) compared to its control condition -

prime not repeated; attended neutral; probe threat (condition 6, Table 1). For neutral words, RTs should be lengthened in the repeated prime; attended threat; probe neutral condition (condition 3, Table 1) compared to its control condition - prime not repeated; attended threat; probe neutral (condition 8, Table 1).

VI Negative priming for threat words (RT for condition 2 - RT for condition 6) should be less pronounced than negative priming for neutral words (RT for condition 3 - RT for condition 8).

VII The effect of negative priming predicted in VI should enter into higher order interactions with the state and trait anxiety variables. That is, state anxiety elevations should result in an increasing inability to inhibit threat stimuli for high trait anxious subjects which is not evident for low trait anxious subjects. That is, the difference in negative priming for threat versus neutral words (prediction VI) should be present for low trait anxious subjects with elevated levels of state anxiety, but this effect should be absent for high trait anxious subjects with elevated levels of state anxiety.

2.2 METHOD

2.2.1 Design

The design required the selection of two groups of subjects. One group consisted of subjects of high trait anxiety (HTA) while another group was comprised of low trait anxious (LTA) subjects. The two groups were equated on depression scores.

High and low trait anxious subjects were tested on two occasions: Once when their state anxiety was high (exam proximal test session) which took place in the week prior to examinations and once when their state anxiety was low (exam distal test session) which occurred either six weeks before or after the examination period. The exam distal test session was conducted on two separate occasions in order to eliminate the possible confound of test order, with half the subjects participating in the test session held six weeks prior to examinations and the remaining subjects completing the test session six weeks after the examination period.

The design was directed at assessing information processing biases that were specific to the experimental predictions. For this reason stimuli were selected to form exam related threat/non-threat word pairs and non-exam related threat/non-threat word pairs. An exam related threat/non-threat word pair contained one word which was exam related and of threatening content and another word that was exam related but not of threatening content. A non-exam related threat/non-threat pair contained one word which was not related to examinations, but of threatening content and another word not related to examinations and not of threatening content. A custom computer program was designed to display a priming pair on the prime phase of each trial, a probe word on the probe phase of each trial, and sometimes display the attention check phase. The priming pair displayed on the prime phase could be drawn from either of these two stimulus domains. One of the words in the pair was printed in green and the other was printed in red. During the prime phase the subject's task was to attend to the green word and ignore the red word. The prime phase was followed by the probe phase on which a word printed in white was displayed. The subject's task was to name the word printed in white (the probe word). The probe word could be the attended or the ignored word from the priming phase or an unrelated word (word not presented during the priming phase). The subject's reaction times to name the probe words across the experimental trials were recorded by the computer and served as a measure of activation or inhibition.

The design comprised of one between subjects factor - trait (high, low), and several within subjects factors - occasion (exam distal, exam proximal), stimulus type (exam related, non-exam related), valence of the word to be named (threat, nonthreat), direction of attention (attending to threat, attending to nonthreat) during the priming phase, and prime status (repeated, not repeated).

2.2.2 Subjects

Twenty female and 12 male University of Western Australia first-year undergraduates were selected to participate in this experiment. These subjects were selected by screening 628 first-year undergraduates on the trait component of the State Trait Anxiety

Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983), and the Beck Depression Inventory (BDI; Beck, Ward, Mendelsohn, Mock & Erbaugh, 1961). Subjects scoring in the upper quartile on the trait section of the STAI were eligible for selection into the HTA group while subjects scoring in the lower quartile formed a pool of subjects that could be selected into the LTA group. Sixteen subjects eligible for the HTA group and 16 subjects eligible for the LTA group were selected for participation in the experiment on the basis of matched depression scores. The LTA group had a mean trait anxiety score of 29.62 (SE = 0.75) and a mean depression score of 6.31 (SE = 0.51). The HTA group had a mean trait anxiety score of 47.19 (SE = 1.00) and a mean depression score of 5.00 (SE = 0.53). A t-test for independent groups confirmed that the difference in mean trait anxiety scores for the LTA and HTA groups was significant; $t(30) = 13.89$, $p < 0.001$. A t-test calculated on the mean depression scores indicated that the group difference was not significant; $t(30) = 1.71$, $p > 0.05$.

The mean age of the female subjects was 18.35 years (SE = 0.59) and the mean age of the male subjects was 18.5 years (SE = 0.57). All of the subjects were recruited within the first six weeks of the academic semester and each of these students was due to sit at least two examinations that would contribute to his/her academic record, within the University examination period scheduled for the last two weeks of the semester. All subjects had normal or corrected-to-normal visual acuity, normal colour vision as assessed by the Ishihara (1954) Test for Colour-blindness, and English as their first language.

2.2.3 Materials

2.2.3.1 Stimulus words

A list of 336 words was constructed to form 4 categories. These categories were exam-related threat, exam-related nonthreat, nonexam-related threat and nonexam-related nonthreat. Each of the categories contained 84 words. These 336 words were then assembled, in random order, on two rating sheets that were given to 10 second-year university undergraduates. The first rating sheet asked the subjects to rate the words in terms of how relevant they thought they were to the process of taking end of semester exams. Subjects responded using a 5 point scale that ranged from 0 (labelled "not at all related to exams") to 4 (labelled "highly related to exams"). The second rating sheet asked the subjects to rate the words in terms of the degree to which they perceived their content to be threatening, neutral or reassuring. Subjects responded using a 5 point scale ranging from -2 (labelled "extremely threatening") to +2 (labelled "extremely reassuring").

On the basis of the ratings, 16 pairs consisting of an exam-related threat word and an exam-related nonthreat word were constructed as well as 16 pairs consisting of a nonexam-related threat word and a nonexam-related nonthreat word. The two words in each pair were matched for length. A 2 x 2 ANOVA was conducted on the mean exam-relatedness ratings with the factors exam relatedness (exam/nonexam) and degree of threat content (threat/nonthreat). The ANOVA revealed that there was a significant difference in terms of exam relatedness; $F(1,60) = 364.68$, $p < 0.001$. The mean exam-relatedness rating for the exam related words was 2.66 (S.E. = 0.12) while the mean exam-relatedness rating for nonexam-related words was 0.11 (S.E. = 0.02). However, the ANOVA revealed that the exam-relatedness ratings did not differ significantly as a function of threat category; F (1,60) = 0.01, p > 0.1. The interaction was also not significant; F (1,60) = 0.26, p > 0.5 (see Table 2 for means). The same 2 x 2 ANOVA design as described for the exam-relatedness analysis was conducted on the mean threat ratings. The ANOVA indicated that the difference between the threat and nonthreat words was significant; F (1,60) = 477.94 p < 0.001, but that the threat ratings did not differ as a function of exam-relatedness category; F (1,60) = 0.13 p > 0.5. The interaction was also not significant; F (1,60) = 0.35, p > 0.5. The mean threat ratings for the threat words was -1.21 (S.E. = 0.04) while the mean threat rating for the nonthreat words was 0.35 (S.E. = 0.05).

Table 2. Mean ratings for threat, exam relatedness, word length and word frequency for each stimulus category with standard errors in parentheses.

Stimulus Category	**Threat**	**Exam Relatedness**	**Length**	**Word Frequency**
Exam-Related Threat	-1.17 (0.06)	2.62 (0.19)	8.18 (0.60)	23.56 (8.42)
NonExam-Related Threat	-1.24 (0.07)	0.14 (0.04)	7.62 (0.55)	43.06 (13.58)
Exam-Related Nonthreat	0.35 (0.10)	2.70 (0.18)	8.18 (0.60)	26.25 (17.16)
NonExam-Related NonThreat	0.36 (0.04)	0.08 (0.03)	7.62 (0.55)	24.62 (10.63)

The nonexam-related threat/nonthreat word pairs and the exam-related threat/nonthreat word pairs were examined on two additional criteria - number of letters in the stimulus set and written frequency (Kucera & Francis, 1967). The two words in each threat/nonthreat pairing were matched in length, however, both the nonexam-related threat/nonthreat word pairs and the exam-related threat/nonthreat word pairs varied in length from 5 to 12 letters in length. An independent groups t-test was conducted on the mean number of letters in each word in the exam/nonexam word sets. The t-test revealed that the difference in word length between the sets was not significant; $t(30) = 0.98$, $p > 0.1$ (see Table 2 for means). A 2 x 2 ANOVA with the factors exam relatedness (exam/nonexam) and degree of threat content (threat/nonthreat) was conducted on the written word frequency (Kucera & Francis, 1967). The ANOVA did not yield any significant effects. The full set of the 32 word pairs used is presented in Appendix A, and summary statistics on the word sets are presented in Table 2. An additional set of 16 length-matched emotionally neutral word pairs which were nonexam-related were constructed and used in the practice session.

2.2.3.2 Experimental hardware

An Archimedes 310 computer, with an Archimedes Series 300 high resolution colour monitor was employed to present stimuli and to record responses. A microphone attached to a velcro neckband was connected to a Lafayette model 18010 voice activated relay which was interfaced to the computer via the mouse port. A mouse was also connected to the computer via the mouse port using a double interface adaptor. The equipment was situated on a desk in a sound-insulated test cubicle, and a chair was positioned in front of the computer monitor.

2.2.3.3 Experimental task

The experiment was carried out through the use of a custom designed computer program, which performed both stimulus presentation and response recording. The experimental task is therefore best conveyed by describing the operation of the experimental software in some detail.

Each experimental trial began with the presentation of a fixation display comprising of a row of three crosses printed in white which appeared in the centre of the computer screen for 500 ms. Following the termination of the fixation display, a prime phase was presented which consisted of two stimulus words matched for length. One of the words was printed in red and the other in green. The letters were 0.6 centimetres (cm) in height and the words were vertically separated by a distance of 2.5 cm. The word printed in the upper position appeared slightly above the position in which the fixation display was previously printed while the word printed in the lower position appeared an equal distance below the position of the previously displayed fixation display. The two allocations of the red and green words to the top and bottom positions were used with equal frequency across the experimental trials. The two words displayed in the prime phase were either a non-exam related threat/nonthreat pair or an exam-related threat/nonthreat pair. These two trial types occurred with equal frequency across the experimental trials. The prime phase lasted for 500 ms. Once this time period had elapsed the probe phase was presented.

The probe phase consisted of a single word printed in white (the probe word). The letters comprising the word were 0.6 cm in height and appeared in the centre of where the two words comprising the prime phase had been presented. The probe word was either the word that had been printed in green (the attended word), the word that had been printed in red (the ignored word) or a word that had not been presented as part of the immediately preceding prime phase (an unrelated word). The attended word was displayed on 25% of the probe phases (positive priming), the ignored word was displayed on 25% of the probe phases (negative priming), while the unrelated word was displayed 50% of the time (control trials). The order in which the positive priming, negative priming and control trials were displayed was randomised for each subject. The probe word remained on the computer screen until the subject named the word. The computer recorded the time taken (in milliseconds) for the subject to name the probe word. Following the probe phase, the next trial either began 500 ms later or the subject was given an attention check task. The attention check task occurred randomly on 25% of the trials with the constraint that it occur 4 times in every 16 experimental trials. This task was designed to check whether the subject had been attending to the word printed in green. The subject was prompted with the question "Was this the green word?" printed in white at the top of the screen and a string of spaces with some letters present was printed in white at the bottom of the screen. The number of spaces and letters was matched to the length of the stimuli on that particular trial. For example, if the word length of the stimuli on a particular trial was 8 letters then the attention check trial contained 8 spaces, half of which (selected at random) were filled with letters. The subject's task was to determine if the word printed in green could be spelt by filling in the missing letters. If the green word could be spelt, the subject pressed the button labelled

"YES" on the mouse otherwise the subject pressed the button labelled "NO". After the subject had made a response the next trial began 500 ms later.

The experimental design comprised of 16 different trial types, each of which occurred twice in each block of 32 trials. The 16 trial types were defined by 4 within subject factors each of which contained 2 levels. Every subject was presented with a total of 256 experimental trials, divided into 8 blocks of 32 trials, during both the high and low stress test sessions. There were 16 threat/nonthreat words in each domain (exam related, non-exam related) which were randomly assigned 2 each to the 8 trial types defined by the factors - valence of the word to be named (threat, nonthreat), direction of attention (attend to threat, attend to nonthreat) during the prime phase, and prime status (repeated, not repeated), and the 32 resulting trial types were presented in random order. The 32 trial types were repeated for each of the 8 blocks, but so that no word pair was assigned to the same cell twice, where the cells were defined by the factors listed above. This resulted in each of the 32 word pairs being displayed 8 times each during the 256 experimental trials. The use of each word pair in each cell it could be used in was counterbalanced across subjects in the high and low trait anxiety groups.

2.2.4 Procedure

Each subject was tested individually on two separate occasions, once far from examinations (exam distal session) and once close to examinations (exam proximal session). The exam proximal session for all subjects took place during the week prior to the first semester University examination period. The exam distal sessions were conducted on two separate occasions - six weeks prior to the exam proximal session and six weeks after the exam proximal session. Half of the low trait anxious subjects and half of the high trait anxious subjects participated in the exam distal session prior to the exam proximal session while the remaining subjects participated in the exam distal session after the exam proximal session. Therefore, across subjects, the order in which the two test sessions were conducted was not confounded with the manipulation of stress level.

At the beginning of their first test session, the subject was given the Test For Colour-blindness (Isihara, 1954). If the subject made more than three errors on the first 25 questions of the test they were excluded from the experiment. After this test, on their first test occasion, and at the beginning of their second test session, the subject was administered the state section of the STAI (Speilberger et. al., 1983), and the BDI (Beck et. al., 1961). After completing these questionnaires, the subject was seated in the test cubicle and instructed to read the instructions presented in Figure 1.

Figure 1. Instructions read by subjects.

"Three crosses (+++) will be presented on the computer screen for a short period of time followed by two words. One word will be printed in red and the other in green. These words will remain on the screen for a short time. Your task is to focus your attention on the green word. Following this presentation, a word printed in white will appear. Your task is to name this word as quickly as you can while speaking clearly. Occasionally, you will be asked what the green word presented on the current trial was. The question will be in the form of a 'fill in the blanks'. Your task is to indicate whether the blanks could be completed to make the word presented in green. If it could be completed to make the green word, press the right mouse button labelled "yes". If it could not, press the left mouse button labelled "no".

The computer task will last about 30-40 minutes and is divided into several sections between which you will be given an opportunity to rest.

The sequence of a trial is diagrammed below:

EVENT	EXAMPLE	WHAT TO DO
fixation	+++	look at crosses
green word red word	APPLE BRICK	focus on APPLE
white word	BRICK	speak BRICK
fill in the blanks	Was this the green word? _D_LE	press NO on mouse

---

Following these instructions the subject was given 16 practice trials which were identical to the experimental task, except that these trials contained only neutral stimuli. During the 16 trials the attention check task occurred 4 times. If the subject made more than one mistake on the attention check trials they were reminded to attend to the word printed in green and the practice session was repeated. Subjects were given the opportunity to rest after completing 4 of the 8 blocks of test trials.

2.3 RESULTS

The central experimental predictions of this study stemming from the disproportionate activation hypothesis and the inability to inhibit hypothesis concern the patterns of reaction times elicited by state anxiety elevations in high and low trait anxious subjects on a repetition priming task. However, before data concerning these hypotheses are considered it is necessary to investigate whether the manipulation of exam proximity was valid, that is, if it served to modify state anxiety. Therefore, the data obtained from the subjects' questionnaire scores across the two test sessions will be reported first, followed by analyses concerning the subjects' reaction times on the repetition priming task.

2.3.1 Validity of the state anxiety manipulation

The STAI state anxiety scores and the BDI depression scores obtained by the low trait anxiety and high trait anxiety subjects on each of the two test occasions are presented in Table 3.

Table 3. Mean scores on the STAI state and BDI questionnaires with standard errors in brackets.

		Exam Distal Session	Exam Proximal Session
Low Trait Anxious Subjects	**STAI Score (State)**	30.56 (1.61)	33.75 (1.73)
	BDI Score	3.81 (0.67)	4.31 (0.98)
High Trait Anxious Subjects	**STAI Score (State)**	35.69 (2.01)	41.25 (3.79)
	BDI Score	4.00 (0.89)	5.31 (1.03)

A 2 x 2 mixed design analysis of variance (ANOVA) was conducted on the STAI state anxiety scores. The between subjects factor was trait anxiety group (high, low) while the within subjects factor was test occasion (exam proximal, exam distal). The ANOVA indicated that exam proximity served as an effective manipulation of state anxiety. Across all subjects, STAI state anxiety scores were higher in the exam proximal session (mean [M] = 37.50, standard error [SE] = 2.16) relative to the exam distal session (M = 33.13, SE = 1.35). This difference was significant; $F(1,28) = 4.46$, $p < 0.05$. However, the high trait anxiety group and the low trait anxiety group did not differ significantly in terms of the magnitude of the increase in their state anxiety scores; $F(1,28) = 0.33$, $p > 0.05$, for the interaction. The ANOVA also revealed a significant effect of trait anxiety group; $F(1,28) = 5.01$, $p < 0.05$. Subjects in the high trait anxiety group had a mean STAI state score of 38.47 (SE = 2.17), while subjects in the low trait anxiety group had a mean STAI state score of 32.16 (SE = 1.20).

The BDI scores were entered into an ANOVA of identical design to the one performed on the STAI state anxiety scores. None of the effects in this analysis was significant, with $F(1,28) = 1.66$, $p > 0.05$, for the largest effect (See Table 3 for the cell means).

In summary, it can be concluded that the exam proximity stress manipulation was valid as it was effective in elevating state anxiety in both high and low trait anxiety groups. However, these elevations in state anxiety were not accompanied by a significant increase in BDI scores in high and low trait anxiety groups from exam distal to exam proximal test sessions.

2.3.2 Accuracy analysis

A 2 x 2 mixed design ANOVA was conducted on the variable percentage correct derived from data recorded on the attention check trials. In this analysis the 16 practice trials were discarded. The between subjects factor was anxiety group (high trait anxiety, low trait anxiety) while the within subjects factor was occasion (exam proximal, exam distal). The analysis did not yield any significant effects, indicating that there is no evidence that the subjects' level of accuracy differed according to anxiety group or test occasion. The subjects' mean level of accuracy was 92.9% with a SE of 0.74%.

2.3.3 Naming latencies on priming task

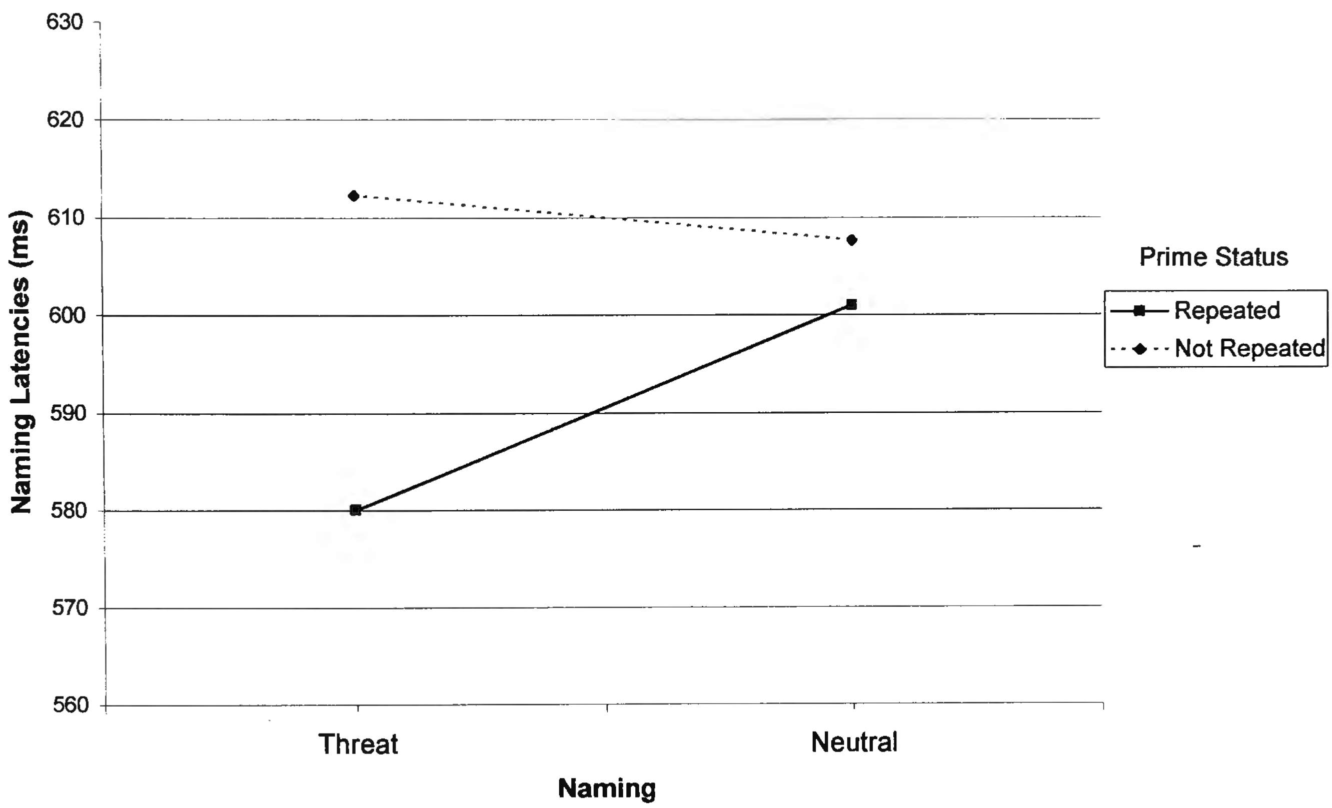
In order to minimise the effects of outlying reaction time scores, MacLeod and Locke (1994) and MacLeod and Rutherford (1992) employed median probe word naming latencies in the analyses of their data. The present study followed the same method. For every subject, the median latency scores was calculated for each experimental condition. These data were then entered into a six-way mixed design ANOVA, which contained one between-subjects factor and five within-subjects factors. The between-subjects factor was anxiety group (high trait anxiety, low trait anxiety). The within-subjects factors were test occasion (exam proximal, exam distal), naming (threat, neutral), domain (word to be named drawn from exam related pair, word to be named drawn from non-exam related pair), prime status (word to be named was repeated from one of the words in the previously presented stimulus pair, word to be named was not repeated from the words in the previously presented stimulus pair), and attend (threat, neutral).

Several significant main effects emerged from the ANOVA. First, there was a significant main effect of prime status; $F(1,30) = 60.91$, $p < 0.001$. This result indicated, as predicted, that words that were previously presented as part of the stimulus pair were named faster (M = 594.68 ms, SE = 5.27) than words that had not been previously presented as part of the stimulus pair (M = 612.88 ms, SE = 5.23). The ANOVA also revealed a significant main effect of attend; $F(1,30) = 7.29$, $p < 0.05$. This effect indicated that when subjects attended to the threat word they were able to name the subsequent probe word faster (M = 600.26, SE = 5.20) than when they attended to the neutral word (M = 607.29 SE = 5.33). This effect may reflect a higher level of arousal to respond to the word to be named after attending to a word which contained emotionally threatening content.

The ANOVA also revealed several significant interactions. There was a significant two-way interaction between naming and attend; $F(1,30) = 23.72$, $p < 0.001$. However, this two-way interaction was modified by a higher-order interaction between naming, prime status and attend; $F(1,30) = 14.16$, $p < 0.001$. This interaction is shown in Figure 2.

This interaction was explored further by conducting a 2 x 2 (naming x prime status) ANOVA for each level of the attend variable. These analyses revealed an interaction of naming and prime status both when subjects attended to neutral ($F(1,31) = 4.99$, $p < 0.05$) and when subjects attended to threat ($F(1,31) = 7.07$ $p < 0.05$). In order to further investigate these interactions, simple effects were calculated for prime status at each level of the naming variable. When subjects were attending to threat (see Figure 2, Panel A) they were significantly faster to name the threat word when it had been displayed as part of the stimulus pair ($M = 580.04$ ms, $SE = 9.85$) than when it had not ($M = 612.30$ ms, $SE = 9.78$; $F(1,31) = 26.98$, $p < 0.001$). However, when subjects were attending to threat but required to name the neutral word, the effect of prime status was not significant; $F(1,31) = 1.53$, $p > 0.05$. On the other hand, when subjects were attending to neutral (See Figure 2, Panel B) they were significantly faster to name the neutral word when it had been previously displayed as a member of the stimulus pair ($M = 586.13$ ms, $SE = 10.15$) than when it had not ($M = 613.63$ ms, $SE = 10.61$; $F(1,31) = 22.95$, $p < 0.001$). Also when subjects were attending to neutral but required to name the threat word, the effect of prime status was not significant; $F(1,31) = 1.01$, $p > 0.05$. The means plotted in Figure 2 and associated standard errors are shown in Appendix B. These results indicate that subjects were positively primed to name the word (whether threat or neutral) that they had been attending to in the prime pair. However, there was no evidence of negative priming - when the word to be named had been the unattended word in the prime pair, reaction time was not slowed compared to when the word to be named had not appeared in the prime pair.

A. Attend to Threat



B. Attend to Neutral

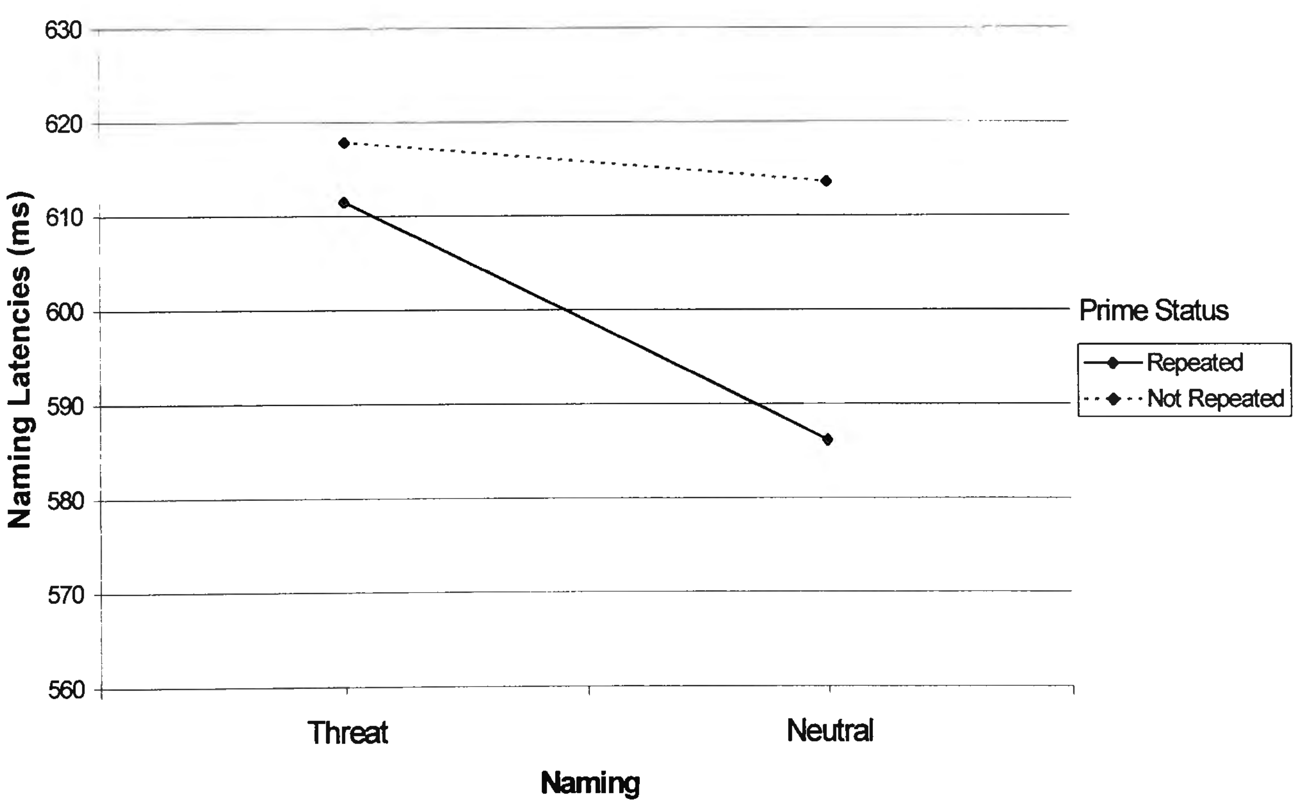
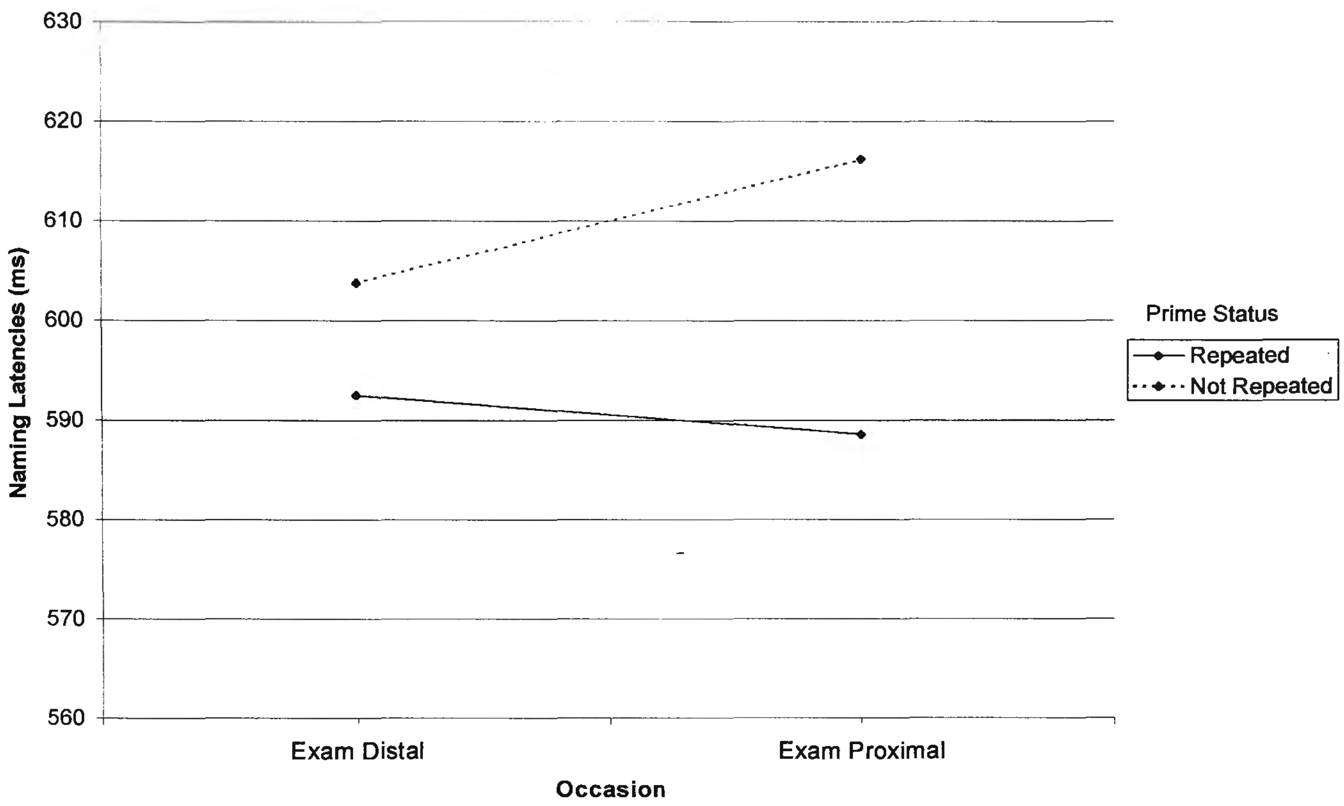


Figure 2. Mean naming latencies for the interaction of naming, prime status and attend.

The major ANOVA also revealed a significant interaction between occasion, prime status and attend, which is shown in Figure 3; $F(1,30) = 7.18$, $p < 0.05$. The means plotted in Figure 3 and associated standard deviations are shown in Appendix B. This interaction was explored further by calculating a 2 x 2 (occasion x prime status) ANOVA for each level of the attend factor. For the condition in which subjects attended to the neutral prime word (see Figure 3, Panel B), the only significant effect was the main effect of prime status; $F(1,31) = 20.27$, $p < 0.001$. For the condition in which subjects attended to the threat word (Figure 3, Panel A), the main effect of prime status was again significant, but in this case, the occasion x prime status interaction was also significant; respectively, $F(1,31) = 35.56$, $p < 0.001$, and $F(1,31) = 9.54$, $p < 0.01$. Because the interaction was significant in the attend-to-threat condition, the simple effect of prime status was tested for each level of the occasion variable. However, both of these simple effects were significant; smaller $F(1,31) = 15.95$, $p < 0.001$. Therefore, considering the interaction as a whole, naming latencies were shorter whenever one of the prime words reappeared as the probe word. However, this advantage was most pronounced when a threat word was attended to in the test occasion which was proximal to exams. This effect had not been predicted. It suggests a general augmentation of performance, perhaps through increased arousal, when a threat-related stimulus is the focus of attention in generally stressful circumstances. None of the other effects in the major ANOVA were significant.

A. Attend to Threat



B. Attend to Neutral

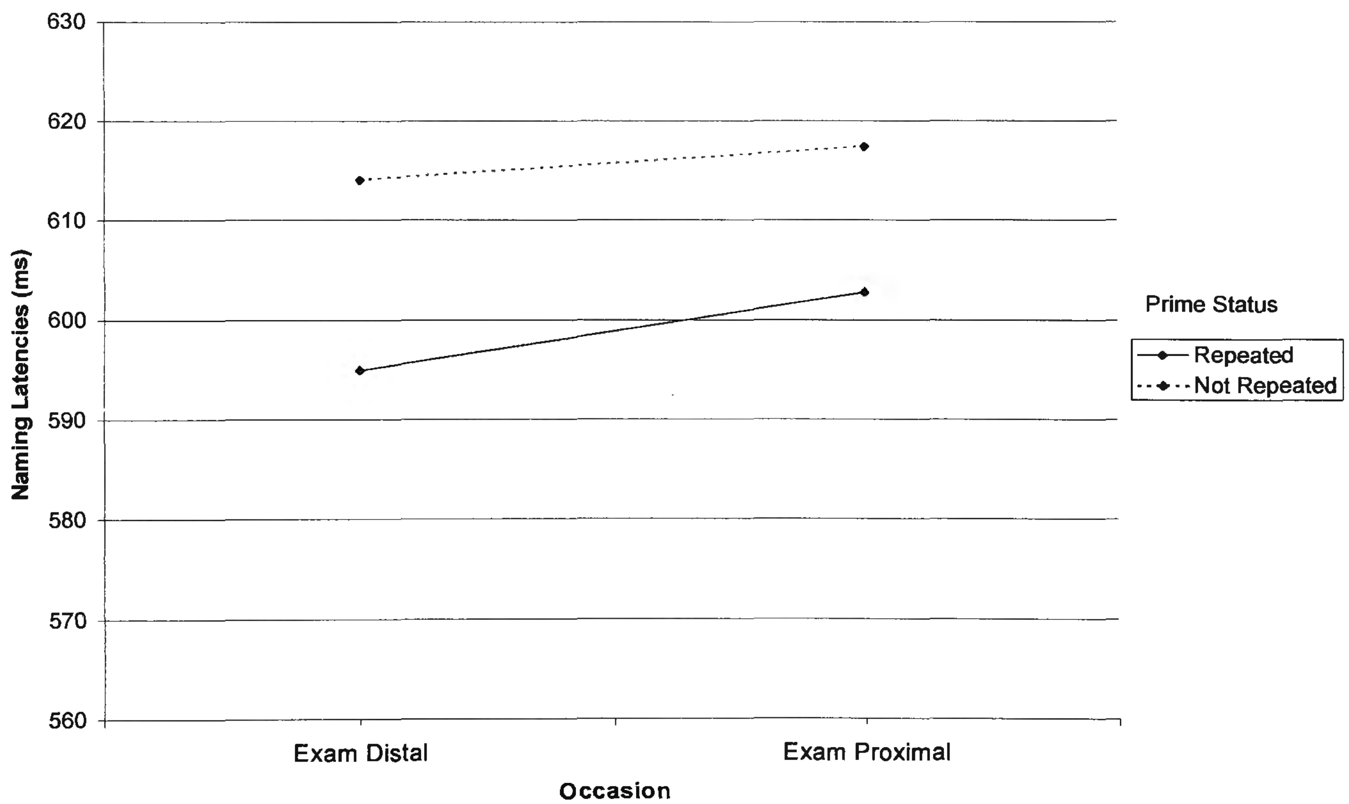


Figure 3. Mean naming latencies for the interaction of occasion, prime status and attend.

2.4 DISCUSSION

2.4.1 Disproportionate activation hypothesis

Recall that based on the research by MacLeod and his colleagues and other researchers (Broadbent & Broadbent, 1988; MacLeod et. al., 1986; MacLeod & Locke, 1994; Mogg et. al., 1992) a number of predictions were made in relation to the selective encoding bias shown by anxious subjects compared to non-anxious subjects. These predictions were that, firstly, that positive priming would occur for threat and neutral words. For threat words RTs were predicted to be shorter in the repeated prime; attended threat; probe threat condition (condition 1, Table 1) compared to its control condition - prime not repeated, attended threat; probe threat (condition 5, Table 1). For neutral words, RTs were expected to be shorter in the repeated prime; attended neutral; probe neutral condition (condition 4, Table 1) compared to its control condition - prime not repeated; attended neutral; probe neutral (condition 7, Table 1). Secondly, positive priming for threat words was predicted to be more pronounced than positive priming for neutral words, and thirdly, it was predicted that this effect would be mediated by trait and state anxiety in the following way. State anxiety elevations will result in an increase in the selective encoding of threat stimuli for high trait anxious subjects. By contrast, an elevation in state anxiety in low trait anxious subjects was predicted to result in the reverse pattern, that is, a decrease in selective encoding for threat material relative to neutral material. Finally, these effects were predicted to occur to an equivalent degree regardless of whether or not the stimuli were related to examinations. These predictions formed the disproportionate activation hypothesis.

Although the results showed overall evidence of positive priming for threat and neutral words (shown in Figure 2) there was no consistent evidence that the positive priming effect was modified by whether the subject attended to the threat or neutral word on the prime phase, or whether the subject named the threat or neutral word on the probe phase. In addition, there was no consistent evidence that the degree of positive priming was influenced by whether the subject was of high or low trait anxiety, or whether the exams were distal or proximal. These results indicate a failure to support the disproportionate activation hypothesis and a failure to replicate the findings of MacLeod and Locke (1994). They had used an attentional deployment task similar to that used in Experiment 1 and found that subjects with high levels of state and trait anxiety were disproportionately primed to respond to threat stimuli compared to low trait anxious subjects with elevated levels of state anxiety.

2.4.2 Inability to inhibit hypothesis

Recall that based on the negative priming paradigm (Tipper, 1985) several predictions regarding the inability to inhibit hypothesis were put forward. The first prediction was that there would be an effect of negative priming for threat and neutral words. That is, RTs were predicted to be longer in the repeated prime; attended neutral; probe threat condition (condition 2, Table 1) compared to its control condition - prime not repeated; attended neutral; probe threat (condition 6, Table 1). For neutral words, RTs were predicted to be longer in the repeated prime; attended threat; probe neutral condition (condition 3, Table 1) compared to its control condition - prime not repeated; attended threat; probe neutral (condition 8, Table 1). The second prediction was that negative priming for threat words should be more pronounced than negative priming for neutral words, and thirdly, the effect of negative priming was predicted to enter into higher order interactions with state and trait anxiety variables in the following way. State anxiety elevations will result in an increasing inability to inhibit threat stimuli for high trait anxious subjects which is not evident for low trait anxious subjects. These predictions formed the inability to inhibit hypothesis.

The absence of a negative priming effect led to a failure to evaluate the inability to inhibit hypothesis and a failure to replicate the results of studies which have found negative priming using selective attention tasks (Allport et. al., 1985; Tipper, 1985; Tipper et. al., 1991; Tipper & Cranston, 1985; Neill et. al., 1995; Yee, 1991; Beech et. al., 1989; Laplante et. al., 1992; Enright & Beech, 1993; Downes et. al., 1995; De La Casa & Lubow, 1994). In Experiment 2, it was decided to explore the reasons for the absence of the negative priming effect.

CHAPTER THREE

EXPERIMENT TWO

3.1 INTRODUCTION

3.1.1 Factors affecting negative priming

The absence of a negative priming effect in Experiment 1 led to an examination of the literature aimed at identifying the factors which may have contributed to the nonoccurrence of negative priming. Several factors were identified. The first factor was the presence of a distractor on the probe phase. Several studies have found negative priming when the probe phase required selection against a distractor stimulus. The second factor identified is the angular separation of the stimulus pair on the prime phase. Several studies have found that a reduced degree of angular separation may enhance negative priming. A third factor identified relates to the attentiveness of the subject - if the subject is unable to report the stimulus on the prime phase that he/she was instructed to attend to (the prime target) positive priming for the nonattended word instead of negative priming may occur. The literature regarding how these factors may influence negative priming will now be discussed.

3.1.1.1 Presence of a distractor on the probe phase

The issue of whether the probe phase on a negative priming task needs to contain a distractor (often referred to as conflict trials) in order for negative priming to occur is somewhat uncertain. A number of studies have found that negative priming is independent of probe-phase conflict. First, Neill and Westbery (1987) required subjects to report the colour of letter-string stimuli in both conflict and nonconflict experimental conditions. In the conflict condition, the stimuli consisted of the words red, blue, green and yellow printed in a red, blue, green, or yellow colour, with the constraint that a word not be written in the colour named by that word. Nonconflict stimuli were generated by substituting the letter "o" for each letter in the conflict words (i.e., ooo, oooo, ooooo), while preserving the same colour constraint. Conflict and nonconflict trials occurred randomly, and Neill and Westbery found that negative priming was observed on both types of trials. Similarly, Neill, Terry and Valdes (1994) presented a target-localisation task in which the probe phase sometimes included conflict (a distractor) and sometimes did not. The presence/absence of the distractor was randomised in the experiment and, once again, the magnitude of negative priming observed was independent of probe-phase conflict.

Negative priming has been observed in experiments where all probe phases are nonconflict, that is, in experiments where the probe phases were similar to those of Experiment 1 in that the probe stimuli were presented without distractors. For example, Yee (1991) presented subjects with different tasks on the prime and probe phases. The task on the prime phase was a form-identification task in which geometrical forms were presented in the centre of the computer screen with one or two words above and/or below the forms. The subjects task was to identify the geometrical form by pressing the designated button while ignoring word(s). On the probe phase a letter string was presented that was either a word or nonword and the subjects task was to make a lexical decision. Yee found that negative priming was observed on the probe phase when two words had been presented on the prime phase and one had been related to the probe-phase stimulus. This procedure is similar to the procedure for the repeated prime conditions where negative priming was predicted in Experiment 1 (i.e. conditions 2 & 3, Table 1). In these conditions, a stimulus pair was presented on the prime phase and a member of the pair was re-presented as a target stimulus without a distractor present on the probe phase. Similar results to Yee have been found by Fox (1994a), Fuentles and Tudela (1992, although the negative priming effect just failed to reach significance) and by Neill, et. al. (1995, Experiment 4).

However, a number of studies have shown that negative priming effects are sensitive to the presence of a distractor or conflicting information on the probe phase. Using a letter-identification task, Tipper and Cranston (1985) observed negative priming on conflict probe phases, but not on nonconflict phases. The subject's task was to name red uppercase letters (targets), while they were to ignore green uppercase letters (distractors), when present. For half the subjects, both prime and probe phases included a target and a distractor. For the other half, the prime phase included both a target and a distractor but the probe phase consisted of just a single letter. Therefore, the probe phase presented to the first group were always conflict trials, whereas the probe phase for the second group were always nonconflict trials. Tipper and Cranston found that for the conflict group, if the distractor from the prime phase was presented as the probe target on the probe phase, negative priming was observed. However, for the nonconflict group, if the distractor on the prime phase became the to-be named letter on the probe phase, no negative priming was observed. Similar results were obtained by Allport et. al. (1985, Experiment 9) also using a letter identification task.

Lowe (1979) used a Stroop task and found that negative priming was sensitive to probe phase conflict. In Lowe's experiment, prime phase stimuli for all subject's were colour words. However, the probe phase differed between three groups of subjects. For one group the probe-phase stimuli were colour words or colour patches. For a second group the probe-phase stimuli were random-letter strings or colour words and for a third group the probe-phase stimuli consisted of colour patches or random letter strings. In each of the groups, the subjects task was to name the ink colour in which the probe stimuli were drawn. Negative priming was assessed in terms of whether naming of the ink colour was slower if that colour had been used as the to-be-ignored word in the preceding prime phase. Lowe found that negative priming was observed on colour-word probe phases, but not on colour patch probe phases. In regard to the random-letter probe phases, Lowe found negative priming when the other probes were colour words (group 2), but negative priming did not occur when the other probes were colour patches (group 3).

Moore (1994) notes that in Lowe's (1979) experiment negative priming did occur on random letter probe phases when the other probe phases involved were colour word probes, even though the random letter-string probes were nonconflict trials. This result led Moore (1994) to hypothesize that the context in which nonconflict trials are presented may affect whether or not negative priming occurs.

Moore (1994) conducted several letter-identification experiments. Her experiments manipulated three factors - trial type, conflict and context. The two trial types were ignored repetition and control. Ignored repetition trials were those trials in which the target on the probe phase was the same as the distractor on the prime phase, and the two phases had no other stimuli in common. Control trials were those in which all the stimuli on the probe phase were different from all the stimuli on the prime phase. Conflict referred to whether the probe phase included a distractor that conflicted with the correct response. Conflict probe phases included a distractor that was chosen from the target set which comprised of the letters I, O, S, and X. Nonconflict probe phases included either no distractor or a distractor that was not from the target set. Context referred to whether the trial blocks included only conflict or only nonconflict probe phases (pure) or whether both conflict and nonconflict probe phases were presented within a block (mixed).

In her first experiment, all prime phases and all conflict trials included both a target and a distractor that were chosen from the target set while nonconflict probe phases included only a target. The effect of context was investigated by comparing conflict and nonconflict probe phases from pure blocks with conflict and nonconflict probe phases from mixed blocks. Moore found that negative priming did not occur when the distractor was absent on the probe phase, while reliable negative priming was observed when probe phase conflict was present. This pattern occurred independent of whether the conflict and nonconflict trials were presented in separate blocks or were randomly intermixed. From these results, Moore (1994) hypothesized that the effect of context may have failed to occur because the singleton characteristic of the nonconflict probe phases may have allowed subjects to identify them extremely quickly as containing no information that could interfere with the correct response and therefore leading to the absence of negative priming.

In order to test this hypothesis, Moore (1994), in her second experiment, added a distracting letter to nonconflict probe phases that was not from the target set (i.e. not I, O, S, or X). In this circumstance, Moore found that when conflict and nonconflict trials were randomly intermixed, negative priming occurred on both conflict and nonconflict probe phases. However, in the pure nonconflict blocks, negative priming failed to occur. From these results Moore concluded that negative priming failed to occur on nonconflict probe phases in her first experiment because the singleton characteristic of these phases allowed subjects to quickly identify them as nonconflict. This finding was further reinforced in Moore's fifth experiment where she made singleton trials less easily identifiable as being nonconflict by presenting a singleton distractor on some of the probe phases which was identified by the subject as being a distractor by being printed in a different colour than the target colour. On these trials subjects were instructed to withhold responding. Therefore, subjects could no longer identify nonconflict trials on the basis on their singleton characteristic. Thus Moore found that negative priming did occur on nonconflict probe phases that previously had not shown negative priming (i.e. trials with a singleton characteristic), under the condition where the nonconflict probe phases could not be easily identified as being nonconflict.

These experimental findings led Moore (1994) to conclude that negative priming will fail to occur on nonconflict probe phases only when these phases can be easily identified as containing no information that might conflict with target identification. These results are consistent with the results of several previous experiments in which the nonconflict trials are easily identifiable. For example, Allport et. al. (1985, Experiment 9) used two types of probe phases - simplex and duplex. Simplex probe phases consisted of a single black figure whereas duplex probe phases consisted of a pair of red and green figures. These researchers found that negative priming occurred on duplex probe phases, but not on simplex probe phases. Tipper and Cranston (1985), using a design similar to Allport et. al. (1985), obtained similar results. Experiments that have found negative priming on both conflict and nonconflict probe phases (e.g. Lowe, 1979; Neill & Westbery, 1987; Neill et. al. 1994) can be seen to have an experimental design in which nonconflict probe phases are not easily identifiable or predictable. For example, Lowe (1979) only found negative priming on nonconflict random letter-string probe phases in the condition where the other targets were perceptually similar conflict colour words. Neill and Westbery (1987) used conflict colour words and perceptually similar nonconflict letter strings and reported negative priming on both trial types. Neill et. al. (1994) employed a target-localisation task in which conflict and nonconflict trials were randomised and found negative priming on conflict and nonconflict probe phases.

However, there have been some studies (e.g. Fox 1994a; Yee, 1991) where negative priming has been observed on nonconflict probe phases even when all probe phases were nonconflict. In response to these findings, Moore (1994) has argued that the processing required by the subjects in these experiments was especially demanding as separate tasks were required on prime and probe phases. In both Yee's and Fox's studies, a categorization decision was required on the prime phase and a lexical decision was required on the probe phase. With respect to the increased difficulty on these different tasks, Moore has put forward that the inhibitory process might be engaged by default when task processing is especially demanding. However, further research is required to clarify this issue.

From the experimental data presented so far, it can be seen that the design of Experiment 1, by not including a distractor to the target stimulus in the probe phase, made all of the probe phases nonconflict. This may have allowed subjects to easily identify the probe target, possibly leading to the absence of a negative priming effect. In order to eliminate this possibility, Experiment 2 will include distractor words for some of the probe phases, and these will be randomly intermixed with trials where distractors are not presented with the probe target stimulus.

3.1.1.2 Angular separation of the stimulus pair

Several studies have found that the degree of spatial separation between target and distractor stimuli on the prime phase influences the magnitude of negative priming. DeSchepper and Treisman (1991; cited in Fox, 1995) conducted a study in which relevant and irrelevant nonsense shapes (cued by colour) shared a contour so that, perceptually, the to-be attended shape was the "figure" and the unattended shape was the "ground". In a second condition, the same shapes were presented as perceptually separate objects. In DeSchepper and Treisman's study the display was similar on both the prime and probe phases. That is, both prime and probe phases involved perceptually-separate or perceptually-integrated stimuli. The results showed that negative priming only occurred when the shapes were perceptually integrated while nonsignificant facilitation occurred when the shapes were perceptually separate. From these results DeSchepper and Treisman concluded that negative priming is observed when relevant objects are more difficult to disentangle from irrelevant objects.

Support for DeSchepper and Treisman's (1991, cited in Fox, 1995) study was provided by Fuentes and Tudela (1992). These researchers manipulated the spatial separation of target and distractor items by either 2.3, 3.3 or 4.3 degrees on the prime phase only. The task of the subject was to attend to a target word while ignoring a spatially displaced distractor word on the prime phase. The subject then made a lexical decision to a single letter string (no distractor) on the probe phase. Fuentes and Tudela found that when the ignored distractors were presented at 4.3 degrees of visual angle from fixation, facilitation or positive priming was observed. However, when the distractor was 2.3 degrees from fixation the researchers found that there was a tendency for priming to become negative, although this just failed to reach significance (Fuentes & Tudela, Experiment 2).

Fox (1994b) manipulated the spatial separation between pairs of letters on the prime phase. The spatial separation between a target and distractor letter was either 0.97, 1.7 or 2.6 degrees of visual angle. Fox found that negative priming from the ignored distractors increased in magnitude with decreasing target-distractor separation (38 ms at 0.97 degrees, 18 ms at 1.7 degrees, and 9 ms at 2.6 degrees). Fox concluded that the results indicated that the magnitude of negative priming increases in a letter identification task when a target letter is more difficult to distinguish from a distractor letter.

However, there have been several studies which have shown that well-separated distractors produce negative priming (Neumann & DeSchepper, 1991; Tipper & Cranston, 1985, Experiment 2; Tipper et. al., 1988). To illustrate, Neumann and DeSchepper (1991) examined negative priming in a colour-naming task in which the target and distractor letters were separated by 2.7 degrees of visual angle on both prime and probe phases. Neumann and DeSchepper found reliable negative priming on trials where the prime distractor became the probe target (ignored repetition) and positive priming when the prime target became the probe target (attended repetition). In addition, these researchers found that the positive priming observed was enhanced when the target and distractor on the prime phase were repeated on the probe phase, indicating that previously ignored distractors produce less interference when they are repeated. This repetition could weaken the effect of negative priming. Similar results were reported by DeSchepper and Treisman (1991, cited in Fox, 1995).

Although the literature regarding the visual separation of the stimuli is somewhat inconsistent it was decided to manipulate the angular separation of the two stimulus words, when present, on both the prime and the probe phase in Experiment 2. This manipulation resulted in the creation of two conditions for the prime phase (prime close, prime far) and two conditions for the probe phase (probe close, probe far), when the probe distractor is present. The condition of prime far and probe distractor absent is identical to Experiment 1. In addition, in Experiment 2 it was decided that none of the stimulus words would be repeated. This is in contrast to the design of Experiment 1 where the stimulus words were repeated but with the restriction that the same word could not occur on two consecutive trials. The reason for not repeating any of the stimulus words in Experiment 2 was based on the finding that repeated stimuli which subsequently become distractors produce less interference and hence reduce the effect of negative priming (DeSchepper & Treisman, 1991, cited in Fox, 1995; Neumann & DeSchepper, 1991).

3.1.1.3 Attentiveness of the participant in processing prime stimuli

In Experiment 1, subjects were queried about the target word presented on the prime phase on 25% of the trials at random. However, Tipper (1985) conducted a study where he presented subjects with two figures. One was printed in red and the other was printed in green and the figures were displayed so that the figure printed in green was superimposed over the red figure. The subjects were instructed to attend to the red figure on the prime phase and name the red figure on the probe phase. Subjects were then asked to recall the prime which had been printed in red. Tipper found that on trials where subjects reported the attended prime, there was negative priming of the ignored prime of 51 ms. In contrast, when the subjects failed to report the prime target, there was positive priming of 52 ms. Therefore, in Experiment 2 it was decided to have the attention check phase occur at the end of each trial. This design would allow trials where the subject could recall the prime target to be analysed separately from trials where the subject could not correctly recall the prime target.

3.1.2 Design

The design of Experiment 2 was aimed at detecting the reason(s) for the absence of a negative priming effect in Experiment 1. In order to provide data on this specific aim, it was not necessary to manipulate anxiety in Experiment 2 nor to vary the emotional content of the stimuli. Thus the participants were not selected in any particular way and the stimulus words used in Experiment 2 were neutral in content.

By conducting a search of the literature, three factors were found to influence negative priming. These are as reviewed above and are the presence/absence of a distractor stimulus on the probe phase, angular separation of the stimulus pairs, and the attentiveness of the subject in processing the prime stimuli.

The examination of these factors in Experiment 2 was planned so that one cell of the design was kept as similar to Experiment 1 as possible. This was done to allow the results obtained in Experiment 2 to be directly compared with the results obtained in Experiment 1. However, other conditions were varied in Experiment 2 to allow for an examination of the conditions on which negative priming may be dependent.

As with Experiment 1 the trials in Experiment 2 were divided into a prime phase, a probe phase, and an attention check phase. The presence of a distractor on the probe phase was either the same as Experiment 1 (absent) or a distractor was present. The angular separation on the prime phase and probe phase was either the same as Experiment 1 (2.39 degrees) or 1.15 degrees (see Section 3.2.3 for a description of this factor with reference to the probe present/absent manipulation). The attentiveness of the subject during the prime phase was assessed by the attention check phase which differed from Experiment 1 in the following ways. Firstly, the attention check phase in Experiment 2 occurred every trial rather than on 25% of the trials as in Experiment 1. Secondly, in Experiment 2 the subject was presented with a word that was either the to-be-attended prime word, the to-be-ignored prime word or a word not presented in the prime phase, and required to decide whether the word was the to-be-attended word displayed during the prime phase. This was in contrast to Experiment 1, where the subject was presented with a series of letters and blank spaces and was required to decide whether the to-be-attended prime word displayed in the prime phase could be spelt by filling in the spaces. The change to the form in which the attention check phases were presented was altered as it was felt that in Experiment 1, the subject could often make a correct response on the attention check phase by answering "YES" or "NO" simply in terms of whether the letters provided could or could not be used to form a word. (This was because the letters provided on "NO" trials were presented in randomly selected positions, sometimes resulting in sequences like TS_ _ _ E). The design of Experiment 2 and its relation to Experiment 1 is shown in the Table 4 below.

Table 4. Comparison of conditions in Experiments 1 and 2.

		Angular Separation on the prime and probe phase	
		2.39 Degrees	1.15 Degrees
Status of the probe distractor	Present	new condition	new condition
	Absent	new condition	same as Experiment 1, except for attention check.

When the factors involving the manipulation of word content in Experiment 1 were removed, it resulted in a design which comprised of three different trial types, which were employed in Experiment 2. These were ignored repetition, attended repetition and control. The ignored repetition trials were designed to measure negative priming. The attended repetition trials were designed to measure positive priming, while the control trials were included to provide a baseline for reaction time measurement.

The design comprised of the following within-subject factors - trial type (attended repetition, ignored repetition and control), probe distractor (present, absent), prime separation (close, far) and probe separation (close, far).

3.1.3 Theoretical predictions

From the design of Experiment 2, three theoretical predictions arise from the areas of literature reviewed. The first prediction is that the presence of a distractor on the probe phase may lead to negative priming. If this is the case, an interaction between the factors trial type and probe distractor would be expected, with reaction times lengthened disproportionately in the condition where ignored repetition is the trial type and the probe distractor is present. This condition is predicted to yield a significantly slower reaction time than the other trial types with the distractor present.

The second prediction is that a reduced angular separation of the stimulus pair on the prime phase, probe phase or both experimental phases may lead to negative priming. If reduced angular separation of the stimuli on the prime phase leads to negative priming, an interaction between the factors trial type and prime separation would be expected, with the condition where the trial type is ignored repetition and the prime separation is close yielding a disproportionately slower reaction time. If reduced angular separation of the stimuli on the probe phase leads to negative priming, an interaction involving the factors trial type and probe separation would be expected, with the condition where the trial type is ignored repetition and the probe separation is close expected to yield a disproportionately slower reaction time than the other trial types. If reduced stimulus separation on both the prime and probe phases leads to negative priming, an interaction between the factors trial type, prime separation and probe separation is expected, with the condition where the trial type is ignored repetition, the prime separation is close and the probe separation is close predicted to be disproportionately slower than the other trial types.

If the attentiveness of the subject in processing the prime stimuli influences negative priming, it is predicted that the trials where the subject responds correctly to the attention check phase will show negative priming in the condition where the trial type is ignored repetition, whereas the trials in which the subject fails to identify the prime target will show positive priming in the condition where the trial type is ignored repetition. This prediction is based on the results obtained by Tipper (1985).

3.2 METHOD

3.2.1 Subjects

Thirty-one female and 13 male University of Western Australia undergraduates participated in this experiment. The mean age of the female subjects was 20.0 years (SE = 0.75) and the mean age of the male subjects was 23.85 years (SE = 2.89). All subjects had normal or corrected-to-normal visual acuity, normal colour vision as assessed by the Test for Colour-blindness (Ishihara, 1954) and English as their first language.

3.2.2 Materials

3.2.2.1 Stimulus words

One thousand one hundred and twenty words of neutral content ranging from 4-12 letters in length were selected from the MRC Psycholinguistic Database: Machine-Usable Dictionary, Version 2.00 (Wilson, 1988). These words were grouped into 224 stimulus sets each containing 5 words that were matched for length. The stimulus words were further divided into 192 sets which were used on the test trials and the remaining 32 sets were used on practice trials. The stimulus sets used on the test trials are listed in Appendix C. The mean length of the words which comprised the 192 test trial stimulus sets was 8.0 letters (S.E. = 0.63) and the mean written word frequency (Kucera & Francis, 1967) was 42.66 (S.E.= 9.32) occurrences per million words.

3.2.2.2 Experimental hardware

The experimental hardware used in this experiment was exactly the same as that used in Experiment 1 described in Section 2.2.3.2.

3.2.3 Experimental task

The experiment was conducted through the use of a custom designed computer program which was designed to manipulate the following within-subject factors- trial type (attended repetition, ignored repetition and control), probe distractor (present, absent), prime separation (close, far) and probe separation (close, far). The manipulation of these factors is best described by discussing the operation of the experimental software in some detail.

The experimental software presented subjects with six basic trial types. These were ignored repetition, attended repetition and control crossed with the factor of probe distractor (present, absent). The six trial types are shown in Table 5. On the ignored repetition trials, the prime distractor was identical to the target displayed on the probe phase, and the probe distractor (when present) was different from the stimulus words used in the prime phase. On the attended repetition condition trials, the prime target was identical to the probe target, and, once again, the probe distractor (when present) was different from the stimulus words used in the prime phase. In the control condition, the target and distractor stimuli in the prime phase were selected to be different from each other and from each word on the probe phase.

The manipulation of the trial type (ignored, repetition, attended repetition, control) and the factor probe distractor (absent, present) were combined with the factors prime separation (close, far) and probe separation (close, far) to create a 24 cell design. In the condition where the probe distractor is absent, probe separation (close, far) refers to the separation of the probe target from the central fixation display. The distance of probe separation in both the close and far conditions, in this case was the same as when the probe distractor was present.

Table 5. Depiction of trial types used in Experiment 2. The stimulus in bold on the prime phase is the one the subject was instructed to attend to. The stimulus in bold on the probe phase is the target.

Probe Distractor Absent			
Condition		**Prime**	**Probe**
1	Ignored Repetition	**Stimulus 1** Stimulus 2	**Stimulus 2**
2	Attended Repetition	**Stimulus 1** Stimulus 2	**Stimulus 1**
3	Control	**Stimulus 1** Stimulus 2	**Stimulus 3**
Probe Distractor Present			
Condition		**Prime**	**Probe**
4	Ignored Repetition	**Stimulus 1** Stimulus 2	**Stimulus 2** Stimulus 4
5	Attended Repetition	**Stimulus 1** Stimulus 2	**Stimulus 1** Stimulus 4
6	Control	**Stimulus 1** Stimulus 2	**Stimulus 3** Stimulus 4

As in Experiment 1, each experimental trial began with the presentation of a fixation display that comprised of a row of 3 crosses printed in white which appeared in the centre of the computer screen for 500 ms. Following the termination of the fixation display, the prime phase was presented. It consisted of two stimulus words, matched for length, one printed in red, the other printed in green, using letters that were 0.6 cm in height. In the prime far condition, which was identical to Experiment 1, the words were separated by a vertical distance of 2.5 cm creating a visual angle of 2.39 degrees with the subject seated 60 cm away from the computer monitor. In the prime close condition, the words were separated by a vertical distance of 1.2 cm, creating a visual angle of 1.15

degrees with the subject seated 60 cm away from the computer monitor. In both conditions, the centre-point of the two-words displayed during the prime phase corresponded to the centre-point of the preceding fixation display. The top and bottom positions of the word printed in red and the word printed in green were selected at random for each trial. As in Experiment 1, the prime phase lasted for 500 ms. Once this time period had elapsed the probe phase was presented.

The probe phase consisted of either one word in the probe distractor absent condition or two words in the probe distractor present condition. In the probe far and probe close conditions, when the probe distractor was present, the target and distractor stimuli were printed in positions identical to the far and close conditions of the prime phase, that is, with a visual separation of 2.39 and 1.15 degrees respectively. In the cases where the probe distractor was absent, the target word occupied one of the positions it would have occupied in the probe present condition. As with Experiment 1, on each trial the probe display remained on the computer screen until the subject named the target stimuli. The computer recorded the time taken for the subject to name the target word on the probe trial.

The probe phase stimuli were presented by using two separate colour sets between subjects. For subjects in colour condition 1, the probe target (word to be named) was printed in blue while the probe distractor word (when present) was printed in yellow. For subjects in colour condition 2, the probe target was printed in yellow while the probe distractor word (when present) was printed in blue. The prime phase stimuli were presented using the colours green and red as in Experiment 1. However, in the present experiment subjects assigned to colour condition 1 were instructed to attended to the word printed in green while subjects assigned to colour condition 2 were instructed to attend to the word printed in red. Half the subjects were assigned to one condition and half to the other.

Once the subject named the target word, an attention check phase followed. In this phase, a word was printed in the lower centre position on the computer monitor and the subject was asked in colour condition 1 whether or not the word displayed was the word printed in green. In colour condition 2, the subject was asked about the word printed in red. The subject's task was to answer "YES" or "NO" by pressing the appropriately labelled mouse button. The word displayed upon which the subject made their decision was either the to-be-attended prime word which was displayed 50% of the time, the to-be-ignored prime word which was displayed 25% of the time, or a word not presented in either the prime or probe phase which was displayed 25% of the time. After the subject had made a response, the next trial began 500 ms later.

The experimental design consisted of 24 different trial types, each of which occurred 4 times in each block of 96 trials. Each subject was presented with 192 test trials divided into 2 blocks each containing 96 trials. The 224 sets of stimulus words were broken into 192 test sets, 24 practice sets and 8 lead-in sets which were used as practice trials after the subject had been given a rest period from the test trials. The order of presentation of the 192 test sets of stimulus words was randomised between subjects. In each block of 24 test trials, the subject received 8 ignored repetition trials, 8 attended repetition trials and 8 control trials. Each of these sets of 8 trials consisted of one trial for each combination of the factors prime (close, far), probe (close, far) and probe distractor (absent, present). The order of the 24 trials in each block was random.

3.2.4 Procedure

Each subject was tested individually. At the beginning of the test session, the subject was administered the Test For Colour-blindness (Ishihara, 1954). As in Experiment 1, if the subject made more than three errors on the first 25 questions of the test they were excluded from the experiment. After successfully completing the Test For Colour-blindness, the subject was seated in the test cubicle and instructed to read the instructions shown in Figure 4 if they had been assigned to colour condition 1. Subjects assigned to colour condition 2 read a second set of instructions which was the same except for the changes in the colour of the stimuli.

Following these instructions, the subject was given 24 practice trials which were identical to the test trials, except that these trials contained stimuli that were not used in the test trials. The software returned a score representing the number of times the subject responded correctly to the attention check phase (maximum 24). If the subject made more than three mistakes on the attention check phase, the subject was reminded to attend to the colour which they had been assigned (either green or red) and the practice session was repeated. Subjects were given a 10 minute rest period after completing half of the test trials.

Figure 4. Instructions given to subjects in colour condition 1.

Three crosses (+++) will be presented on the computer screen for a short period of time followed by two words. One word will be printed in red and the other in green. These words will remain on the screen for a short time. Your task is to focus your attention on the green word. Following this presentation, on all trials a word printed in blue will appear. The word printed in blue will sometimes be accompanied by a word printed in yellow. Your task in both of these cases is to name the word printed in blue as quickly as you can while speaking clearly. You will then be asked whether a word - printed at the bottom of the computer screen was the word printed in green. You task is to answer "YES" or "NO" by pressing the appropriately labelled buttons.

The computer task will last about 30-40 minutes and is divided two sections between which you will be given an opportunity to rest.

The sequence for a trial is diagrammed below:

EVENT	**EXAMPLE**	**WHAT TO DO**
fixation	+++	look at crosses
green word red word	APPLE BRICK	focus on APPLE
blue word Sometimes a word printed in yellow will be present	BRICK	speak BRICK
Is this the green word?	SPADE	press button labelled "NO"

3.3 RESULTS

3.3.1 Accuracy analysis

A one-way within-subjects analysis of variance (ANOVA) was conducted on the variable percentage correct obtained from the data recorded on the attention check trials. In this analysis the 24 practice and 8 lead-in trials were discarded. The within subjects factor was trial type (ignored, attended or not previously presented). The percentage of correct responses to the attention check trials for each condition with standard errors in parentheses is shown in Table 6 below.

Table 6. Percentage of correct responses for each condition of the attention check trials with standard errors in parentheses.

Check Trial Type	Percentage Correct
Ignored	95.06 (0.084)
Attended	94.45 (0.080)
Not Previously Presented	98.92 (0.023)

The analysis yielded a significant effect of check trial type; $F(2, 86) = 17.35$, $p < 0.001$. This effect was further investigated by conducting post-hoc t-tests under the Bonferroni procedure (Maxwell & Dulaney, 1990). Of the three pairwise comparisons performed, the comparisons of the not previously presented condition with the other two conditions yielded a significant difference, but the remaining comparison did not. This result indicates that the subjects were more accurate when deciding if the word presented on the attention check trial was the prime-target when the word had not been previously displayed.

3.3.2 Naming latencies on priming task

The procedure used to minimise the effects of outlying reaction time scores was identical to Experiment 1. That is, median probe phase naming latencies were calculated for each experimental condition. The data were then entered into a four-way within-subjects ANOVA. The within subjects factors were trial type (attended repetition, ignored repetition and control), probe distractor (present, absent), prime separation (close, far) and probe separation (close, far).

Three significant main effects were indicated by the ANOVA. First, there was an effect of trial type; $F(2, 86) = 20.20$, $p < 0.001$ (see Table 7 for means) . The analysis of the effect of trial type was completed by conducting post-hoc t-tests under the Bonferroni procedure (Maxwell & Dulaney, 1990). Of the three pairwise comparisons calculated, the comparisons of the attended repetition condition with the other two conditions were significant, however the remaining comparison was not significant. This result is indicative of a positive priming effect. However, there was no significant difference between control and ignored repetition trials, indicating the absence of a negative priming effect.

Table 7. Mean reaction times in milliseconds for each trial type, with standard errors in parentheses.

Trial Type	Mean Reaction Time
Ignored Repetition	801.99 (11.05)
Attended Repetition	753.05 (10.00)
Control	823.30 (10.37)

The second main effect was that of the probe distractor; F (2, 86) = 135.68, $p < 0.001$. This result indicated that subject's responded significantly faster to the probe-target when the probe distractor was absent (M = 743.97 ms, SE = 7.88 ms) than when the probe distractor was present (M = 841.59 ms, SE = 8.89 ms). Therefore, the probe distractor did have the effect of distracting the subjects attention away from the probe target.

The third main effect was that of prime separation; F (2, 86) = 5.30, $p < 0.05$. This result indicated that subjects responded faster to the probe target in the condition where the prime phase was displayed in the close position (M = 783.53 ms, SE = 7.86 ms) than when the prime phase was displayed in the far position (M = 802.03 ms, SE = 9.36 ms).

In order to test the prediction that negative priming may occur only on the trials where the subject could recall the prime target, a separate analysis identical to the analysis described above was performed. This analysis excluded the trials where subjects made errors on the attention check phase. However, the results from this analysis were unchanged from the analysis reported above.

CHAPTER FOUR

GENERAL DISCUSSION

4.1 Overview of results

The central factor of interest in Experiment 1 concerned the patterns of reaction times elicited by state anxiety elevations in high and low trait anxious subjects on a repetition priming task. These patterns of reaction times were hypothesised to provide support for the disproportionate activation hypothesis or the inability to inhibit hypothesis. It was also possible for both hypotheses to be supported.

Recall that the central prediction stemming from the disproportionate activation hypothesis was that high trait anxious subjects compared to low trait anxious subjects under conditions of elevated state anxiety would record faster reaction times to threat stimuli attended to on the prime phase. The central prediction of the inability to inhibit hypothesis was that high trait anxious subjects would show a reduced effect of negative priming in the condition where they were attending to the neutral stimulus during the prime phase and the threat stimulus was presented as the target on the probe phase (condition 2, Table 1) compared to the condition where they were attending to the threat stimulus during the prime phase and the probe target was neutral (condition 3, Table 1). In contrast to the results predicted for high trait anxious subjects, no difference between the reaction times in conditions 2 and 3 of Table 1 were predicted for low trait anxious subjects.

Although the results of Experiment 1 showed overall evidence of positive priming for threat and neutral stimuli, there was no consistent evidence that the positive priming effect was modified by whether or not the subject attended to the threat or neutral stimulus on the prime phase or whether the subject named the threat or neutral word on the probe phase. In addition, there was also no consistent evidence to suggest that the magnitude of the positive priming effect was modified by whether or not the subject was of high or low trait anxiety or whether the subject was tested under conditions of low or elevated state anxiety. These results failed to provide support for the disproportionate activation hypothesis and therefore failed to replicate the findings of research which has found support for that hypothesis (Broadbent & Broadbent 1988; MacLeod et. al., 1986; MacLeod & Locke 1994; Mogg et. al. 1992). The results obtained in Experiment 1 could not be used to evaluate the inability to inhibit hypothesis as an effect of negative priming was not obtained. These results failed to replicate research which has reported negative priming (Allport et. al., 1985; Tipper, 1985; Tipper et. al., 1991; Tipper & Cranston, 1985; Neill et. al., 1995; Yee, 1991; Beech et. al., 1989; Laplante et. al., 1992; Enright & Beech, 1993; Downes et. al., 1995; De La Casa & Lubow, 1994).

In light of the findings of Experiment 1 concerning the inability to inhibit hypothesis, Experiment 2 was designed to investigate the reasons for the absence of the negative priming effect. Recall that several factors discussed in detail in section 3.1.1 were manipulated in Experiment 2 - probe distractor (present, absent), prime separation (close, far) and probe separation (close, far). In addition, the attention check phase was made more difficult. However, these manipulations failed to produce the predicted negative priming effect.

As a result of the failure to find support for the disproportionate activation hypothesis or the inability to inhibit hypothesis in Experiment 1 and the absence of a negative priming effect in Experiment 2, the discussion will have several aims: firstly, to identify factors which may have contributed to not obtaining the pattern of effects which would have provided support for the disproportionate activation hypothesis; secondly, to identify factors which may have led to the absence of a negative priming effect which was a necessary condition in order for the inability to inhibit hypothesis to be evaluated. It is hoped that through an analysis of these factors that guidelines for the direction of future research in this area can be formulated.

4.2 Failure to find support for disproportionate activation

It is difficult to identify factors which may have led to the lack of support for the disproportionate activation hypothesis obtained in Experiment 1. This is because the design of Experiment 1 was based closely on the work of MacLeod and Locke (1994) who found support for the disproportionate activation hypothesis. However, when the results obtained in MacLeod and Locke's study are compared to those obtained in Experiment 1 an important difference emerges with regard to the manipulation of stress levels.

In Experiment 1, although the difference between the STAI scores (state) in the exam distal and exam proximal test session was significant, $t(31) = 2.11$, $p < 0.05$ (exam distal mean = 33.1, exam proximal mean = 37.5), the results reported by MacLeod and Rutherford (1992) and MacLeod and Locke (1994) show a larger difference between the test sessions. Using the SDs provided by Rutherford (personal communication, 1998) and Locke (personal communication, 1998) it was possible to calculate the effect size for the STAI state manipulation for each of the studies (Maxwell & Delaney, 1990). The effect size for the STAI state manipulation for MacLeod and Rutherford (1992) and MacLeod and Locke (1994) were very similar - 0.58 and 0.57 respectively. The effect size for the STAI state manipulation in Experiment 1 was 0.43. It may have been the case that the smaller effect size obtained in Experiment 1 led to a failure to replicate the results obtained by MacLeod and Rutherford and MacLeod and Locke whose results supported the disproportionate activation hypothesis.

The magnitude of the state anxiety manipulation based on exam distal and exam proximal test occasions is important in terms of obtaining support for the disproportionate activation hypothesis. This is due to the disproportionate activation hypothesis being based on the theory put forward by Williams et. al. (1988) who state that stable patterns of threat selectivity only occur when state anxiety is elevated in non-clinical samples. That is, high trait anxious non-clinical subjects will only be disproportionately activated to respond to threatening stimuli compared to low trait anxious subjects when state anxiety is elevated. Therefore, it may have been the case in Experiment 1 that state anxiety was not sufficiently elevated to produce the effects which would have provided support for the disproportionate activation hypothesis.

Another possibility is that in the MacLeod and Locke (1994) study, subjects were not instructed to direct their attention to either of the prime stimuli. However, in Experiments 1 and 2 subjects were directed to attend to one of the coloured words presented during the prime phase. It is possible that any tendency to preferentially attend to threatening information in high trait anxious subjects is only present when there is no direction to attend selectively. In the studies of Broadbent and Broadbent (1988) and MacLeod et. al. (1986) who found support for the disproportionate activation hypothesis, subjects were not instructed to selectively attend to stimuli but were instructed to read the word presented above the fixation point first.

4.3 Factors influencing negative priming

4.3.1 The time course of negative priming

Houghton, Tipper, Weaver, and Shore (1996) conducted an experiment where the prime phase was either long or short in duration. In the long display condition, the prime stimuli remained on the screen until the probe display was presented. In the short duration condition, the prime display appeared for 150 ms and then was replaced by question marks until the probe stimuli appeared. In the long display condition, non-significant negative priming was found along with a large interference effect. These results are identical to the results of Experiment 2 where there was non-significant negative priming, but a high level of interference. That is, subjects took longer to respond in the distractor present condition compared to the distractor absent condition. In the short display condition, Houghton et. al. found significant negative priming and reduced interference.

The results of Houghton et. al. (1996) raise two possible factors which may mediate the occurrence of negative priming. The first is the time interval for which the prime stimuli remain on the screen. The second is, the time interval between the termination of the prime phase and the presentation of the probe phase. Houghton's study did not provide a test of the first issue as the time that the prime stimuli remained on the screen was confounded with the time interval separating the presentation of the prime and probe phases. The rest of the negative priming literature appears to have followed a similar methodology.

The majority of studies use a short duration (35 - 150 ms) for the presentation of the prime phase and include a relatively lengthy interval (300-500 ms) between the termination of the prime phase and the presentation of the probe phase during which the screen is typically blank (Enright & Beech, 1993; Fox, 1994; Fuentes & Tudela, 1992; Moore, 1994; Neumann & DeSchepper, 1991; Ortells & Tudela, 1996; Park & Kanwisher, 1994; Rutheruff & Miller, 1995, Tipper, 1985; Tipper et. al., 1990; Williams, 1995). Each of these studies reported the occurrence of negative priming. One study which did not report negative priming (Lorch, Balota & Stamm, 1986) displayed the prime phase for 1400 ms and had a 50 ms interval between the termination of the prime phase and the presentation of the probe phase. The duration of the prime phase in Experiments 1 and 2 was 500 ms and there was no time delay between the termination of the prime phase and the onset of the probe phase. Therefore, it is unclear whether the comparatively long presentation of the prime phase or the lack of a delay between the prime and probe phases in Experiments 1 and 2 may have led to the lack of a negative priming effect.

Houghton et. al. (1996) have provided a theoretical account of why it is necessary to have a time interval between the termination of the prime phase and the presentation of the probe phase. These researchers state that when attentional selection begins, the inputs received from the target stimulus and the distractor stimulus are compared to a selection template. The selection template is an internally generated representation of goals and plans which are relevant to the guidance of the person's current actions. Selection of objects that fit the selection template is achieved via a matching process. Stimuli are matched on the basis of particular features such as colour and location. Objects containing features that match the target become selectively enhanced. That is, their activation level is increased, whereas mismatching objects have their activation levels suppressed.

According to the model of Houghton et. al. (1996) each encoded object is represented as a connected set of processing elements referred to as nodes. Nodes represent all aspects of an object's current location and details and are linked to a subsystem which contains two feedback loops - one excitatory and the other inhibitory. Before a stimulus is perceived the excitatory and inhibitory feedback loops are in equilibrium or at resting levels. In order for inhibition to take place the balance between the excitatory and inhibitory feedback loops must be upset so that the representation of the ignored distractor drops below the resting level. Houghton et. al. argue that while the prime phase distractor is still in view its activation level does not drop below resting levels due to the continued perceptual input. However, once the distractor input is terminated, the activation level drops below the resting level for a period of time before its activation level returns to the resting level. Houghton et. al. have described the behaviour of the ignored distractor as "inhibitory rebound", which is shown in Figure 5, and state that if the previous distractor (or similar item) is re-presented as the probe target in the presence of a probe distractor while in this rebound phase then selection is impaired. On the assumption that similar objects share nodes, the model predicts that negative priming will be greater the more similar the ignored prime and probe. However, Houghton et. al. have not provided an exact time frame which states how long it takes for the rebound cycle to be at the stage where the activation of the prime distractor is maximally suppressed or when the rebound cycle is completed so that negative priming will fail to occur.

4.3.2 Prime phase task

A number of studies investigating negative priming have used a different methodology to Experiments 1 and 2. In particular, a response is required on both the prime and probe phases (Chiappe & MacLeod; Fox, 1994a; Houghton et. al., 1996; Park & Kanwisher, 1994; Stadler & Hogan, 1996; Tipper et. al., 1990; Yee, 1991) instead of just on the probe phase as in Experiments 1 and 2. Requiring the subject to make a response on the prime phase may lead to an increased chance of obtaining negative priming as requiring the subject to overtly select the prime phase target may lead to increased encoding of the prime target and increased suppression of the distractor stimulus. In addition, Moore (1994) has argued that requiring the subject to perform fairly complex high level processing such as a categorisation task on the prime phase followed by a lexical decision task on the probe phase may lead to inhibitory processing being engaged by default. However, there have been several studies where no response was required on the prime

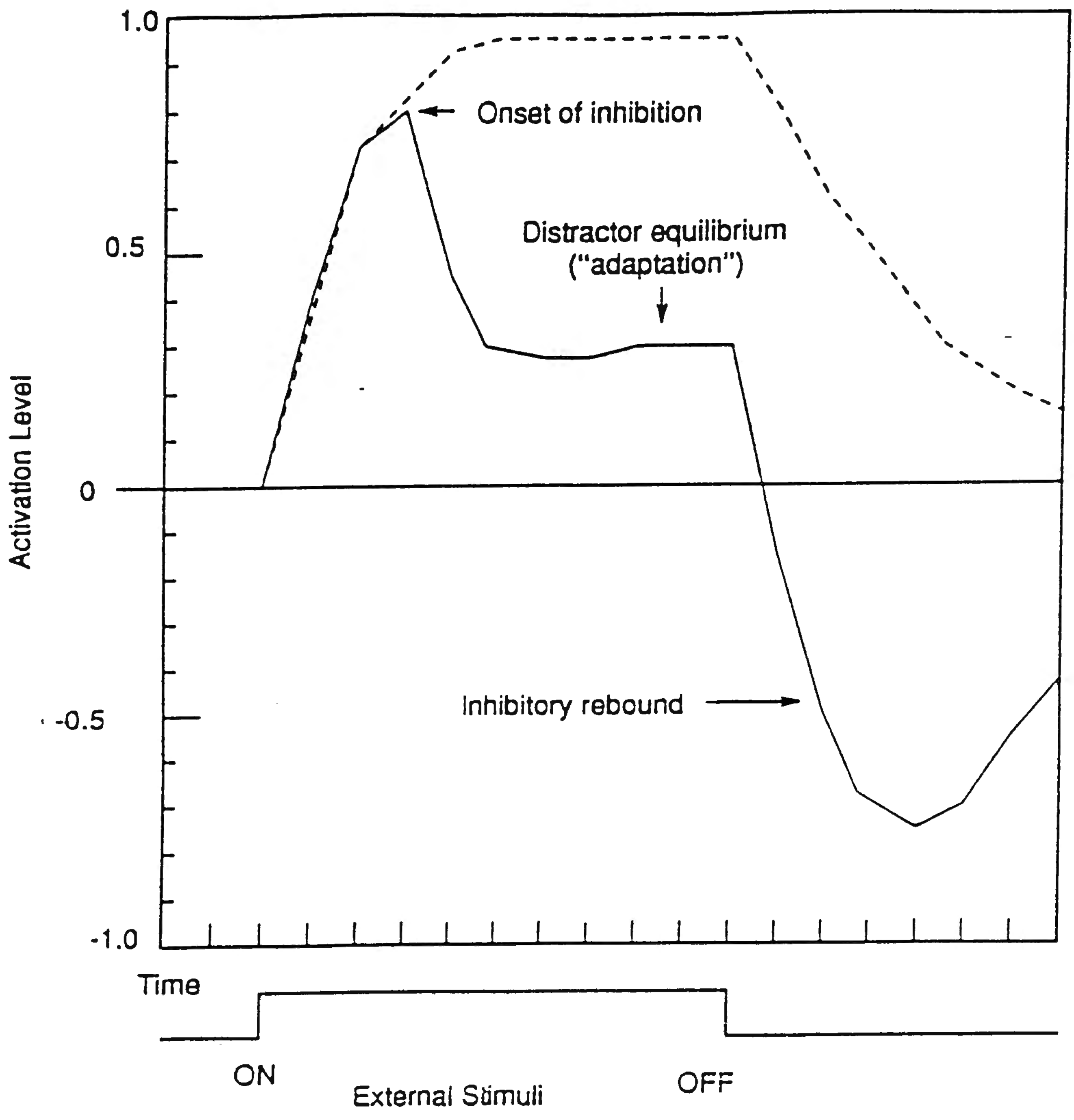


Figure 5. The inhibitory rebound cycle. The attended stimulus is indicated by the dashed line and the ignored distractor is represented by the solid line (from Houghton et. al., 1996)

phase and negative priming was obtained (Fuentes & Tudela, 1992; Lupker & Colombo, 1994; Neumann & DeSchepper, 1991). Therefore, it appears that requiring the subject to make a response on the prime phase is not necessary to obtain negative priming, but may be a factor which increases the likelihood of obtaining negative priming.

4.3.3 Ease of selection

Another factor which may influence negative priming is the ease with which the target and the distractor stimuli can be distinguished. Rutheruff and Miller (1995) investigated ease of selection by carrying out two between subjects manipulations. The first manipulation involved the colour in which the stimuli were presented. One group of subjects discriminated between green and purple letters which were highly discriminable, and the other half discriminated white and light blue letters, which were less discriminable. Rutheruff and Miller predicted that the amount of negative priming will be smaller when selection is easy - that is, when the colours are highly discriminable. This is because when selection is easy it is not necessary for the subject to process the distractor stimuli as deeply.

The second manipulation involved varying the degree of certainty the subject could have regarding the location of the prime and probe stimuli. There were three levels of location uncertainty manipulated between subjects. For one third of subjects, the target and distractor positions on the prime and probe phases varied unpredictably from trial to trial (the difficult selection condition). In this condition, the target and distractor letters on each phase were always positioned along diagonally opposite corners of an imaginary square centred around the fixation point. For another third of the subjects, the prime and probe target was always presented at the fixation point, but the prime and probe distractor appeared randomly at one of the four corners of the imaginary square (the easy selection condition). For the remaining third of subjects, the prime and probe target always appeared at fixation, and the prime and probe distractor always appeared at the same corner of the imaginary square within a block (the very easy selection condition). The centres of the target and distractor letters on both the prime and probe phases were 1.4 degrees apart in all three selection conditions.

Rutheruff and Miller (1995) found that negative priming did not depend on the discriminability of the target and distractor colours. However, Houghton et. al. (1996, Experiment 2) have shown that the discriminability of the stimuli can affect the amount of negative priming observed. These researchers manipulated the colour of the prime distractor and found that when the prime distractor was white against the black background of the screen more negative priming was observed than when the prime distractor was dark gray. In this experiment the prime target was always printed in light gray. Therefore, it is uncertain whether the discriminability of the stimuli affects negative priming. However, the majority of studies have used red and green to display the prime phase stimuli and obtained negative priming (Allport et. al., 1985; Enright & Beech, 1993; Neumann & DeSchepper, 1991; Tipper & Driver, 1988; Tipper, 1985; Williams, 1995). These were the colours used in Experiments 1 and 2.

Rutheruff and Miller (1995) found negative priming in the difficult and easy selection conditions which did not vary significantly between the two conditions. There was no negative priming in the very easy selection condition. The researchers concluded that negative priming depends on the degree of difficulty of stimulus selection, but were not able to determine whether the difficulty of prime selection was relevant to the prime phase, probe phase or both phases. In a second experiment, Rutheruff and Miller replicated the results of their first experiment while holding the ease of target selection on the probe phase constant. Therefore, the researchers concluded that the effects obtained in their first experiment could be attributed unambiguously to the differential processing of the prime displays.

It is not possible to directly compare the experiment of Rutheruff and Miller (1995) with Experiments 1 and 2 reported here, as neither of the three selection conditions exactly matched those of Experiments 1 and 2. The stimulus presentation used in Experiments 1 and 2 has characteristics in common with both the very easy and the easy selection conditions of Rutheruff and Miller's experiment. Recall that in the very easy condition the target always appeared at fixation and the distractor always appeared in the same corner of the imaginary square. Rutheruff and Miller's easy selection condition was identical to their very easy selection condition in terms of the presentation of the target stimulus, but the distractor stimulus could appear randomly in any of the four corners of the imaginary square. The stimulus presentation used in Experiments 1 and 2 is similar to Rutheruff and Miller's very easy selection condition in terms of presenting the target at fixation, but differs in terms of the location the stimuli were presented at. In Experiments 1 and 2 the target and distractor stimuli presented on the prime phase could appear in one of two locations whereas in the very easy condition of Rutheruff and Miller the prime target and prime distractor always appeared in the same location between trials. Therefore, the selection difficulty of Experiments 1 and 2 is more difficult than Rutheruff and Miller's very easy selection condition. However, in Rutheruff and Miller's easy selection condition the prime distractor could appear in one of four possible locations whereas the prime distractor in Experiments 1 and 2 could only appear in one of two possible locations. Therefore, the selection difficulty of Experiments 1 and 2 falls somewhere between the very easy and easy selection conditions of Rutheruff and Miller. Hence the absence of negative priming in Experiments 1 and 2 is broadly consistent with the results of Rutheruff and Miller.

Several experiments which have reported negative priming have been designed so that target and distractor stimuli are presented in an overlapping manner (e.g., Enright & Beech, 1993; Tipper & Driver, 1988; Tipper, 1985). In this situation, negative priming may have occurred due to the target and distractor stimuli being difficult to disentangle which may have led to more resources being devoted to suppression of the distractor stimuli. Other experiments which have reported negative priming are similar to the design of Rutheruff and Miller (1995) where stimuli can be presented in a number of different locations (e.g., Houghton et. al., 1996; Park & Kanwisher, 1994; Tipper, Brehaut & Driver, 1990). However, in other experiments reporting negative priming the design is similar to Experiments 1 and 2 where the location of the prime phase stimuli is randomised between top and bottom screen positions (e.g. Chiappe & MacLeod, 1995; Malley & Strayer, 1995). Therefore, it appears that ease of selection of the prime phase stimuli may play a role in determining whether or not negative priming occurs, but does not provide an explanation which encompasses all of the negative priming literature.

4.3.4 Instructions

Ortells and Tudela (1996) performed two experiments investigating positive and negative priming. In their first experiment the researchers did not obtain a negative priming effect. However, upon further examination of their data, Ortells and Tudela found that in the condition which measured negative priming, of the 30 subjects taking part in the experiment, 12 showed evidence of slowed responses and 18 showed facilitation effects. In order to further investigate these results, Ortells and Tudela designed a second experiment to determine whether the instructions given to subjects had an influence on negative priming. They manipulated the instructions across three experimental groups. One group of subjects was instructed to actively attend to and remember the prime target and actively ignore the prime distractor (attend and remember condition). A second group was instructed to ignore the entire prime phase and to consider the two primes as distractors that could interfere with their responses to the probe phase (ignore condition). A third group of subjects were instructed to focus their attention on the prime target and disregard the prime distractor (attend only condition). The attend only instructions were a repetition of the instructions used in Ortells and Tudela's first experiment and were similar to the instructions presented to subjects in Experiments 1 and 2 where the subject was instructed to focus on the prime target.

Ortells and Tudela (1996) obtained reliable negative priming in the attend and remember condition and the ignore condition. However, in the attend only condition the researchers obtained positive priming in the condition measuring positive priming and non-significant positive priming in the condition measuring negative priming. Ortells and Tudela concluded that instructions to ignore primes are associated with negative priming. The results obtained in Ortells and Tudela's second experiment provide an explanation for the failure to obtain negative priming in Experiments 1 and 2. Ortells and Tudela's results have been replicated in a number of experiments which have instructed subjects to ignore the distractor stimuli and have found negative priming (e.g. Enright & Beech, 1993; Fuentes & Tudela, 1992; Houghton et. al., 1996; Neumann & DeSchepper, 1991; Williams, 1995; Yee, 1991). However, it appears that there are studies that have reported negative priming under conditions where subjects were not given instructions to ignore the distractor, for example, Fox (1994b, pg 567) in her method section writes "subjects were encouraged to respond to the letter with the bar marker beside it (the target) as quickly as possible ..." and no mention was made regarding distractor stimuli. In some of the literature it is not possible to ascertain whether subjects were given specific instructions to ignore the distractor (e.g. Moore, 1994; Rutheruff & Miller, 1995; Tipper et. al., 1990). Given these uncertainties, it appears that the instructions given to subjects may be an important factor which influences whether negative priming occurs.

4.3.5 Repetition priming

Another factor which may have led to the absence of a negative priming effect in Experiments 1 and 2 is the influence of word repetition effects. It is possible that the re-presentation of the ignored word displayed on the prime phase as the word to be named on the probe phase could result in a facilitatatory associative repetition priming effect. If this were the case, it would result in negative priming being shown as a reduced repetition benefit for the probe, rather than a penalty in naming time for the probe. However, a number of studies have reported negative priming effects using word pairs as stimuli (Chappe & MacLeod, 1995; Enright & Beech, 1993; Fuentes & Tudela, 1992; Lorch, Balota & Stamm, 1986; Ortells & Tudela, 1996; Tipper & Driver, 1998). For example, Chiappe and MacLeod (1995) found that negative priming occured for identical words (same word displayed as prime distractor and probe target), but not for stimuli which were semantically related. From these findings it appears that re-presenting the same stimuli on prime and probe phases is a necessary condition for negative priming to occur. Therefore, the absence of negative priming in Experiments 1 and 2 is more likely to be due to the previously discussed factors rather than repetition priming.

4.4 Guidelines for future research

As a result of comparing the designs of Experiments 1 and 2 with the current literature, a number of factors have been identified which need to be considered in the planning of future research. One factor is the manipulation of state anxiety levels in non-clinical subject populations. It may have been the case that the results of Experiment 1 were influenced by the manipulation of state anxiety being of smaller magnitude than research which has obtained results compatible with the disproportionate activation hypothesis (e.g. MacLeod & Locke, 1994). Therefore, it is important that the state anxiety manipulation be as powerful as in research which has reported support for the disproportionate activation hypothesis.

Another factor which requires further investigation is whether instructing subjects to preferentially attend to one of the stimuli on the prime phase leads to a pattern of results which do not support the disproportionate activation hypothesis. In MacLeod and Locke's (1994) study which found support for the disproportionate activation hypothesis subjects were not instructed to selectively attend to one of the stimuli on the prime phase.

Although a number of the factors influencing negative priming were manipulated in Experiment 2, several additional factors have been identified which require further investigation. One factor is the duration of the prime phase. The vast majority of studies investigating negative priming have used a short time interval for the presentation of the prime phase (35 -150 ms) compared to the 500 ms interval used in Experiments 1 and 2. It may be the case that the occurrence of negative priming is influenced by the duration of the prime phase, although the theoretical mechanisms for why this may be the case have not been investigated. Therefore, this factor requires further investigation.

The time interval between the termination of the prime phase and the presentation of the probe phase also appears to be a factor which influences the occurrence of negative priming. Houghton et. al. (1996) have proposed a theoretical explanation which aims to account for why negative priming takes time to develop. However, Houghton's et. al.'s account leaves some important questions unanswered. Two central issues are how long does it take for the inhibitory rebound to be at a level where maximum negative priming is obtained, and after what time interval does the inhibitory rebound return to resting level so that negative priming will no longer occur?

Another factor which may influence negative priming is whether or not the subject is required to make a response on the prime phase. It may be the case that requiring the subject to make a response leads to stronger encoding of the target stimulus and increased suppression of the distractor stimulus. This factor also requires further investigation.

It is possible that the prime and probe phase tasks may influence negative priming. Moore (1994) has argued that tasks which require the subject to perform a high level of processing such as categorisation on the prime phase followed by lexical decision on the probe phase may engage the inhibitory mechanisms by default. Therefore, the difficulty of tasks assigned to subjects in negative priming experiments requires further investigation.

Another factor which may influence negative priming is the ease of selection of the stimuli on the prime phase. Rutheruff and Miller (1995) found that negative priming failed to occur when it was very easy to select the prime target from the prime distractor, that is, when the prime stimuli appeared in locations which were very easy for the subject to predict. As a result of Rutheruff and Miller's findings, the predictability of stimulus display locations needs to be taken into consideration when designing research to investigate negative priming. Finally, the instructions presented to subjects has been shown to influence negative priming. Ortells and Tudela (1996) found that negative priming fails to occur unless subjects are explicitly instructed to ignore the distractor on the prime phase.

4.5 Conclusion

Despite the generally nonsignificant outcomes of the two experiments reported, it appears that disproportionate activation of threatening information in high trait anxious normal samples is likely to depend upon substantial elevation of state anxiety. It may also depend upon the subject not being instructed to selectively attend to one of the stimuli on the prime phase. With respect to negative priming, the two experiments and a review of the literature suggests that a number of task conditions may be important in maximizing negative priming. These include the duration of the prime phase, the time interval between the termination of the prime phase and the presentation of the probe phase, whether subjects are required to make a response on the prime phase, the difficulty of the prime and probe phase tasks, ease of selection of the stimuli on the prime phase, and the instructions presented to subjects. Therefore, a test of the inability to inhibit hypothesis in respect of the effect of anxiety on information processing must await more basic research directed at establishing the critical determinants of negative priming.

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APPENDIX A

Table A-1. Non-exam Threat and Non-exam Nonthreat stimulus word pairs used in Experiment 1.

Pair Number	**Non-exam Threat**	**Non-exam Nonthreat**
1	CRIME	OCEAN
2	DEATH	DAILY
3	LONELY	KITTEN
4	COFFIN	CARTON
5	CRUSHED	VEHICLE
6	IMPALED	COOKING
7	STABBED	SAILING
8	SUICIDE	FLOWERS
9	DISEASE	BICYCLE
10	HAUNTED	FISHING
11	INJURIES	EXCHANGE
12	DISABLED	OUTDOORS
13	CORONARY	PURCHASE
14	FLATTENED	NEIGHBOUR
15	HOSPITALISED	TECHNOLOGIES
16	INCAPACITATED	ACCOMMODATION

Table A-2. Exam Threat and Exam Nonthreat Stimuli used in Experiment 1

Pair Number	Exam Threat	Exam Nonthreat
1	SLACK	QUIET
2	DUNCE	ESSAY
3	DISMAL	SIMPLE
4	FAILURE	READING
5	NERVOUS	RESULTS
6	PANICKY	SILENCE
7	MISREAD	CAREFUL
8	ANXIOUS	WRITING
9	STRESSED	STUDIOUS
10	HOPELESS	APTITUDE
11	INABILITY	READINESS
12	DIFFICULT	ANSWERING
13	UNPREPARED	CALCULATOR
14	EXAMINATION	REMEMBERING
15	UNPRACTISED	SUPERVISORS
16	UNSATISFACTORY	IDENTIFICATION

APPENDIX B

Table B-1. Mean naming latencies plotted in Figure 1, Panel A with standard errors in parentheses.

Prime Status	Naming	
	Threat	Neutral
Repeated	580.04 (9.85)	601.02 (10.95)
Not Repeated	612.30 (9.78)	607.70 (10.83)

Table B-2. Mean naming latencies plotted in Figure 1, Panel B with standard errors in parentheses.

Prime Status	Naming	
	Threat	Neutral
Repeated	611.52 (11.01)	586.13 (10.15)
Not Repeated	617.89 (10.91)	613.63 (10.61)

Table B-3. Mean naming latencies plotted in Figure 2, Panel A with standard errors in parentheses.

Prime Status	Exam	
	Distal	Proximal
Repeated	592.50 (9.86)	588.55 (11.03)
Not Repeated	603.79 (9.92)	616.21 (10.68)

Table B-4. Mean naming latencies plotted in Figure 2, Panel B with standard errors in parentheses.

Prime Status	Exam	
	Distal	Proximal
Repeated	594.92 (10.94)	602.73 (10.34)
Not Repeated	614.10 (10.69)	617.42 (10.64)

APPENDIX C

Table C-1. Stimuli used in Experiment 2.

Set #	Stimulus Words				
1	cart	axle	pear	keel	fuse
2	hook	crib	bale	mink	pact
3	isle	nail	maze	ramp	sofa
4	robe	cord	reed	bean	disc
5	bulb	fare	knot	oven	exit
6	lamb	stew	roast	oval	glue
7	acre	chef	gene	dusk	prop
8	herb	mint	peer	duck	cave
9	coil	chap	thaw	comb	cage
10	moss	hose	gram	oxen	vent
11	coin	bolt	pony	tune	slug
12	zinc	mask	wool	rack	poll
13	rust	echo	veil	gala	wolf
14	haze	twin	duck	heel	doll
15	brow	suds	halt	veto	junk
16	cafe	nest	rice	iron	salt
17	wave	wood	shop	rain	film
18	ball	farm	book	town	door
19	home	year	hour	hall	data
20	room	city	edge	camp	king
21	park	walk	unit	boat	song
22	roof	snow	moon	tree	wine
23	file	bank	sign	pool	food
24	land	line	text	tape	fish
25	bear	lake	seat	gold	milk
26	meat	gate	tent	pond	coal

27	beer	golf	corn	stem	card
28	mail	ring	coat	ship	road
29	rock	suit	yard	pipe	barn
30	bird	hill	wall	wife	area
31	hound	hitch	niece	scout	bacon
32	dingy	easel	badge	relic	frost
33	spine	glare	spear	plank	thigh
34	epoch	manor	satin	basin	cable
35	apron	swamp	argon	canoe	cargo
36	otter	batch	coral	gully	spoon
37	album	filly	sonar	proxy	maple
38	baton	skiff	choir	polar	apple
39	trunk	stool	medal	abbey	mulch
40	buggy	olive	arena	barge	crane
41	hatch	flask	meter	altar	tenor
42	pearl	resin	spade	forum	tease
43	steer	wheat	salad	stamp	flour
44	eagle	thumb	ledge	villa	guild
45	algae	linen	ankle	berry	topic
46	glove	paste	slate	token	rally
47	elbow	tiger	vowel	alley	booth
48	ocean	fruit	shirt	cloud	bench
49	sugar	motel	paint	chair	pilot
50	bread	wagon	music	water	house
51	floor	horse	radio	plant	paper
52	party	glass	store	wheel	drink
53	beach	steel	phone	motor	novel
54	coast	knife	train	cloth	piano
55	title	frame	glass	river	child

56	board	field	light	stock	table
57	space	range	stone	uncle	brain
58	index	shore	metal	chain	brush
59	guest	track	sheet	truck	earth
60	story	world	teeth	price	staff
61	baker	shade	honey	radar	chart
62	clock	sauce	grain	panel	drill
63	lunch	clerk	trail	actor	cabin
64	sheep	skirt	movie	fence	shell
65	shovel	hamper	oyster	rocket	aerial
66	iodide	squall	puppet	peanut	volley
67	banner	mutton	gravel	picket	zenith
68	syntax	cherry	enzyme	wallet	sesame
69	barber	violet	sailor	tenant	attire
70	clutch	beacon	strait	circus	sponge
71	ballad	errand	larvae	salami	radish
72	puzzle	button	mosque	buffet	nickel
73	gallon	cortex	shrine	jaguar	agenda
74	torque	barley	lotion	willow	outlet
75	recipe	format	locker	radius	tunnel
76	waiter	quarry	serial	squire	throne
77	jockey	scotch	kitten	tariff	sonata
78	sherry	manual	trifle	thesis	export
79	pillow	shield	cradle	subway	bucket
80	castle	tucker	buckle	racket	deacon
81	grease	nephew	margin	trophy	midday
82	cattle	summer	coffee	valley	window
83	school	market	theory	corner	writer
84	doctor	bridge	island	office	camera

85	stream	pocket	family	degree	energy
86	dinner	winter	bottle	street	pencil
87	studio	carbon	mirror	butter	saddle
88	cotton	branch	campus	prince	oxygen
89	author	agency	barrel	lumber	muscle
90	people	nation	whisky	reader	lawyer
91	temple	phrase	worker	avenue	liquid
92	cousin	player	estate	budget	patent
93	sister	report	church	season	permit
94	animal	memory	league	county	police
95	saline	palace	bureau	heaven	salary
96	screen	travel	parade	career	father
97	friend	nature	square	middle	signal
98	record	income	design	editor	leader
99	balcony	martini	bayonet	solvent	palette
100	obelisk	plywood	cyclist	indices	turbine
101	steeple	geology	capsule	vitamin	feather
102	digital	trolley	garment	masonry	laundry
103	acetate	chimney	dessert	quantum	excerpt
104	terrier	penance	fairway	shutter	terrain
105	athlete	reactor	coconut	peasant	gravity
106	diamond	barrier	terrace	deposit	mansion
107	elastic	royalty	trumpet	cushion	vacancy
108	platoon	crimson	albumin	quartet	perfume
109	diagram	balloon	caravan	kinetic	recital
110	grocery	mercury	segment	costume	gazette
111	boulder	luggage	imagery	concord	harness
112	cathode	dialect	blossom	prophet	hammock
113	bicycle	holster	biology	bivouac	prelude

114	package	account	weather	traffic	citizen
115	pattern	college	picture	produce	village
116	station	student	section	outside	program
117	blanket	factory	chicken	stomach	concert
118	plastic	crystal	plaster	sheriff	mustard
119	journey	textile	partner	vehicle	edition
120	display	journal	library	stadium	tractor
121	circuit	pioneer	leather	ceiling	speaker
122	faculty	chapter	brother	teacher	kitchen
123	address	storage	capital	project	officer
124	example	company	council	captain	shelter
125	article	message	theatre	premier	protein
126	tangent	horizon	climate	passage	uniform
127	amateur	finance	society	service	million
128	century	concept	history	manager	subject
129	mechanic	formulae	comedian	overture	ignition
130	stairway	aviation	beverage	pedestal	blizzard
131	kerosene	polarity	lecturer	membrane	elephant
132	pastoral	cerebral	protozoa	sculptor	tapestry
133	pharmacy	passport	mahogany	alveolar	savannah
134	semester	telegram	delegate	aeration	symmetry
135	trousers	fragment	molecule	paradigm	surveyor
136	scaffold	postcard	township	recorder	geometry
137	princess	sandwich	wardrobe	umbrella	moisture
138	converse	diplomat	banister	metaphor	graphite
139	engineer	politics	aircraft	industry	business
140	universe	daughter	magazine	concrete	mountain
141	customer	calender	equation	football	operator
142	basement	composer	platform	festival	minister

143	republic	symphony	employee	workshop	commerce
144	district	official	property	campaign	interior
145	envelope	monument	quantity	diameter	majority
146	purchase	attorney	hydrogen	schedule	solution
147	civilian	sergeant	estimate	doctorine	entrance
148	language	merchant	particle	fraction	contract
149	electrode	franchise	machinist	meteorite	brigadier
150	syndicate	perennial	amplifier	potassium	commodity
151	hamburger	cartridge	economist	amplitude	viscosity
152	satellite	chocolate	colleague	vegetable	patronage
153	reservoir	symposium	volunteer	cathedral	container
154	publisher	sanctuary	courtyard	capillary	phosphate
155	reflector	sophomore	acropolis	carpenter	fragrance
156	spotlight	directory	enclosure	signature	byzantine
157	constable	curvature	spectator	geography	phonology
158	catalogue	migration	partition	parameter	peninsula
159	equipment	personnel	telephone	yesterday	president
160	narrative	conductor	admission	invention	associate
161	architect	amendment	substance	candidate	territory
162	submarine	democracy	telegraph	assistant	breakfast
163	apartment	afternoon	committee	furniture	newspaper
164	reception	institute	professor	intensity	reference
165	detergent	education	astronomy	residence	apparatus
166	commander	mechanism	landscape	component	editorial
167	statement	insurance	precision	allotment	objective
168	structure	technique	orchestra	procedure	existence
169	insulation	typewriter	journalist	arithmetic	ingredient
170	pedestrian	tablespoon	microscope	instructor	thermostat
171	technician	hippodrome	manuscript	automation	mineralogy

172	metropolis	contractor	navigation	topography	commentary
173	laboratory	occupation	tournament	ambassador	automobile
174	television	government	university	literature	commission
175	dictionary	atmosphere	philosophy	production	population
176	statistics	profession	foundation	lieutenant	recreation
177	accelerator	calibration	terminology	certificate	propagation
178	confederacy	distributor	compression	interpreter	handwriting
179	linguistics	inscription	orthography	subtraction	secretariat
180	transaction	irradiation	photography	merchandise	grandmother
181	workmanship	duplication	congressmen	reservation	homogeneity
182	agriculture	measurement	mathematics	temperature	corporation
183	maintenance	application	information	publication	composition
184	environment	electricity	instruction	probability	arrangement
185	electronics	institution	legislation	appointment	exploration
186	anniversary	scholarship	association	alternative	nationalism
187	multiplicity	prescription	ossification	anthropology	commonwealth
188	entrepreneur	polarization	championship	inauguration	psychologist
189	illumination	nomenclature	acquaintance	handkerchief	philharmonic
190	manufacturer	organisation	headquarters	constitution	illustration
191	civilisation	conversation	refrigerator	introduction	congregation
192	construction	presentation	announcement	registration	availability