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The causal role of selective information processing biases towards threat in anxiety

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by

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Abstract

The causal link between selective information processing biases and vulnerability to anxiety was investigated by examining change in emotional vulnerability as mediated by attentional training. Training was given on a modified dot-probe detection task, where participants were trained either to attend towards threat or towards neutral stimuli. Pre and post training assessment consisted of the anagram stress task (measure of emotional vulnerability), the dot-probe detection task (measure of training effectiveness), and the emotional Stroop task (measure of generalisation of training). The 54 undergraduate student participants, who were in a mid-range of trait anxiety, were randomly allocated to one of 3 orders in which to receive these tasks pre and post training. There was a failure to train selective attention overall, however there was success in training attention in one of the orders, where participants received the anagram stress task before assessment on the dot-probe task. There was no generalisation of training found on the emotional Stroop task. Due to the overall failure to train selective attention, and the finding of no change in emotional vulnerability, conclusions regarding causality and the underlying mechanism of change as measured by the emotional Stroop transfer task could not be made. Future research still needs to investigate whether training can transfer onto the emotional Stroop task.

Declaration

I certify that this thesis does not, to the best of my knowledge and belief:

(i) incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education.

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INTRODUCTION

Overview

This study aimed to investigate the causal nature of information processing biases in anxiety through examining changes in emotional vulnerability due to attentional training. It was also aimed to determine if attentional training on a modified dot-probe task could generalise onto the emotional Stroop task, thus investigating the underlying mechanism of change in emotional vulnerability. This introduction will first review evidence for the existence of selective processing biases in clinically anxious and high trait anxious individuals. Then, research addressing the causality hypothesis will be reviewed. Finally, the design, aims, and predictions of the experiment will be discussed.

It is now well established that anxious individuals display selective information processing biases. Selective processing in anxiety has been investigated in the domains of selective encoding, interpretation and memory. There is considerable evidence for a selective interpretative bias in anxiety, in which threatening interpretations are imposed upon ambiguous information (MacLeod, 1996a). The evidence for a selective memory bias towards recalling emotionally threatening information is less strong, particularly on explicit memory tasks (MacLeod & Rutherford, 1998). However, there is now some evidence that anxious individuals do show a selective bias towards recalling threat-related information on implicit memory tasks (Amir, McNally, Riemann & Clements, 1996; MacLeod & McLaughlin, 1995; Mathews, Mogg, May & Eysenck, 1989; Richards & French, 1991). The

focus of the current research, however, is on the selective encoding biases of anxious individuals. MacLeod (1996a) reviews the interpretative and memory biases in anxiety.

Selective encoding biases in anxiety have been investigated through a variety of experimental techniques. The simplest of these have been emotional target detection tasks where anxious individuals are presented emotionally threatening and emotionally neutral words under conditions that make perception difficult, in which they are required to detect specific emotional target words. Clinically anxious patients have consistently displayed an increased ability to detect the emotionally threatening targets relative to neutral targets compared to non-anxious controls (Mathews & MacLeod, 1994). For example, using the dichotic listening task, agoraphobic, social phobic (Burgess et al., 1981) and obsessive-compulsive (Foa & McNally, 1986) patients have displayed an increased ability in comparison to non-anxious controls to detect the emotionally threatening words. While these results indicate a selective encoding advantage for emotionally threatening information, it is possible that performance on these tasks is influenced by guessing biases. For example, the anxious individuals may have simply been more likely to guess that a threat word had been presented under conditions of uncertainty (MacLeod, 1996a). Consequently, these findings cannot be taken as adequate evidence for a selective processing bias towards threat in anxiety.

More reliable evidence for a selective processing bias towards threatening stimuli in anxiety has been found on interference tasks. The most common task used is the emotional Stroop task, which is a variation on the Stroop colour naming task (Stroop, 1938). The emotional Stroop task involves participants being presented with either emotionally threatening or emotionally neutral words in a range of different colours. Participants must

name the colour of the word as quickly as possible, while ignoring the content of the word. The assumption is that any difficulty participants have in avoiding the processing of word content will be revealed by delayed colour-naming responses. Clinically anxious patients have been found to consistently display disproportionately longer colour naming latencies towards threat words than neutral words when compared to non-anxious controls. This effect has been found in a range of disorders including generalised anxiety disorder (Mathews & MacLeod, 1985; Mogg, Mathews & Weinman, 1989), social phobia (Hope, Rapee, Heimberg & Dombeck, 1990; Mattia, Heimberg & Hope, 1993), spider phobia (Lavy, van den Hout & Arntz, 1993; Thorpe & Salkovskis 1997; van den Hout, Tenney, Huygens & de Jong, 1997; Watts, McKenna, Sharrock & Tresize, 1986), panic disorder (Ehlers, Magraf, Davies & Roth, 1988; McNally et al., 1994), obsessive-compulsive disorder (Lavy, van Oppen & van den Hout, 1994) and post-traumatic stress disorder (Cassiday, McNally & Zeitlin, 1992; Thrasher, Dagleish & Yule, 1994). Although the longer time taken to name the colours of the threat words suggests that clinically anxious patients selectively attend towards, and are unable to ignore the content of threat words, there are problems with this interpretation. For example, the longer time taken to colour name threat words may result from attempting to avoid processing the threat words, if this avoidance was so large as to impair encoding of all stimuli including colour (de Ruiter & Brosschot, 1994; MacLeod, 1990). Consequently, the emotional Stroop task does not provide absolute evidence that anxious individuals are selectively encoding threatening stimuli.

There is, however, strong evidence from the use of attentional probe tasks, which are more direct measures of selective encoding, that anxious individuals do selectively process threatening information. MacLeod, Mathews and Tata (1986) developed the dot-probe

detection task where word pairs, one of which is emotionally threatening, and one of which is emotionally neutral, are presented on a computer monitor, one word above the other. The participants' task is to detect a small dot-probe that occasionally replaces one of the words. The assumption is that participants will be faster to detect probes that appear within the area they are attending to on the screen. Anxious individuals consistently exhibit faster detection latencies for probes occurring in the spatial location of threat words, relative to probes occurring in the location of neutral words. This effect has been found in generalised anxiety disorder (MacLeod et al., 1986; Mogg, Mathews & Eysenck, 1992), social phobia (Asmundson & Stein, 1994) and post-traumatic stress disorder (Bryant & Harvey, 1997). Consequently, although there are problems with experimental paradigms such as emotional target detection and interference tasks, taken overall with results from attentional probe tasks, there is strong and convincing evidence that clinically anxious individuals do possess a selective processing bias towards encoding emotionally threatening information.

The research reviewed has been carried out with clinically anxious patients in comparison to non-anxious controls. Clinically anxious patients typically show both higher state and trait anxiety than controls, with their state and trait anxiety levels often correlating as high as 0.7 (Spielberger, Gorsuch & Lushene, 1970). Consequently, it is difficult to determine whether the selective processing bias towards threat shown by clinically anxious patients is a characteristic of elevated state anxiety, trait anxiety, or both. MacLeod and Mathews (1988) devised an experimental design that is able to dissociate the roles of trait and state anxiety. Non clinically anxious university students were divided into two groups; high and low trait anxious, by a median split on the Trait scale of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983). To manipulate

state anxiety, the students were tested twice; once when state anxiety was low (early in the semester) and once when state anxiety was high (1 week before exams). They used the dot-probe detection task and found that under low state anxiety neither the high nor low trait anxious students showed a selective processing bias towards threat related words. However, under high state anxiety the high trait anxious students showed an attentional bias towards threat by faster detection of probes that replaced threat words, whereas the low trait anxious students showed an attentional avoidance of threat by faster detection of probes that replaced neutral words. MacLeod and Rutherford (1992) also found similar results using the emotional Stroop task, where under high state anxiety, high trait anxious participants showed an attentional bias towards threat, whereas low trait anxious showed an attentional avoidance of threat. Consequently, both clinically anxious patients and high trait anxious normals under stress appear to possess a selective processing bias towards encoding threatening information. However, low trait anxious individuals do not possess such a bias towards threat; in fact under high state anxiety they appear to show an opposite bias, towards avoiding threatening information.

It has been suggested that these individual differences in the patterns of selective processing elicited by state anxiety may provide a causal explanation for individual differences in anxiety vulnerability (MacLeod, 1996a). For example, for individuals who respond to state anxiety elevations with an increased tendency to process threat, state anxiety elevations will escalate into intense anxiety. Those who respond to state anxiety elevations with an increased tendency to avoid threat enjoy the benefits of a homeostatic mechanism that prevents escalations of state anxiety (MacLeod, 1996a). While this explanation for a causal role of selective information processing biases in mediating anxiety vulnerability

appears to be a logical explanation, the research reviewed has only *assumed* such a causal role and demonstrated an association rather than a causal link between processing biases and anxiety vulnerability. The issue of causality is extremely important to resolve. If selective processing biases do indeed cause and/or maintain anxiety, then this suggests a cognitive target for therapy to change anxiety vulnerability. This in turn is important since cognitive therapy for anxiety has not been designed to target these processing biases, but instead focuses rather generally on challenging conscious maladaptive beliefs (Meichenbaum, 1995).

One method of addressing the causal hypothesis is to measure selective attention before exposure to a stressful life event, and then use this measure to predict subsequent reactions to the stressor. MacLeod and Hagan (1992) used the emotional Stroop task to measure the selective attention of women about to undergo investigation of cervical pathology, and then tested the subsequent emotional response of those diagnosed with pathology. They found that the degree of colour naming interference shown towards threat words powerfully predicted the intensity of emotional response to the diagnosis. Similarly, Ng (1991) found that measures of selective attention given to Singaporean students prior to arriving in Australia to study was the only independent predictor capable of predicting the magnitude of state anxiety responses to the transition. However, whilst these studies suggest a causal role of selective processing biases towards threat in mediating anxiety vulnerability, they cannot be taken as evidence of such, as they are only correlational designs which cannot impute causation.

The only design that is capable of testing the causal hypothesis is one that manipulates an individual's pattern of selective attention and then assesses the impact of such a manipulation on emotional response to a subsequent stressful event (MacLeod, 1996a).

Hicks (1993) used such a design with high and low trait anxious university students. Their selective encoding bias towards threat was measured on the emotional Stroop task given before and after a training task designed to modify their selective attention either towards encoding threatening information or towards encoding positive information. Following these measures, participants received a stress induction task using the anagram stress task (Mogg, Mathews, Bird & MacGregor-Morris, 1990). The anagram stress task involves participants trying to solve difficult or impossible-to-complete anagrams while being videotaped and under time pressure, and then given negative feedback. The emotional response to this elevation in stress was then measured. There appeared to be no effectiveness of training in that the training group that reported the greatest anxiety to the stress induction was the one who had been trained to attend to positive words. However, Hicks only provided a small amount of training, and the nature of the training task designed using the emotional Stroop task may not have been an optimal one for manipulating selective encoding biases.

A subsequent study by Ebsworthy (1994) did manage to manipulate patterns of selective attention in participants, which had some influence on later emotional responses to elevations in state anxiety. Ebsworthy used 64 first year psychology students who scored within a mid-range on the Trait section of the STAI (Spielberger et al., 1983) to minimise the pre-existence of any selective processing biases. To manipulate selective attention a modification of the dot-probe detection task was used. Participants were trained either to attend towards threat, or towards neutral words. To train selective attention, for those in the attend threat condition, the dot-probe always appeared in the vicinity of the threat word, whereas for those in the attend neutral condition, the dot-probe always appeared in the vicinity of the neutral word. This is different to the standard dot-probe detection task, where

the dot-probe has an equal probability of appearing in the vicinity of either a threat or neutral word. Following training, the participants' emotional vulnerability was measured by their emotional response to the anagram stress task. Ebsworthy found that the manipulation was only effective in training a selective encoding bias for those trained to attend towards threat, and was not effective for those trained to attend towards neutral stimuli. This is similar to Churcher's (1991) findings with high and low trait anxious students. He also found training on the dot-probe training task to be effective only for those trained to attend towards threat, and not for those trained to attend towards neutral. Ebsworthy found that on the change of emotional vulnerability due to training, although there was no significant difference in subsequent emotional response to the stressor task between the groups either trained towards threat or towards neutral, he did find a trend in those trained towards threat to show greater elevations in dysphoria in response to the stressor.

One reason why Ebsworthy (1994) may have failed to find a significant difference in changes of emotional vulnerability between the two training groups was that he did not obtain baseline measures of selective encoding bias or emotional vulnerability, and thus could not detect any changes in emotional vulnerability resulting from trained changes in selective attention. However, a study by Holker (1997) addressed this problem by utilising a design where baseline measures were taken. In addition, Holker also gave the homophone spelling task before and after training to use as a transfer task. The homophone spelling task involves participants listening to a list of words with ambiguous meanings (e.g., Groan/Grown, Weak/Week), and being required to write the words down in a "spelling test". The spelling of these words gives an indication of whether the participant was interpreting the words as threatening. The 64 first year psychology students were first given a measure of

emotional vulnerability by their response to the anagram stress task, a measure of threat interpretations on the homophone spelling task and a measure of pre-existing selective encoding bias on the dot-probe detection task. Training was then given to either attend towards threat or towards neutral words on the dot-probe training task. Training on the dot-probe task was the same as Ebsworthy used, by always pairing the dot-probe with the valence participants were being trained towards. Following training, the dot-probe detection task, homophone spelling task, and anagram stress task were administered again to detect changes in these due to training. The training was found to be effective in manipulating selective attention, for both those trained to attend towards threat, and those trained to attend towards neutral. That is, those trained to attend towards threat showed a greater bias towards threat words, and those trained to attend towards neutral showed a greater bias towards neutral words on the dot-probe detection task after training. The training was also effective in changing emotional vulnerability for those trained towards neutral, but not for those trained to attend towards threat. This was shown by the group being trained towards neutral showing a significant reduction in anxiety to the second stressor task, while the group trained towards threat showed no significant difference in their anxiety response between the first and second stressor tasks. This is an important finding, as it suggests that training people to attend away from threat can reduce subsequent negative emotional reactions to stressful events, which supports the possible clinical utility of the training task.

Apart from investigating the effect of training on changes in emotional vulnerability, Holker (1997) also investigated the underlying mechanism of these changes. There are two possibilities that Holker proposed may underlie changes in selective attention causing changes in emotional vulnerability. First, the participants may acquire a *general* selective

processing bias from training, which later causes differences in emotional response to stressors. Alternatively, changes may reflect a specific task strategy not involving any general changes in selective processing, for example by learning a task-specific contingency relationship between the location of probes and the valence of words. Holker investigated the underlying mechanism of change by using the homophone spelling task as a transfer task, to determine if trained changes in selective attention could also be detected on this task. In other words, was there any "transfer" and generalisation of training to another task? Holker proposed that if changes in threatening interpretations on the homophone spelling task after training were in the direction of training given, where the attend threat group showed an increase in threatening interpretations and the attend neutral group showed a decrease in threatening interpretations, then the underlying mechanism of change will be a change in general processing bias. However, if there were no changes in threatening interpretations, this would indicate the underlying mechanism is specific to training. Holker found that the trained change in selective attention on the dot-probe training task did not transfer onto the homophone spelling task, as there was no difference between the amounts of threatening interpretations made on the spelling task before and after training across all participants. Holker argued that this finding indicated that the underlying mechanism of change in emotional vulnerability was a task specific process, rather than a change in general selective processing bias.

However, Holker (1997) also argued that an alternative explanation of the results does not rule out the possibility that a general processing bias mechanism was underlying the change in emotional vulnerability. The alternative is that a selective processing bias was trained, but it was specific to the domain of attention, so that training did not generalise onto

the homophone spelling task, which measures interpretative bias. This alternative explanation is supported by Holker's finding that the mechanisms underlying attention and interpretation were independent of one another, since interpretation predicted additional variance in emotional vulnerability over and above attention, and that attention and interpretation had very little correlation with each other. Consequently, since attention and interpretation appeared to be independent of one another, Holker argued that they are therefore not conducive to transferring from one type of task to another. Due to this problem, Holker suggested that to further investigate whether mechanisms underlying change in emotional vulnerability are due to general processing changes or task specific learning, a more specific transfer task that measures selective attention, such as the emotional Stroop task, should be used. While both the dot-probe detection task and the emotional Stroop task measure attention, they are sufficiently different in methodology to determine if training on one task could transfer to the other task, thus allowing an investigation of the underlying mechanism of change.

Holker (1997) is correct in stating that a reason for the failure to find a transfer effect may be that the tasks were not conducive to transfer due to measuring the different mechanisms of attention and interpretation. However, she ignores a second explanation, which is that this failure may also have been due to the design of the experiment. After training, the participants received the dot-probe assessment task, and then the transfer task of homophone spelling. A problem with this is that if the trained change in selective attention only lasts temporarily, then Holker's design would not be good at detecting a transfer of training. It is not yet known how long these trained changes in selective attention last. It seems reasonable to assume, however, that to have the maximum chance of discovering a

transfer effect, the transfer task should immediately follow training. While using such a design would ensure the maximum chance of detecting transfer, if trained change in selective attention is indeed relatively temporary, then the time lag of having the dot-probe assessment task come after the transfer task may mean that such a design would have a poorer likelihood of detecting an attentional training effect on the dot-probe task. One way to get around this problem would be to use a design where pre and post training assessment tasks are given in different orders across participants. The current study used such a design to extend Holker's work by using a more adequate transfer task, and a design including different order of assessment tasks so that the effects of time delay post-training on detecting attentional training and transfer effects could be examined.

The experiment consisted of a pre-training assessment phase, training on the dot-probe training task, and a post-training assessment phase. Participants were randomly assigned to one of three test orders in which they received the pre and post training assessment tasks. In order 1 participants received; (i) emotional Stroop task, (ii) dot-probe assessment task, and (iii) anagram stress task. In order 2 participants received (i) dot-probe assessment task, (ii) anagram stress task, and (iii) emotional Stroop task. In order 3, participants received (i) anagram stress task, (ii) emotional Stroop task, and (iii) dot-probe assessment task.

This study had four main purposes. The first aim was to determine if Holker's (1997) findings of the effectiveness of training in inducing a selective attention bias for participants trained to attend both towards threat and towards neutral could be replicated. This is because previous studies either failed to find training to be effective at all, or only effective for participants trained towards threat (Churcher, 1991; Ebsworthy, 1994). Second, this study aimed to determine whether attentional training could change emotional vulnerability in

participants trained towards threat, as well as those trained towards neutral, as Holker only found training to change emotional vulnerability in those trained towards neutral. Thus, one aim was to investigate the causality of selective processing biases in emotional vulnerability. Third, the underlying mechanism of change in emotional vulnerability due to training was examined by using a more adequate transfer task of the emotional Stroop task. Finally, the effects of task order, and the effects of time lag after training on detecting attentional training effects and a transfer effect were examined by assigning participants to three different orders in which to receive assessment tasks.

There were several predictions that were tested in this study. The first was that training would be effective for both those trained to attend towards threat and for those trained to attend towards neutral. This would be shown by a selective processing bias towards the valence participants were trained towards on a measure of selective attention given after training. Second, it was predicted that training both towards threat and towards neutral would be effective in changing emotional vulnerability. This would be evident by those trained towards threat responding with an increase in stress response, and those trained towards neutral responding with a decrease in stress response to a stressor given after training. Such a finding would suggest that selective processing biases play a causal role in emotional vulnerability. Third, it was predicted that a trained change in selective attention would also be detected and thus "transfer" to the emotional Stroop task. This result would indicate that the underlying mechanism of change in emotional vulnerability is due to a general change in selective processing bias rather than to a task-specific change. No prediction was possible as to the effect that order of assessment tasks would have, as this was an exploratory component. If a training effect and a transfer effect could be detected across

all participants regardless of order, then this would indicate that the training has a durable effect that is not affected by time lag, or alternatively that the effect of training cannot be wiped out by having the post-training dot-probe assessment task with no contingency.

METHOD

Overview

In this section, first participant characteristics and allocation across conditions will be outlined, followed by materials used including emotional assessment materials and word stimulus materials, and descriptions of each of the experimental tasks. Then, the experimental procedure will be outlined. For a comprehensive summary of the experiment, refer to Appendix A.

Participants

Fifty-four first year psychology students from the University of Western Australia were recruited. All had scored within the middle two-thirds on the Trait section of the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1983), during a mass testing of 654 first year psychology students carried out 18 weeks prior to the current study. Participants were recruited from within a mid-range of Trait anxiety to minimise the existence of any pre-existing selective processing biases. There were 42 females and 12 males who were randomly allocated across training groups and orders. Each training group (Attend Threat, Attend Neutral) consisted of 27 participants, with 9 participants in each of the three test orders. There were 7 females and 2 males within each of these cells of 9 participants. Mean age of participants was 18.8 years, mean state anxiety was 33.09, mean trait anxiety was 38.64, and mean BDI score was 5.66. All participants received course credit for doing the experiment. Conduct of the experiment was approved by the UWA ethics review committee.

Materials

Emotional Assessment Materials

State-Trait Anxiety Inventory

The STAI was used to measure State and Trait anxiety. The STAI has two components; a 20-item Trait scale that measures the relatively stable personality characteristic of vulnerability to anxiety (i.e., anxiety proneness) and a 20-item State scale that measures a transitory condition of perceived tension. On each of the scales the maximum score is 80 and the minimum score is 20. Higher scores represent higher anxiety. Cronbach alpha co-efficients range from .83 to .92 for State scores and .86 to .92 for Trait scores (Spielberger et al., 1983).

Beck Depression Inventory

The Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock & Erbaugh, 1961) was used to measure participants' level of depression. The BDI is a 21-item measure of severity of depression. Scores range from 0 to 63, with higher scores indicating higher depression. Alpha co-efficients for the BDI range from .73 to .95 (Beck, Steer & Garbin, 1988).

Visual analogue mood scales

Two types of analogue mood scales were used to assess participants' state anxiety and depression. Each scale was a 15cm line, divided into 30 segments of equal length. The

analogue scale measuring anxiety was labelled *anxious* at one end and *relaxed* at the other end. The analogue scale measuring depression was labelled *depressed* at one end and *happy* at the other end. The participants were asked to choose one of the 30 positions on the scale as to the way they were feeling "right at the moment". The scores ranged from 0 at the *relaxed* or *happy* end, to 30 at the *anxious* and *depressed* end. A higher score therefore indicates higher state anxiety and depression.

Visual analogue scales have been found to be valid and reliable measures of state anxiety and depression. Anxiety mood ratings using visual analogue scales have been found to be highly correlated with the State scale of the STAI (Bond, Shine & Malcolm, 1995). Computer administrated visual analogue mood scales have also been found to be highly correlated with the State scale of the STAI and the CES-D depression scale (Radloff, 1977), so providing an effective measure of state anxiety and depression (Maruff et al., 1994).

Word Stimulus Materials

Dot-probe tasks and emotional Stroop task stimuli

Practice sets

The dot-probe practice set consisted of 12 pairs of emotionally neutral words with a mean frequency of occurrence of 45.75, according to Kucera and Francis (1967), and mean length of 4.83 letters. The emotional Stroop practice set consisted of 12 emotionally neutral words with a mean frequency of 64 and a mean length of 5 letters. None of the practice words appeared in the experimental set. Refer to Appendix C for the practice set stimuli.

Experimental set

A total stimulus set of 432 word pairs was created from a pool of 490 word pairs taken from past research (Churcher, 1991; Ebsworthy, 1994; Rutherford, 1994) and newly created word pairs. Word pairs consisted of one emotionally neutral and one emotionally negative (threatening) word. All word pairs were matched for length and frequency using norms from Kucera and Francis (1967). Frequency ranged from 1 time per million words to 277 times per million words. The pool of 490 word pairs was rated by five Master of Psychology students for level of emotionality on a nine point scale ranging from 1 = negative, 5 = neutral, and 9 = positive. To be included in the final set of 432 word pairs, emotionally negative (threatening) words required a mean rating between 1.4 and 3.6, and emotionally neutral words required a mean rating between 4.6 and 6.2. Words falling outside this range were excluded.

The total pool of 432 word pairs was then randomly divided into 3 sets; A, B, and C, with 144 word pairs in each. These sets were further divided into 3 subsets within each set. Consequently, the final stimulus set was made up of set A1, A2, A3, set B1, B2, B3, and set C1, C2, C3 with 48 word pairs in each of these 9 subsets. Each of the sets was matched for mean length, frequency, negativity and neutrality. A series of one-way ANOVAs were conducted on each of these characteristics. There were no differences on frequency between Set A (M = 14.51, SD = 19.32), Set B (M = 14.75, SD = 23.86), and Set C (M = 16.20, SD = 33.04) ($F(2, 429) = .17$, *ns*). There were no differences on length between Set A (M = 7.5, SD = 2.04), Set B (M = 7.33, SD = 1.91), and Set C (M = 7.59, SD = 2.39) ($F(2, 429) = .56$, *ns*). There were also no differences on negativity ratings between Set A (M = 2.55, SD = .52), Set B (M = 2.58, SD = .54), and Set C (M = 2.56, SD = .57) ($F(2, 429) = .16$, *ns*).

Finally, there were no differences on neutrality ratings between Set A (M = 5.16, SD = .39), Set B (M = 5.08, SD = .35), and Set C (M = 5.07, SD = .35) ($F(2, 429) = 2.69$, *ns*). In addition to this analysis, each of the 9 subsets were also compared on a series of one-way ANOVAs, and this also revealed no significant differences between length, frequency, negativity or neutrality (refer to Appendix D for details). Thus, it can be concluded that the stimulus sets were equal on each of these characteristics. For a copy of the experimental stimuli set refer to Appendix C.

The word sets were allocated across the experiment by assigning participants to one of 9 rotations. There were all new words across each task, however in the training task word pairs were repeated. For details refer to the table of rotation in Appendix E.

Anagram stress task stimuli

Practice set

Four practice anagrams were presented. These ranged from a length of 3-4 characters, and were considered to be very easy to solve (e.g., fcae).

Experimental set

The experimental anagram set consisted of 24 anagrams taken from Holker (1997). Holker derived these anagrams from a pilot study using ten first year psychology students who scored in a mid-range of Trait anxiety on the STAI (Spielberger et al., 1983) from mass testing data. Participants were given an unlimited time in which to solve 40 anagrams. Half of these anagrams were deemed hard to complete. They were chosen from the pilot study if at least 10% but no more than 30% of participants could complete them. The other half were

impossible to complete as one of the letters had been removed before being jumbled. These were chosen from the pilot study if 100% of participants could not complete them. The set of 24 final anagrams were then divided into 2 subsets; A and B. Six of the anagrams in each subset were selected from the hard to complete anagrams, and six were selected from the impossible to complete anagrams. Each subset was equal to the other in the percentage of completions of successive anagrams it included, and therefore each subset was equally hard to complete.

Experimental Hardware

The experimental stimuli were presented using an Acorn Archimedes 510 microcomputer, on a high resolution Archimedes colour monitor. A three-button mouse was connected, which was used in rating mood on the visual analogue scales. A two button response box was also connected, with stickers underneath each button, with one dot on the left button, and two dots on the right button, for use in the dot-probe tasks. Also, above each button was a label "no" on the left button and "yes" on the right button, for use in the anagram stress task. A Lafayette Instrument Voice Activated Relay, connected to the microcomputer detected colour-naming response on the emotional Stroop task. A JVC VF-C511E video camera, with the lens directed at the participant was used during the stress induction phase.

Tasks

The dot-probe training task was used to train a selective attention bias. The effect of this training on participants' selective attention bias was measured by giving the dot-probe

assessment task pre and post attentional training. The emotional Stroop task was also given pre and post training to assess the transfer of training onto this measure. The anagram stress task was also given pre and post training, to assess the effects of training on emotional vulnerability.

Dot-probe training task

This task was designed to manipulate selective attention either towards emotionally threatening words, or towards emotionally neutral words. The dot-probe training task consisted of 576 trials. Participants were randomly allocated to either the Attend Threat or the Attend Neutral group. In the Attend Threat group, the dot-probe always followed in the vicinity of the threat word. In the Attend Neutral group, the dot-probe always followed in the vicinity of the neutral word. Each trial consisted of the word pair being displayed for 500ms. Following this a single or double dot-probe appeared in either the vicinity of the threat word or the neutral word depending on the training condition. The probe remained on screen until a response was detected. There was no fixation point, and no inter-stimulus interval. The location of the threat word at either the bottom or the top of the screen and whether the dot-probe consisted of one or two dots was randomised. Words were presented in 5mm high white letters 3cm above or below the centre of the screen. The dot-probes consisted of red pixels, with one pixel for the single dot-probe, and two adjacent pixels for the two dot-probe. Participants responded as to whether they saw a single or a double dot-probe by pressing the appropriate key of a two button response box. The software recorded attentional probe latency, which was the reaction time taken to respond to whether a single or double-dot probe appeared.

Dot-probe assessment task

The dot-probe assessment task given pre and post attentional training consisted of 96 trials. The procedure for these trials was exactly the same as for the dot-probe training task, except that the probability of probe presentation was that the probe was equally likely to appear in the vicinity of either a threat or neutral word. Different word stimuli were used in the pre and post dot-probe assessment tasks, so that no words were repeated (refer to appendix E).

Emotional Stroop task

The emotional Stroop task given pre and post attentional training consisted of 96 trials. Each trial consisted of a word being presented on the screen until the participants' vocal response was detected. Words were presented in the middle of the screen in 1cm high letters in either red, green, yellow or blue. The software recorded colour naming latency, which is the reaction time taken to name the colour of the word. Different word stimuli were used in the pre and post emotional Stroop tasks, so that no words were repeated (refer to appendix E).

Anagram stress task

This task was based on one described by Mogg et al. (1990) who first designed the task to increase levels of state anxiety in participants. Participants were told that the anagram task is a part of the psychology department's ongoing research program into the relationship between academic performance and cognitive tasks, and that an association has been established between intelligence and the ability to solve anagrams. They were then told that

they had three minutes in which to solve as many anagrams as possible. Participants were then informed that the task was going to be videotaped, and that they would be rated according to their performance on the task. They were told that if their score fell in either the upper or lower ten percent, they would be asked whether they were willing for their videotape to be used in the research examining the link between intelligence and the ability to solve anagrams. At the end of each anagram task, participants received a message on the computer screen stating the number of anagrams solved. The message also informed participants that their result was in the bottom 10%, and that the outcome was to use the videotape in the intelligence and anagram solving ability research. Then, a visual analogue scale was given, to measure the participant's response to the stressor, and following this participants were presented with another screen stating that these were practice trials, and that they would get another chance later to perform the task. This was done so that there would not be carry over state anxiety and depression effects across the rest of the experiment, where participants were thinking about how badly they had done on the anagram task. This was also done so that the second anagram stress task after training would still be stressful as they were expecting this to be "the real thing".

The anagram stimuli were presented one at a time in random order in the centre of the screen in 1cm high white letters, within a three-minute period. Participants were told to press the response box button labelled "yes" when they had solved the anagram, and to write their answer down on an "anagram answer sheet". The next anagram appeared on screen once the "yes" button had been pressed. The participants were also given the chance to move on from an anagram if they thought it was too hard by pressing the response box button labelled "no", so that the next anagram appeared. All participants were informed they had performed in the

bottom 10%. Because most participants either solved none or 1-2 anagrams, this result appeared plausible as they most often pressed "no". However, a potential problem with the task is that the participant could press "yes" the whole time and still receive a rating of bottom 10%. Nevertheless, when subjects were being debriefed they reported believing the anagram stress task to be a real task, therefore this was unlikely to have been a major problem.

Procedure

Participants were greeted, then they read and signed a subject information and agreement form (see Appendix G), and filled out the BDI (Beck et al., 1961) and STAI (Spielberger et al., 1983). Participants were then taken into the testing room and told they were going to start with some practice. First, an example of the visual analogue scales was presented. Responding by use of the mouse keys was explained, and the experimenter completed a practice example of the scales while the participant watched. Participants were then informed that they were going to receive practice with the tasks they would complete in the experiment. They were told that they were going to receive three tasks, in blocks, that would be given in various orders throughout the experiment. The first practice task presented was the emotional Stroop task. Participants were shown the colours of the words that they would see. Then they were told that their task was to name the colour of the word that appeared on the screen as quickly as possible, while ignoring the content of the word. Following the 12 practice emotional Stroop trials, participants were told that another task they would receive was a dot-probe task. They were told that they would see two words, which would disappear, and following these a probe would appear where one of the words was, and their

task was to respond to whether it was one or two dots that appeared by pressing the appropriate key on the response box. They were also told that this was a reaction time task so they needed to respond as quickly and as accurately as possible. Participants were then given the 12 dot-probe practice trials. After this, participants were told that another task they would do is an anagram task. It was checked that the participant knew what anagrams were, and that their task was to unscramble words. They were then given instructions regarding the task as a measure of intelligence, told that it would be videotaped, how to complete the task, and that if they fell in the upper or lower 10% their tape may be used in the intelligence research. The video camera was turned on and focused at the participant while they were sitting in front of the computer, and a light appeared on the video camera to add credibility to the deception. They were then given four practice anagrams to solve. Following this, participants were asked to complete a practice visual analogue scale themselves, and were given a chance to ask questions. Then the experimenter left the room and the experiment begun.

The experiment was designed so that participants were unlikely to be aware of the pre-training assessment, training, and post-training assessment phases. The experiment was constructed so that participants thought they were receiving tasks in blocks, and in random order. To make this more plausible, each task followed the same format, where first participants would receive a visual analogue scale to measure mood before going into the task, then a screen saying "press return to continue, dot-probe trials to follow" (or whichever trials were following, e.g., colour naming, anagrams). Following this the participant received the particular trials, then at the end of the trials received another visual analogue scale, and then a message "pause for a break, press return to continue". The reason for including visual

analogue scales before and after each task and consistent instructions was so that each block of trials appeared the same throughout the experiment. The experiment actually consisted of pre-training assessment, training, and post-training assessment, with participants receiving assessment tasks in different orders depending on which order they had been assigned to (refer to Appendix B for a table outlining the orders).

Following the experiment participants were debriefed. They were told that they were not going to receive another anagram task, that the anagram task was bogus and not a real measure of intelligence, that everyone was told they had scored in the bottom 10% and the video camera was not recording. Participants' questions were answered, and they were asked whether they were suspicious about the deception with the anagram stress task. For a detailed script of instructions read to the participants, refer to Appendix F. For a detailed summary of the experiment refer to Appendix A.

RESULTS

Overview

The results will be examined in 2 sections in which the cognitive effects of attentional training will be considered first, followed by the effects of attentional training on emotional vulnerability. However, preceding an examination of experimental manipulations, participant characteristics across the different groups will be examined. An alpha level of .05 was used for all statistical tests.

Participant Characteristics

The characteristics of participants in each of the training groups are shown in Table 1.

Table 1

Participant Characteristics

	TRAINING GROUP	
	Attend Threat	Attend Neutral
Characteristics	Mean S.D. Range	Mean S.D. Range
State anxiety	33.44 (7.13) 23-48	32.74 (7.24) 20-48
Trait anxiety	38.77 (5.38) 30-48	38.51 (7.02) 26-52
BDI (depression)	5.44 (4.42) 0-18	5.92 (3.97) 0-15
Age	18.62 (2.63) 17-28	19.14 (3.17) 17-31

To determine if there were any significant differences between the training groups on these characteristics, a series of one-way ANOVAs were conducted. There were no differences between the training groups on age ($F(1, 52) = .42$, *ns*), depression ($F(1,52) = .17$, *ns*), state anxiety ($F(1,52) = .12$, *ns*), or trait anxiety ($F(1,52) = .02$, *ns*). In addition, there was no difference in participants assigned to orders 1, 2 or 3 in each of the training groups on age ($F(5,48) = .35$, *ns*), depression ($F(5,48) = .29$, *ns*), state anxiety ($F(5,48) = .62$, *ns*), or trait anxiety ($F(5,48) = 1.21$, *ns*). Thus, it can be concluded that there were no differences among the training groups and orders that participants were assigned to, on age, depression, state anxiety or trait anxiety.

A check for outlying participants was also made on the characteristics of depression, state and trait anxiety by examining z scores, histograms and boxplots. No outliers were detected.

Cognitive Effects of Attentional Training

In this section, the effects of the attentional training procedure are examined. First, the effectiveness of the dot-probe training task is considered by examining whether the task was able to induce a bias in selective attention in the direction of training given. Following this, the effects of attentional training on the emotional Stroop transfer task is examined to determine if training on the dot-probe task influenced performance on the emotional Stroop task.

Effect of Attentional Training on the Dot-Probe Task

To examine the effectiveness of training, the dot-probe assessment tasks given pre and post training were analysed. For each participant, a median detection latency was extracted, which was used rather than mean detection latencies, as this minimises the influence of outlying data points. To simplify the interpretation of the relationship between Threat Position x Probe Position, an index was calculated for each of the dot-probe tasks called "Speeding to Probes in the Vicinity of Threat" (SPVT) following MacLeod and Mathews (1988). The SPVT index provides a measure of attentional speeding of response to threat words. The formula used to calculate this index is:

SPVT = [(Threat top probe bottom – Threat top probe top) + (Threat bottom probe top – Threat bottom probe bottom)] / 2.

This equation calculates the mean speeding of detection latencies to probes in the same area as the threat word by subtracting them from probe detection times when the threat word is in a different location to the probe. A score of zero on this index indicates that threat stimuli had no influence on detection latencies for probes in either area. A positive score on the index indicates speeding to detect probes where threat words appeared, that is, an attentional bias towards threat stimuli. A negative score on the index indicates speeding to detect probes where neutral words appeared, that is, an attentional avoidance of threat stimuli, or attentional bias towards neutral stimuli. The SPVT index was calculated using this formula for the pre-training and post-training dot-probe assessment tasks.

To examine the effectiveness of training, a 2 x 2 x 3 mixed design ANOVA was conducted with SPVT serving as the dependent variable. Two between groups factors of training group (Attend Threat, Attend Neutral) and test order (1,2,3), and one within groups factor of time (pre vs. post training) served as independent variables in the analysis. Assumptions of normality and homogeneity of variance were met. There was no significant interaction of training group x time ($F(1, 48) = .02$, *ns*), as can be seen in Figure 1.

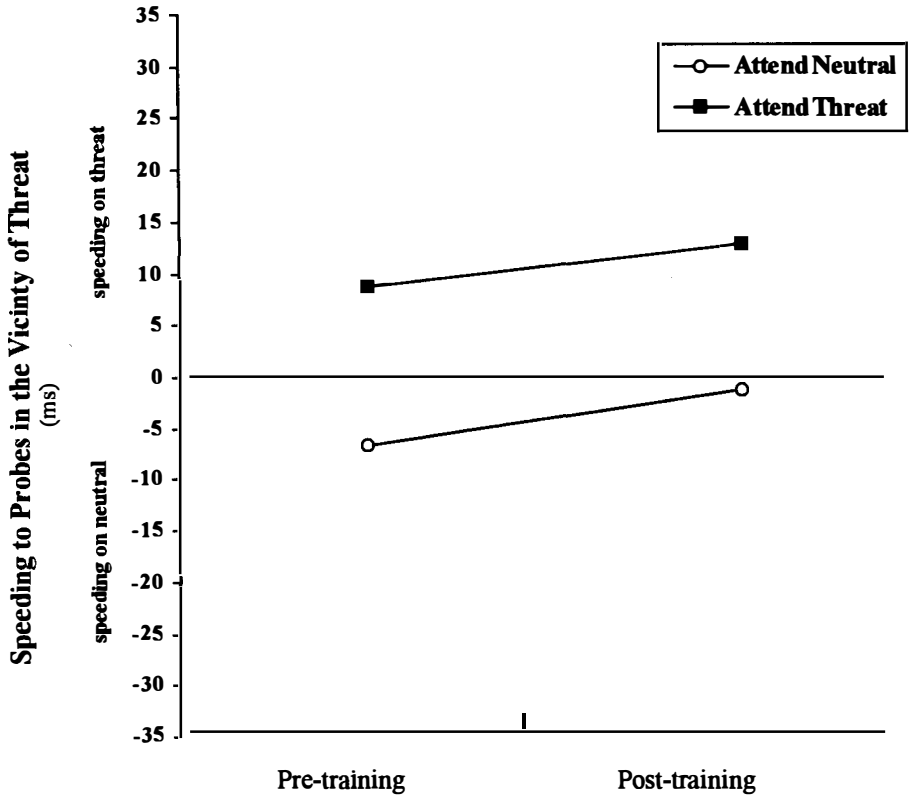

Figure 1. Training group x time interaction on the dot-probe task.

This result suggests that training was not effective in inducing a bias in selective attention across all orders in both training groups. There were, however, significant main

effects of training group ($F(1,48) = 9.05$, $p = .004$) and order ($F(2,48) = 4.87$, $p = .01$). There was also a significant interaction of training group x time x order ($F(2,48) = 3.91$, $p = .03$). Post-hoc analyses consider the main effects of training group and order first, followed by the training group x time x order interaction.

Training group effects

There was a main effect of training group found at the pre-training phase. This was examined to determine if there were any pre-training attentional biases by investigating training group collapsed across order at the pre-training phase. A one-way ANOVA revealed an effect approaching significance ($F(1,52) = 3.58$, $p = .06$), where the attend threat group showed a disproportionate speeding towards probes in the vicinity of threat words ($M = 8.79$, $SD = 24.42$), whereas the attend neutral group showed a disproportionate speeding towards probes in the vicinity of neutral words ($M = -6.66$, $SD = 34.69$). Thus, the main effect of training group is indicating an almost significant pre-existing bias in selective attention in each group. The attend threat group is showing a bias towards threat, and the attend neutral group is showing a bias towards neutral prior to going into the training procedure, as can be seen in Figure 1.

Given the failure to find the expected training group x time interaction, an exploratory analysis was conducted on training group at post-training, to determine if the training groups were differing pre and post training. A one-way ANOVA revealed a significant difference between the training groups ($F(1,52) = 4.46$, $p = .03$). Those in the attend threat group showed a disproportionate speeding towards threat words ($M = 12.87$, $SD = 23.96$), whereas those in the attend neutral group showed a slight speeding towards

neutral words (M = -1.29, SD = 25.26). This indicates that after training, the attend threat group was showing a bias towards threat, and the attend neutral group was showing a bias towards neutral, as was seen in Figure 1. Given the almost significant difference before training, and the significant difference after training, it must be concluded that the training groups differed pre and post training, but in the same way. The attend threat group showed a bias towards threat both pre and post training, and the attend neutral group showed a bias towards neutral, both pre and post training, as seen in Figure 1.

Order effects

There was also a main effect of order found at the pre-training phase. To follow up the main effect of order, order collapsed across training groups was examined at the pre-training phase. On the pre-training dot-probe assessment task, regardless of which training group participants were in, those who received order 3 showed a significantly larger bias towards threat (M = 14.16, SD = 19.92), than those who received order 1 (M = -10.83, SD = 32.98), who showed a bias towards neutral ($F(2,51) = 3.25$, $p = .04$). There were no significant differences in those who received order 2 compared to orders 1 or 3, with order 2 showing neither a pronounced bias towards threat or towards neutral (M = -.13, SD = 33.54). Thus, the main effect of order is due to those in order 3 showing a significantly larger bias towards threat than those in order 1, who showed a bias towards neutral.

Exploratory analyses were also conducted on order at the post-training phase, to determine if the orders differed pre and post training. On the post-training dot-probe task, collapsed across training groups, there were no significant differences between

those who received order 1 ($M = 2.5$, $SD = 19.90$), order 2 ($M = 1.11$, $SD = 23.45$) or order 3 ($M = 13.75$, $SD = 31.07$) ($F(2,51) = 1.35$, *ns*).

Interaction effects

To examine the significant interaction of training group x time x order, each order (1,2,3) was examined by training group, at each level of time (pre vs. post). For those in order 1, at pre-training there was a significant difference between the training groups. Those in the attend threat group showed a bias towards threat ($M = 5.27$, $SD = 22.37$), whereas those in the attend neutral group showed a bias towards neutral ($M = -26.94$, $SD = 35.03$) ($F(1,16) = 5.40$, $p = .03$). However, at post-training, there was no significant difference between the attend threat group ($M = 2.5$, $SD = 14.25$) and the attend neutral group ($M = 2.5$, $SD = 25.27$) ($F(1,16) = .0$, *ns*).

In comparing those who received order 2, there was no difference between the attend threat group ($M = 4.44$, $SD = 24.42$) and the attend neutral group ($M = -4.72$, $SD = 41.80$) on the pre-training dot-probe task ($F(1,16) = .32$, *ns*). There was also no significant difference on the post-training dot-probe task between those in the attend threat group ($M = 1.94$, $SD = 19.75$) and those in the attend neutral group ($M = .27$, $SD = 27.87$) ($F(1,16) = .02$, *ns*).

For those in order 3, there was no significant difference on the pre-training dot-probe task between the attend threat group ($M = 16.66$, $SD = 27.15$) and the attend neutral group ($M = 11.66$, $SD = 9.60$) ($F(1,16) = .27$, *ns*). However, there was a significant difference on the post-training dot-probe task. Those in the attend threat group showed a bias towards threat ($M = 34.16$, $SD = 22.53$), and those in the attend neutral group

showed a bias towards neutral (M = -6.66, SD = 24.62) ($F(1,16) = 13.46, p = .002$). The nature of this difference between the groups with order 3 in pre-training and post-training can be seen in Figure 2.

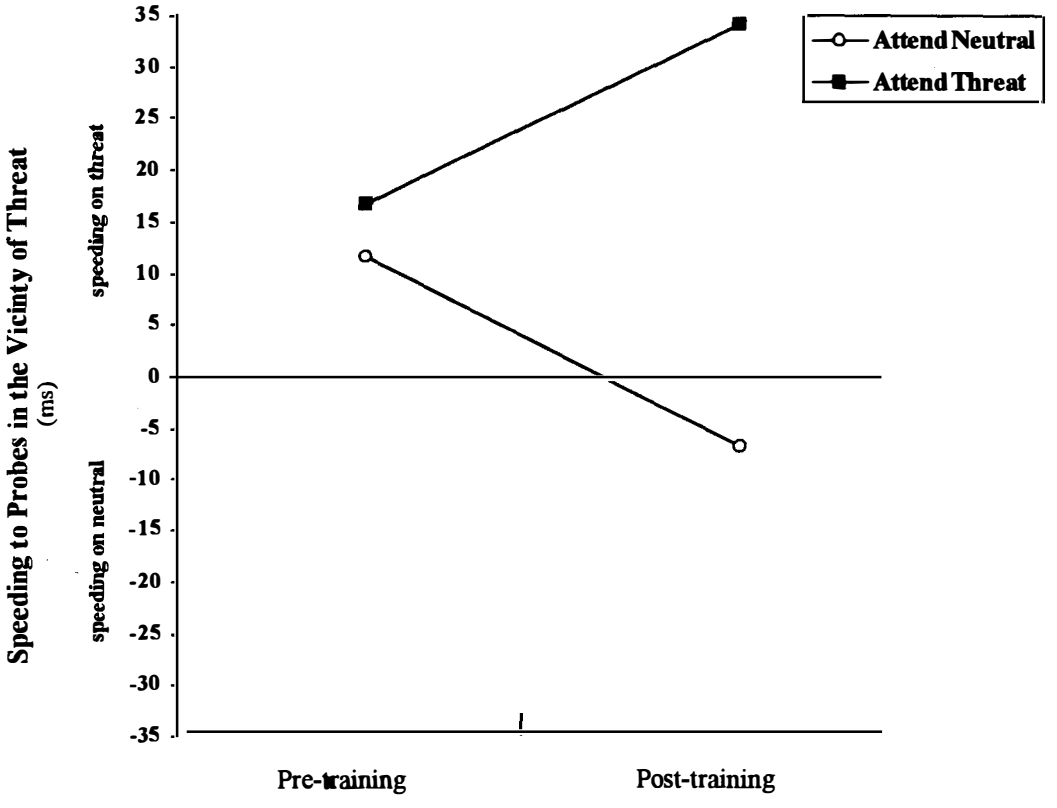

Figure 2. Training group x time interaction for order 3 alone.

In examining these results, it is apparent that there was no training effect for orders 1 or 2 in either of the training groups. Those in order 1 showed some differential degree of bias before training, there was no difference after training and those in order 2 showed no difference between training groups either before or after training.

However, there was an attentional training effect found in order 3. Prior to training there was no difference between the attend threat and attend neutral groups, who in fact both showed a bias towards threat, however after training there was a significant difference. This was in the direction of training given; the attend threat group showed a magnification of a bias towards threat pre to post, whereas the attend neutral group showed a change from a bias towards threat pre training to a bias towards neutral post training.

Therefore, in considering the results overall, whilst there was a failure to find a straight training group x time interaction that would have indicated an effectiveness of training groups across all orders, this training group x time interaction was subsumed under order. Training was only effective in inducing a bias in selective attention for those in order 3, and not effective for those in orders 1 or 2. For those in order 3, training was effective in inducing both an attentional bias to threat, and an attentional bias to neutral.

Effect of Attentional Training on Emotional Stroop Transfer Task

In this section, the transfer of training on the emotional Stroop task is examined. For each participant, median colour naming latencies on the emotional Stroop task were determined. To gain a single index of bias in selective attention towards threat, a "Threat Processing Index" (TPI) was calculated for each of the emotional Stroop tasks, following MacLeod and Rutherford (1992). This index is calculated by the following equation:

TPI = (Colour naming latency threat word trials – colour naming latency neutral word trials) / 2.

A positive score on this index indicates that threat words produced greater colour naming interference than neutral words, that is, an attentional bias towards threat stimuli. A negative score on this index indicates that threat words produced less colour naming interference than neutral words, that is, an attentional avoidance of threat, or bias towards neutral stimuli. The Threat Processing Index was calculated for the pre-training and post-training emotional Stroop tasks.

A 2 x 2 x 3 mixed design ANOVA was conducted with the Threat Processing Index serving as the dependent variable, and with two between groups factors of training group (Attend Threat, Attend Neutral) and order (1,2,3) and one within groups factor of time (pre vs. post). This revealed no significant main effects of training group ($F(1,48) = .40$, *ns*), order ($F(2,48) = 1.01$, *ns*), or time ($F(1,48) = .67$, *ns*). There were also no significant interactions between any of these factors, and importantly there was no significant interaction of training group x time ($F(1,48) = .01$, *ns*), which needed to be significant to show a transfer of training effect. One reason why no interaction of training group x time was observed could be that the different orders had differential effects, as seen in the dot-probe task. Hence some supplementary analyses with order were conducted to investigate if there were any differential effects of order on the emotional Stroop tasks.

Order effects

On an examination of order collapsed across training groups, there was no difference on the pre-training emotional Stroop task between those receiving order 1 (M = 3.33, SD = 8.78), order 2 (M = -.69, SD = 18.76), or order 3 (M = -.13, SD = 13.01) (F(2,51) = .42, *ns*). At post-training, there was again no difference between those who received order 1 (M = 1.38, SD = 23.92), order 2 (M = -5.97, SD = 17.88), or order 3 (M = -.83, SD = 13.14) (F(2,51) = .72, *ns*). Order was then examined in each of the training groups separately. In the attend threat group there was no difference on the pre-training emotional Stroop task between those receiving order 1 (M = 4.44, SD = 9.25), order 2 (M = 2.5, SD = 15.66), or order 3 (M = -.83, SD = 11.59) (F(2,24) = .41, *ns*). There was also no difference on the post-training emotional Stroop task between order 1 (M = 5.55, SD = 14.45), order 2 (M = -3.61, SD = 19.80), or order 3 (M = -4.72, SD = 13.66) (F(2,24) = 1.09, *ns*). In the attend neutral group, there was no difference on the pre-training emotional Stroop task between those in order 1 (M = 2.22, SD = 8.70), order 2 (M = -3.88, SD = 21.90), or order 3 (M = .55, SD = 15.14) (F(2,24) = .34, *ns*). On the post-training emotional Stroop task there was also no difference between those given order 1 (M = -2.77, SD = 31.11), order 2 (M = -8.33, SD = 16.58), or order 3 (M = 3.05, SD = 12.10) (F(2,24) = .63, *ns*).

It can be concluded therefore that there was a failure to find a transfer of training effect on the emotional Stroop task.

Emotional Effects of Attentional Training

Before the effects of training on emotional vulnerability as measured by responses to the anagram stress task is considered, the direct effects of attentional training on mood state will be examined.

Mood State During Attentional Training

Ratings of anxious and depressed mood were taken at the end of each of the 4 blocks in training, which are shown in table 2.

Table 2

Scores on Visual Analogue Scales across Attentional Training Task

		TRAINING CONDITION	
	Trial Block	Attend Threat	Attend Neutral
Visual Analogue Scale		Mean (S.D.)	Mean (S.D.)
ANXIETY	1	10.96 (6.02)	9.29 (6.64)
	2	11.70 (5.95)	10.40 (7.00)
	3	11.25 (6.44)	11.00 (7.73)
	4	11.66 (6.24)	10.00 (7.05)
DEPRESSION	1	10.25 (4.85)	9.51 (6.01)
	2	10.44 (4.97)	9.51 (5.82)
	3	11.59 (5.22)	10.14 (6.4
	4	11.62 (5.30)	10.18 (6.33)

To examine the effects of attentional training on anxious mood state, a 2 x 2 x 4 ANOVA was conducted with two between groups factors of training group (Attend Threat, Attend Neutral) and order (1,2,3), and one within groups factor of trial block (1 - 4). This revealed no significant main effect of block ($F(3,144) = 1.75$, *ns*), training group ($F(1,48) = .49$, *ns*), or order ($F(2,48) = .57$, *ns*), and no significant interactions of training group x block ($F(3,144) = .93$, *ns*), order x block ($F(6,144) = 1.39$, *ns*), or training group x order x block ($F(6,144) = 1.72$, *ns*). This indicates that there were no significant changes in anxious mood state across training and there were no differences between the training groups or orders in anxious mood ratings, as can be seen in Figure 3.

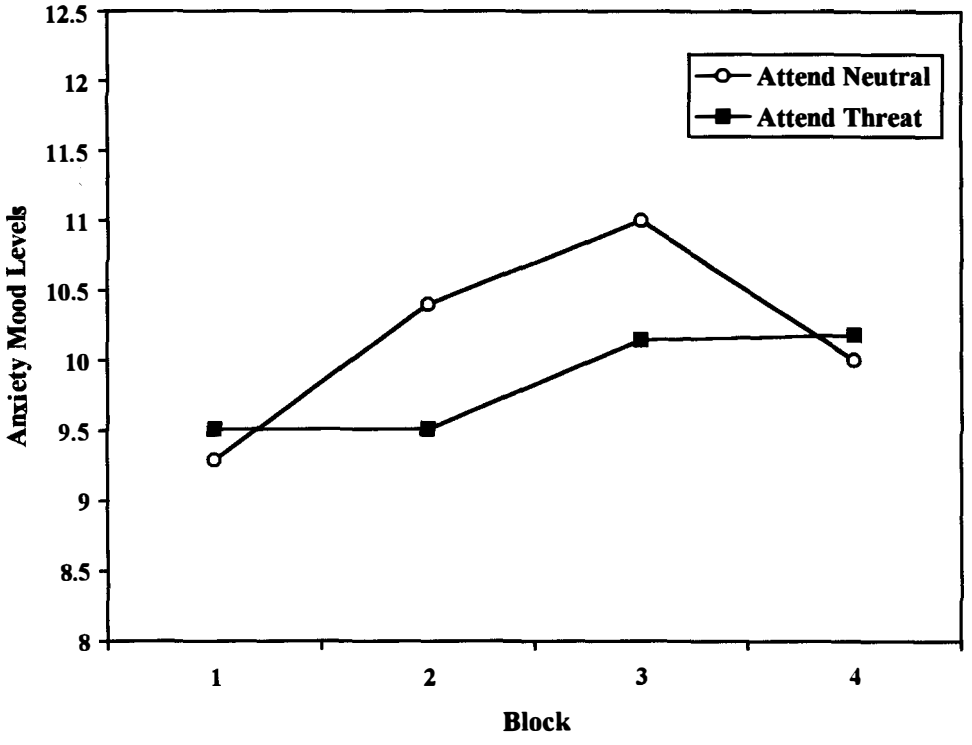

Figure 3. Anxiety mood ratings across training, by training group.

To examine the effects of attentional training on depressive mood state, the same ANOVA as used for the anxious mood ratings was used, but with the depressive mood ratings as dependent variables. This revealed a main effect of block ($F(3,144 = 4.44, p = .005$). As indicated in figure 4, the main effect of block reflects an increase in depressive mood state in both groups as training progressed. There were no differences between the training groups or orders on depressive mood ratings, with no main effect of training group ($F(1,48) = .61$, *ns*), or order ($F(2,48) = 2.07$, *ns*), and no significant interactions were detected, as can be seen in Figure 4.

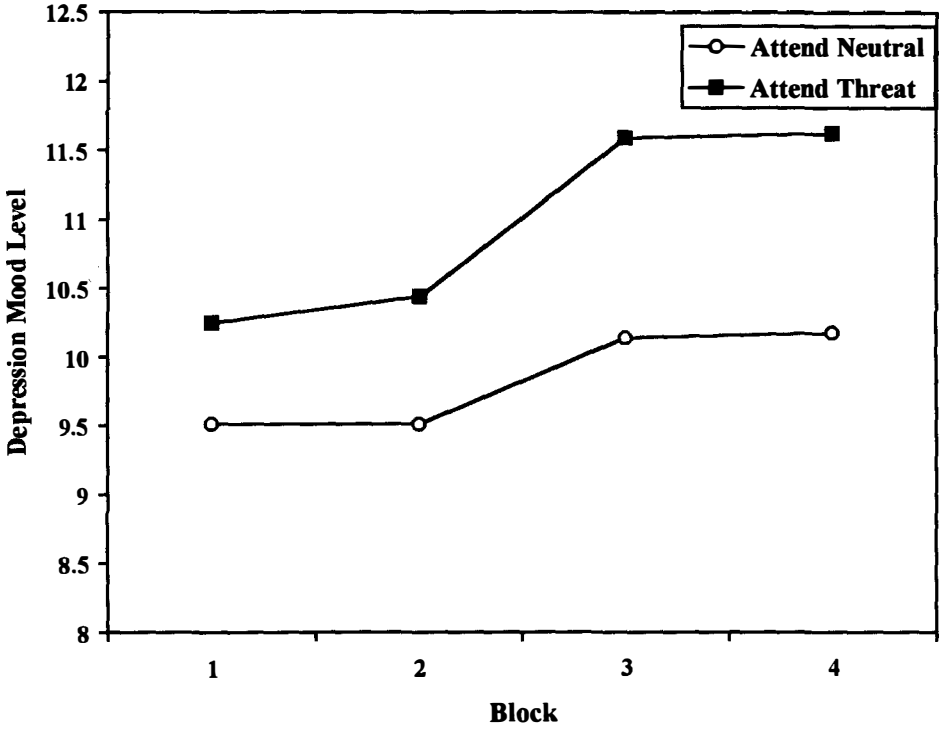

Figure 4. Depression mood ratings across training, by training group.

In summary, there was no elevation in anxious mood ratings during training, although there was some degree of elevation in depressive mood ratings. However, there

were no differences between the training groups or orders on anxious or depressed mood state across training. Thus, it can be concluded that the effect of training task on mood state was not modified by training group or order.

Mood State Effects Before and After Training

To investigate whether there were any differential mood effects as a result of the type of attentional training given that would carry onto the post-training assessment phase, average levels of anxiety and depression from ratings taken before and after each assessment task were analysed. This was calculated by the mean of ratings before and after each dot-probe task, and the mean of ratings before and after each emotional Stroop task.

Mood state effects within the pre-training and post-training dot-probe tasks

To determine whether attentional training influenced mood state on the post-training dot-probe task, two 2 x 2 x 3 ANOVAs were conducted with time (pre vs. post), training condition, and order as the independent variables, and average anxiety and depression ratings for each dot-probe task as dependent variables.

Anxiety mood state effects

There was a significant main effect of time ($F(1,48) = 4.06$, $p = .04$), where anxiety ratings were higher on the dot-probe task after training ($M = 11.46$, $SD = 6.89$) than before training ($M = 10.31$, $SD = 5.96$). There was no significant training group x time

interaction ($F(1,48) = 1.95$, *ns*), indicating that attentional training did not influence state anxiety in a way that was detectable on the post-training dot-probe task.

Depression mood state effects

A significant main effect of time was found for depression mood ratings ($F(1,48) = 38.4$, $p < .001$), where depression ratings were higher on the dot-probe task after training ($M = 11.01$, $SD = 5.82$), than before training ($M = 8.16$, $SD = 4.98$). There was no significant interaction of training group x time ($F(1,48) = 2.72$, *ns*), indicating that attentional training did not influence depression in a way that was detectable during the post-training dot-probe task. There was however, a significant time x order interaction ($F(2,48) = 3.53$, $p = .03$). To further analyse this effect, order was examined at each level of time (pre vs. post), collapsed across training group. There were no significant differences on depression between the orders on the pre-training dot-probe task ($F(2,51) = .81$, *ns*), but there was an effect approaching significance on the post-training dot-probe task ($F(2,51) = 2.84$, $p = .06$). Those in order 2 had a higher level of depression on the post-training dot-probe task ($M = 13.55$, $SD = 6.22$) than those in order 1 ($M = 9.36$, $SD = 4.41$) or order 3 ($M = 10.11$, $SD = 6.07$).

Mood state effects within the pre and post training emotional Stroop tasks

To determine whether attentional training influenced mood state on the post-training emotional Stroop task, two 2 x 2 x 3 ANOVAs were conducted with time (pre vs. post), training condition, and order as the independent variables, and average anxiety and depression ratings as dependent variables.

Anxiety mood state effects

There were no significant effects in the anxiety ratings. Importantly, there was no training group x time interaction ($F(1,48) = .90$, *ns*), indicating that attentional training did not influence state anxiety in a way that was detectable during the post-training emotional Stroop task.

Depression mood state effects

Several significant effects in the depression ratings were detected. There was a significant main effect of time ($F(1,48) = 23.73$, $p < .001$), where depression ratings were higher on the post-training emotional Stroop task ($M = 11.31$, $SD = 6.04$) than on the pre-training emotional Stroop task ($M = 9.28$, $SD = 5.36$). There was no significant training group x time interaction ($F(1,48) = .33$, *ns*) indicating that training did not affect state depression in a way that was detectable on the post-training emotional Stroop task. There was, however, a significant main effect of order on the pre-training emotional Stroop task ($F(2,48) = 4.04$, $p = .02$), where order 2 had significantly higher depression ratings ($M = 11.83$, $SD = 5.72$) than order 1 ($M = 6.80$, $SD = 3.33$). Those in order 3 showed an intermediate level of depression, between the two other orders ($M = 9.19$, $SD = 5.69$). There was also a significant difference on depression ratings on the post-training emotional Stroop task ($F(2,51) = 3.39$, $p = .04$), again where those in order 2 had significantly higher depression ratings ($M = 14.19$, $SD = 9.55$), than those in order 1 ($M = 9.55$, $SD = 4.27$). Those in order 3 again showed a level of depression between the two orders ($M = 10.19$, $SD = 6.13$).

Effects of Attentional Training on Emotional Vulnerability

To investigate whether there were any differential effects of type of training (Attend Threat, Attend Neutral) on changes in emotional vulnerability, anxious and depressive mood ratings before and after each anagram stress task were examined. To gain an index of change in emotional vulnerability due to each anagram stress task, Stress Induced Elevation Scores were calculated, following Holker (1997). Effects of training on changes in anxiety vulnerability are considered first, followed by depression vulnerability.

Training effects on anxiety vulnerability

The anxiety mood ratings before and after each of the pre-training and post-training stress tasks can be seen in Table 3.

Table 3

Anxiety Mood Ratings Before and After the Pre-Training and Post-Training Anagram Stress Tasks

	PRE-TRAINING		**POST-TRAINING**	
	Attend Neutral mean (s.d.)	Attend Threat mean (s.d.)	Attend Neutral mean (s.d.)	Attend Threat mean (s.d.)
Pre-stress	10.78 (7.70)	9.67 (5.84)	11.04 (7.80)	11.81 (7.20)
Post-stress	13.11 (8.50)	13.96 (6.23)	11.48 (8.68)	13.37 (7.11)

First, to examine if participants in the different training groups and orders went into the anagram stress tasks with different levels of state anxiety, a 2 x 2 x 3 mixed design ANOVA was conducted, with the pre anagram anxiety ratings for both stress tasks as dependent variables, and training condition, time (pre vs. post) and order as independent variables. There were no significant effects. In particular there was no training group x time interaction ($F(1,48) = 1.41$, *ns*) or order x time interaction ($F(2,48) = 1.60$, *ns*), which indicates that participants in the different training groups and orders did not go into either of the pre-training or post-training anagram stress tasks with different levels of state anxiety.

To gain a measure of change in anxiety vulnerability due to the anagram stress task an index called the "Stress Induced Anxiety Elevation Score" (SIAES) was calculated for each of the anagram stress tasks using the following formula:

SIAES = (anxiety response post stressor – anxiety response pre stressor) / 2

A high score on the index indicates a high anxiety response to the anagram stress task, whereas a low score on the index indicates a less intense anxious response to the anagram stress task.

A 2 x 2 x 3 ANOVA was conducted using the SIAES index as a dependent variable, with two between groups factors of training group and order, and one within groups factor of time (pre vs. post). There was no significant interaction of training group x time ($F(1,48) = .36$, *ns*) found (see Figure 5) which needed to be significant if type of training resulted in changes in anxiety vulnerability.

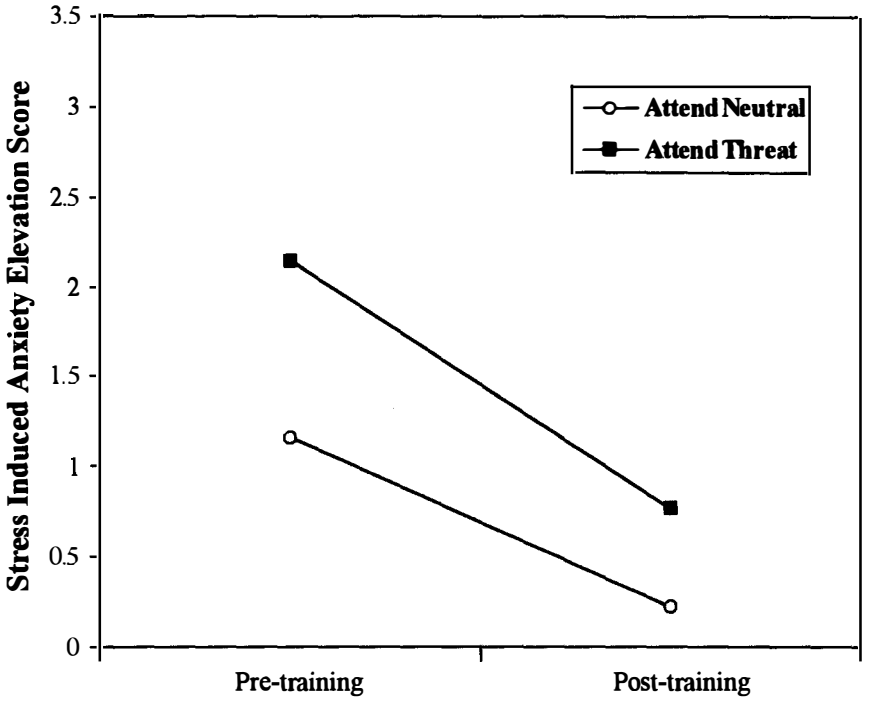

Figure 5. Anxiety elevation due to the anagram stress task as a function of training group and time.

There was, however, a significant main effect of time ($F(1, 48) = 10.6, p = .002$). As indicated in figure 5, this effect was such that the pre-training stress task elevated anxiety levels more ($M = 1.65$, $SD = 2.69$) than the post-training stress task ($M = .50$, $SD = 2.01$).

Training effects on depression vulnerability

The depression mood ratings before and after each of the pre-training and post-training anagram stress tasks are presented in Table 4.

Table 4

Depression Mood Ratings Before and After each Pre-Training and Post-Training Anagram Stress Task

	PRE-TRAINING		POST-TRAINING	
	Attend Neutral mean (s.d.)	Attend Threat mean (s.d.)	Attend Neutral mean (s.d.)	Attend Threat mean (s.d.)
Pre-stress	7.26 (3.95)	7.67 (4.37)	10.22 (5.73)	10.59 (6.14)
Post-stress	13.74 (7.12)	12.19 (6.16)	14.41 (1.63)	14.37 (6.33)

First, to examine if participants in the different training groups and orders went into the anagram stress tasks with different levels of depression, a 2 x 2 x 3 mixed design ANOVA was conducted with the pre anagram depression ratings for both stress tasks as dependent variables, and training group, time (pre vs. post) and order as independent variables. There were no significant effects. In particular there was no training group x time interaction ($F(1,48) = .0$, *ns*) or order x time interaction ($F(2,48) = 1.83$, *ns*), which indicates that participants in the different training groups and orders did not go into either anagram stress task with different levels of depression.

To determine the effects of training on depression vulnerability an index called "Stress Induced Depression Elevation Score" was calculated for each of the anagram stress tasks using the following formula:

SIDES = (depression response post stressor – depression response pre stressor) / 2

A 2 x 2 x 3 ANOVA was conducted using the SIDES index as a dependent variable, with two between groups factors of training group and order, and one within groups factor of time (pre vs. post). The interaction of training group x time as seen in Figure 6 was not significant ($F(1,48) = 1.3$, *ns*), which needed to be significant if there was an effect of type of training given on changing depression vulnerability.

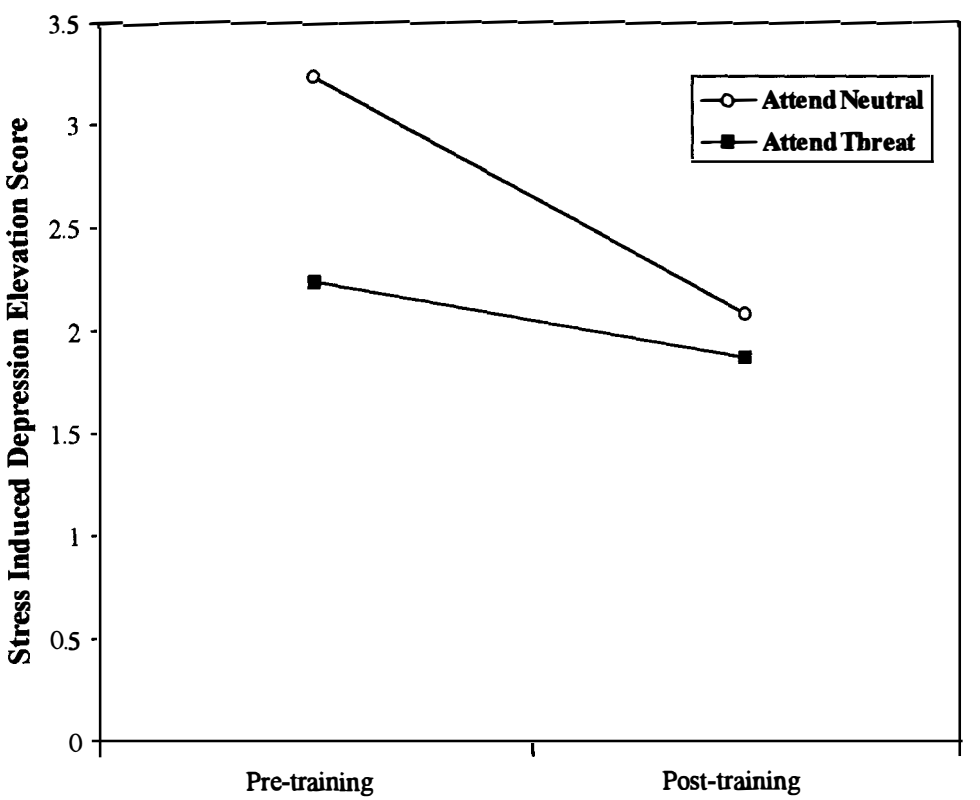

Figure 6. Depression elevation due to the anagram stress task as a function of training group and time.

There was however a significant main effect of time (pre vs. post) ($F(1, 48) = 4.97$, $p = .03$). As indicated in figure 6, this effect was such that the pre-training stress task

elevated depression levels more ($M = 2.75$, $SD = 2.50$) than the post-training stress task ($M = 1.99$, $SD = 2.46$).

Exploratory Analysis of Data

Due to a failure to find some of the expected results, subsidiary exploratory analysis of the data was conducted.

Associations between Measures of Cognitive Bias and Emotional Vulnerability

Further investigation of the data was undertaken to examine the relationship between anxiety and depression vulnerability, degree of bias on the dot-probe task, and degree of bias on the emotional Stroop task. It would be expected that in general there should be an association between attentional bias measures and emotional vulnerability. However, given the failure to find expected changes in trained selective attention and emotional vulnerability, this suggests that in the present study these measures may not have been associated. To determine if each of the measures were indeed associated with each other, following Holker (1997) measures of intra-participant variation on the attentional bias measures, and emotional vulnerability indexes were calculated for each participant by obtaining the difference between pre and post measures, regardless of training condition or order. The meaning of each of these indexes is detailed below.

Intra-Participant Variation (IPV) in Dot-Probe Bias Index:

(SPVT pre-training dot-probe task - SPVT post-training dot-probe task): A positive score indicates that training resulted in a decrease in bias to threat stimuli, whereas a negative score indicates that training resulted in an increase in bias to threat stimuli.

Intra-Participant Variation (IPV) in Emotional Stroop Bias Index:

(TPI pre-training emotional Stroop task - TPI post-training emotional Stroop task): A positive score indicates that training resulted in a decrease in bias to threat stimuli, whereas a negative score indicates that training resulted in an increase in bias to threat stimuli.

Intra-Participant Variation (IPV) in Anxiety Vulnerability Index:

(SIAES pre-training anagram stress task - SIAES post-training anagram stress task): The larger the index, the greater the decrease in anxiety vulnerability as a result of training.

Intra-Participant Variation (IPV) in Depression Vulnerability Index:

(SIDES pre-training anagram stress task - SIDES post-training anagram stress task): The larger the index, the greater the decrease in depression vulnerability as a result of training.

Hierarchical regression analyses were conducted, with two different orders of entry. Either the dot-probe task or emotional Stroop task was entered first, to examine the *independent* contributions of the indices of IPV in dot-probe bias and IPV in emotional

Stroop bias to variations in IPV in anxiety and depression vulnerability. The results are presented in Table 5.

Table 5

Hierarchical Regression Analyses between Attentional Bias Measures and Emotional Vulnerability

	Dependent Variable							
	Anxiety Change Index				**Depression Change Index**			
Variable								
Entry order 1	**R**	**R^2ch**	**F**	**p**	**R**	**R^2ch**	**F**	**p**
1. DOT-PROBE	.0002	.0002	.01	.91	.001	.001	.06	.79
2. STROOP TASK	.014	.0138	.36	.69	.001	.0005	.04	.95
Entry order 2								
1. STROOP TASK	.013	.013	.71	.40	.0004	.0004	.02	.88
2. DOT-PROBE	.014	.0005	.36	.69	.001	.001	.04	.95

It can be seen from Table 5 that neither the dot-probe bias index, nor the emotional Stroop bias index was capable of predicting variation in anxiety vulnerability, or variation in depression vulnerability. This is contrary to Holker (1997) who found that the dot-probe bias index accounted for variation in anxiety vulnerability. The fact that no significant effects were found currently may call into question the reliability of these

attentional measures across time and participants. However, given that Holker found training to change anxiety vulnerability, and here there was no overall training effect and a failure to change emotional vulnerability, it is consistent that there were no associations found between the measures.

DISCUSSION

Overview

The current study had four main purposes. (1) to determine if participants could be trained to attend selectively either towards threat stimuli or towards neutral stimuli; (2) to determine if this attentional training could change emotional vulnerability, which would indicate whether selective processing biases play a causal role in emotional vulnerability; (3) to determine the underlying mechanism of change in emotional vulnerability by investigating transfer on the emotional Stroop task; and (4) to determine if test order had any differential effects. This discussion will first consider the effectiveness of training, followed by effects of attentional training on changes in emotional vulnerability, and finally the underlying mechanisms of change on the emotional Stroop transfer task. The effects of order will be considered throughout each of these areas. Following this, the implications of these findings, and suggestions for future research will be made.

Effectiveness of Attentional Training

One of the central purposes of the current study was to examine whether Holker's (1997) ability to train a bias in selective attention in participants attending both towards threat and towards neutral stimuli could be replicated. Unlike Holker's study, there was no evidence of a training group x time interaction, indicating that in both training groups, regardless of test order, there was a failure to find an overall training effect. This overall failure to find a training effect may be due to the almost significant pre-training attentional bias in the direction participants were being trained towards. There is no

logical reason why this difference occurred; participants were assigned randomly to the training groups, and did not differ significantly on any other measured characteristic. The effect of this pre-existing bias in selective attention likely made it much more difficult to find a training group x time interaction, and thus a training effect, when participants already had a bias *before* going into training that would have been expected *after* training.

Nevertheless, despite the failure to find an overall training effect, there was evidence of a training effect mediated by order. Training appeared to be effective in inducing an attentional bias for those given test order 3. This was evidenced by those in order 3 in the attend threat group showing a magnification of a bias to threat shown pre-training, whereas order 3 in the attend neutral group showed a change from a bias to threat pre-training to a bias to neutral post-training.

One reason for finding training to be effective in order 3, but not orders 1 or 2, may be that the dot-probe task was more sensitive at detecting training effects when participants have been recently stressed. This explanation carries a possibility that training may have been effective in orders 1 or 2, but because they had not received a recent stressor prior to their assessment on the dot-probe task training effects were not detected. Another possible explanation for training effectiveness in order 3 is that receiving a recent stressor may lower the perceptual threshold for both the threatening and neutral words. That is, the recently stressed participants may be more able or quicker to detect either the threat or neutral words, and depending on the nature of training given, will thus show a selective processing bias to the valence of words trained towards. However, participants not recently stressed may have a higher threshold to detecting both

valences of words, and thus did not respond as fast to the emotional valence, so a bias and training effect was not detected. Small and Robins (1988) studied thresholds for identifying emotional words following a depressive mood induction procedure. They found reduced perceptual thresholds for both negative and positive words. Similarly, Hermans, De Houwer and Eelen (1996) found that affective decisions could be made significantly faster following a mood induction procedure. Williams, Watts, MacLeod and Mathews (1997) claim that results such as these support the existence of an affective decision mechanism at an early stage of processing. It may be that an increase in state anxiety or depression results in a lower threshold for the affective decision mechanism, so that decisions regarding emotional valence are made quicker. Consequently, in this experiment when participants in order 3 were recently stressed, they may have been quicker to make the judgement about emotional valence, and depending on training given, were quicker to respond to the valence of words they were trained towards, thus showing the attentional bias due to training.

However, while it appears that there was a training effect in order 3, there are cautions in interpreting this that must be raised. First, when comparing the effects of order, there were only 9 subjects per cell, so that comparisons were based on small sample sizes. Also, there is an alternative explanation of these results, which may suggest that there was actually no training effect observed in order 3. For example, in pre-training order 1 in the attend threat group and the attend neutral group showed a difference, although order 2 and order 3 showed no difference between the training groups. When averaging across these findings, it could appear that there was no difference between the orders in each of the training groups. Similarly, on post-training,

there was no difference between orders 1 and 2 in each of the training groups, however there was a difference between training groups for order 3, which was taken as evidence of an attentional training effect. However, as for pre-training, if these results are averaged out, then it could appear that there was no difference between orders in each of the training groups. While this interpretation needs to be considered, it is most likely unnecessarily rigid.

As an aside to the effectiveness of training, there were also some interesting results in terms of order on the pre-training dot-probe assessment task that deserve attention. On the pre-training dot-probe task, there was a significantly larger bias in selective attention towards threat shown by those in order 3 compared to order 1 who showed a bias to neutral, and order 2 showed neither a bias to threat or neutral. Only test order 3 received the stress task before the dot-probe assessment task; the other two orders received the stress task after the dot-probe task. It is possible that having the stress task before assessment on the dot-probe may have increased stress so that what is being observed is a bias in selective attention being induced by this elevation in stress. This would not have been observed in the other two orders, as they were not exposed to the stressor before being measured on the dot-probe task. This argument is supported by the findings of Mogg et al. (1990). They assigned high and low trait anxious participants to either a high stress condition (anagram stress task similar to the one used here), or a low stress condition (easy anagrams with false positive feedback). The high or low stress anagram task was presented first followed by the dot-probe task. It was found that all participants in the high stress condition showed a bias to threat, regardless of their trait anxiety level (high or low). This was also found here, where all participants in order 3 that were

recently under stress showed a selective bias towards encoding threat even though they were within a mid-range of trait anxiety (i.e., not high trait anxious). An explanation that Mogg et al. proposed that may also apply here is that a stressful experience may directly prime cognitive representations of threat in memory, which results in attention being selectively allocated toward any further threat. In other words, there is a direct priming effect of stressful events. Mogg et al. also argued that their findings implicate a different process involved in an acute source of stress versus a prolonged source of stress. While prolonged stressors may involve an interaction effect of state and trait anxiety (i.e., under high state anxiety, high trait anxious allocate attention to threat whereas low trait anxious avoid threat; MacLeod & Mathews, 1988; MacLeod & Rutherford, 1992), acute stressors may engage bias to threat regardless of trait anxiety level. This explanation would also seem to apply here, where even though participants were within a mid-range of trait anxiety, with an acute stressor all participants who were recently stressed allocated their attention to threat. Consequently, the current findings of a large bias to threat on the dot-probe task for order 3 after an acute source of stress seem to support Mogg et al.'s claims for different processes involved in acute and prolonged stress. This has implications for models explaining cognitive biases such as one proposed by Williams et al. (1997) who consider the state/trait anxiety interaction as determining emotional response to stress increases. The results of the current experiment suggest that they may need to consider this possible difference between acute and prolonged stressors.

Attentional Training Effects on Emotional Vulnerability

In this section, results of the effects of attentional training on changes in emotional vulnerability will be discussed. However, mood state during training, and in the pre-training and post-training assessment phases will be discussed first.

Mood ratings were examined during training to determine if there were any changes in state anxiety or depression as a result of training. There was no change in anxiety ratings across training, however there was a change in depression ratings, showing a general increase in depression across training. Although there was a general increase in depression across the task, there were no differences between the orders or training groups on depression, so the groups were not affected differentially by the training. This is important, as it can be concluded that any effects of training on changes in emotional vulnerability are not due to different mood states induced by training. The general increase in depressive ratings across training in both the attend threat and attend neutral group is likely reflecting boredom with the training task. This increase in depressive ratings across training has been found in other studies (e.g., Ebsworthy, 1994; Holker, 1997), who concluded similarly that it was likely due to the participants' boredom during the training task.

Mood state effects were also examined in the pre-training and post-training dot-probe and emotional Stroop assessment tasks. This was to determine if there were any differential mood effects as a result of training that carried through onto the post-training assessment phase. On the dot-probe tasks, both anxiety and depression ratings were found to be higher on the post-training than the pre-training task. This effect was also found by Holker (1997), and likely also reflects boredom or fatigue by the time the post-

training assessment arrives. This was also found with the emotional Stroop tasks, where depression ratings were higher on the post-training task. There were some differences between the orders on depressive mood in the pre-training and post-training emotional Stroop tasks, for example with order 2 showing higher depression ratings on some tasks. This finding is not particularly important - it may have been due to random fluctuation across the groups. The most important finding was that there was no training group x time interaction using the assessment tasks. This indicates that training did not influence mood in a way that was detectable on the post-training assessment tasks, and that the increase in depression seen during training was a transient effect, and did not carry onto the post-training tasks. Given these analyses, the effects of training on changing emotional vulnerability were accurately assessed, without any influence of mood effects of training.

The important question of whether attentional training could change emotional vulnerability was assessed by examining changes in anxious and depressed mood on the anagram stress tasks. There was no evidence of attentional training changing either anxiety or depression vulnerability. This is in contrast to Ebsworthy (1994), who found training to have a trend towards changing depression vulnerability in the attend threat group, and Holker (1997) who found training to change anxiety vulnerability in the attend neutral group. However, given there was no overall training effect found (only for order 3), it is not surprising that attentional training was unable to change emotional vulnerability. The consequence of this failure to change emotional vulnerability is that assumptions regarding the causality of selective processing biases cannot be made. That is, it cannot be argued presently that since there was no change in emotional vulnerability

that selective processing biases are not causal, as there was no overall training effect found. Thus, inferences regarding causality can only be made when there is evidence of attentional training effects.

The only significant effect that was found on the anagram stress tasks was that the pre-training stress task elevated both anxiety and depression more than the post-training stress task. Holker (1997) also found this result, where the first anagram stress task appeared to be more stressful. It was hoped that including a different set of instructions in this design, where participants thought they were a doing practice anagram task, and would receive another chance later, would alleviate this problem so that the second stress task would still be as stressful as the first. However, it appears that this change in instructions did not make any difference. Therefore, the current design and that used by Holker, while having the advantage of being more sensitive at detecting a change in emotional vulnerability, has the problem that the second stress task is less stressful for participants.

Underlying Mechanism of Change: The Emotional Stroop Transfer Task

The emotional Stroop task was included as a transfer task to determine if training on the dot-probe task could generalise onto the emotional Stroop task, thus allowing an investigation of the underlying mechanism of change in emotional vulnerability due to training. It was hypothesised that if the effect of training on the dot-probe training task could also be detected on the emotional Stroop task, then the underlying mechanism of change would be a change in general processing bias. However, if the training effect was

not detected on the emotional Stroop task then the effect would be a task-specific change. There were no significant effects found with the emotional Stroop task, including no change in emotional Stroop task scores as a function of training. Therefore, there was a failure to find any transfer and generalisation of training onto the emotional Stroop task.

This effect cannot, however, be taken as evidence that the underlying mechanism of change was due to a task-specific process, rather than a general change in selective processing bias. This is because making claims about the underlying mechanism of change in emotional vulnerability due to training is obviously not valid when no overall training effect was found, and there was no change in emotional vulnerability. Given that there was no overall training effect found, it is not surprising that training effects were not detected on the emotional Stroop task.

Implications and Future Directions

Before implications of the current findings are discussed, limitations of the study must be raised so there is caution in considering the implications. The main limitation is in comparisons made on order. As mentioned previously, all comparisons made on order were done so with only 9 participants per cell, which is a small sample size. A second limitation is that some findings may have been subject to inflation of type 1 error rate due to the numerous analyses conducted. However, since many of the analyses were of an exploratory nature, it was decided to set the alpha level at .05 rather than to be very conservative and have a reduced chance of finding effects. Another possible limitation was the repeated use of visual analogue scales throughout the experiment, with these being administered 17 times in total. While the increase in depression across training and

the higher anxiety and depression ratings on post-training tasks were explained in terms of boredom or fatigue, it is possible that these results may reflect demand characteristics. That is, when participants keep receiving ratings of mood, they may assume that the experimenter is expecting changes to occur, and so increase their ratings. The repeated use of visual analogue scales may be an issue for future research to pursue, as there is no data on the reliability, validity, or sensitivity of their repeated use over a short time span.

In considering implications of the experiment, the finding that there was no overall training effect, but there was a training effect in order 3, has some interesting implications. First, the training effect seen in order 3 was durable in terms of time lag since training. Order 3 had the longest period of time between training and dot-probe assessment for each of the test orders, where training lasted for at least 15 minutes. This addresses some of the initial reasons for which order was included in the design, to address the effects of time lag on detecting training effects. Training also appeared to be effective in ability to generalise to all new words, as there were all new words on the dot-probe assessment task post-training, so that the training effect was not a function of having seen the words previously. Therefore, there was "within-domain stimulus generalisation" (MacLeod, 1996b), which indicates that the selective attention bias induced was able to generalise to different stimulus materials. This is important since the aim of developing attentional training procedures is that they will be central in nature, and general across stimulus domains, rather than a bias specific to the particular training task, or particular set of training stimuli (MacLeod, 1996b).

The recommendations for future research that can be made from these findings is that test order is examined again to determine if order 3 could again show a training effect

where the other two orders could not. At the very least, if test order is not further examined, then future research should consider only using test order 3 pre and post attentional training, as these findings suggest it is the order that has maximum chance of detecting a training effect.

One important implication of the current findings is that it highlights the importance of being able to train attentional biases, as without training effects assumptions regarding causality and underlying nature of changes cannot be confirmed or refuted. No claims were able to be made about the causality of selective processing biases here, as there was no overall training effect, and no change in anxiety vulnerability. There was even no *association* found between selective processing biases and anxiety vulnerability in a hierarchical regression. Thus, the question of causality is left open to future research. As previously discussed, the question of causality is extremely important to resolve. At the least, if selective processing biases are not found to be causal in the development and maintenance of anxiety disorders, but instead are "cognitive markers" of anxiety, then these markers may provide researchers with more sensitive measures of emotional vulnerability than standard self-report measures (MacLeod & Rutherford, 1998). However, if selective processing biases are found to be causal in the development and maintenance of anxiety disorders, then the type of training task used here could be applied in clinical populations. For example, anxiety patients could be provided with repeated exposure to training sessions using the dot-probe training task where they are trained to selectively attend away from threat stimuli (MacLeod & Rutherford, 1998). This type of training may be used in conjunction with standard cognitive behaviour therapy for anxiety disorders, both as a part of treatment, and to prevent future relapse of

responding to state anxiety elevations with increased processing of threat stimuli. In addition, high trait anxious individuals could receive training sessions, which may reduce the likelihood of them responding to elevations in state anxiety with increased processing towards threat and thus anxiety.

The failure to find an overall training effect, or change in emotional vulnerability, also had the effect that claims about transfer of training on the emotional Stroop task, and thus the underlying mechanism of change in emotional vulnerability could not be made. However, future research should also include the emotional Stroop task as a transfer task, because when a study finds an overall training effect, then transfer and generalisation onto the emotional Stroop task can be adequately assessed. This is a very important outcome to pursue, because designing training procedures that are central with "cross-task generalisation" is important (MacLeod, 1996b) for effective training procedures. This means that an induced bias in selective attention could also be found on different attentional tasks, such as the emotional Stroop task. Only when there are effective training procedures, which can consistently train attentional biases, and are central in nature, can the causality hypothesis be properly addressed, and thus the possible clinical utility of the training task.

In considering general future research directions, one direction is towards improving the ecological validity of the experiments. The stress task that was utilised here was artificial. To increase the external validity of claims made, future research may consider using real life stressors. For example, participants could be trained to attend towards threat, or towards neutral stimuli prior to a stressful life event, then their subsequent emotional response measured. Another direction for research that is very important to

follow is in determining the clinical applications of the training task. One criticism of the training technique that could be made is that it is artificial, and thus it is hard to assess whether training might extend to real life stimuli. Consequently, it is necessary to begin to use clinical populations in research to determine if training can change emotional vulnerability in this group, and thus the clinical usefulness of this technique.

Whilst the current study failed to find some predicted effects, interesting results were found in terms of test order. As there was no overall attentional training effect found, the causality of selective processing biases and the underlying nature of change as measured by the emotional Stroop transfer task could not be adequately assessed. Thus, future research may consider replicating the present study, however only using test order 3. The questions not able to be answered fully here are important and need to be further addressed both for theoretical importance in determining the causality of selective processing biases, and clinically in the potential application of attentional training tasks to clinically anxious individuals. Answering these questions will only serve to further understanding of the link between cognition and emotion, and as such, understanding of how to more effectively treat anxiety disorders.

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Appendix A

SUMMARY OF EXPERIMENT

PRE-EXPERIMENT:

- Complete consent form, BDI, STAI.
- Complete practice trials, receive instructions.
- Allocation to training group (attend threat, attend neutral), order (1,2,3) and word rotation (1-9).

EXPERIMENT:

Pre-Training Assessment Phase

ORDER 1	**ORDER 2**	**ORDER 3**
Visual analogue scales (VAS)	VAS	VAS
Emotional Stroop task (96 trials)	***Dot-probe***	***Anagram***
VAS	VAS	VAS
Break (self-timed)	Break	Break
VAS	VAS	VAS
Dot-probe assessment task (96 trials)	***Anagram***	***Stroop***
VAS	VAS	VAS
Break	Break	Break
VAS	VAS	VAS
Anagram stress task (3 minutes)	***Stroop***	***Dot-probe***
VAS	VAS	VAS
Break	Break	Break

Training Phase
(Dot-probe training task: 576 trials)

VAS	VAS	VAS
Block 1 - 144 trials	Block 1	Block 1
VAS	VAS	VAS
Break	Break	Break
Block 2 - 144 trials	Block 2	Block 2
VAS	VAS	VAS
Break	Break	Break

Block 3 - 144 trials	Block 3	Block 3
VAS	VAS	VAS
Break	Break	Break
Block 4 - 144 trials	Block 4	Block 4
VAS	VAS	VAS
Break	Break	Break

Post-Training Assessment Phase

VAS	VAS	VAS
Emotional Stroop task (96 trials)	***Dot-probe***	***Anagram***
VAS	VAS	VAS
Break	Break	Break
VAS	VAS	VAS
Dot-probe assessment task (96 trials)	***Anagram***	***Stroop***
VAS	VAS	VAS
Break	Break	Break
VAS	VAS	VAS
Anagram stress task (3 minutes)	***Stroop***	***Dot-probe***
VAS	VAS	VAS

POST-EXPERIMENT:

- Participant de-briefing as to nature of deception in the anagram stress task, and nature of experiment.

Appendix B

TEST ORDER

Table 1

Order of Tasks given, in both Pre-Training and Post-Training Assessment Phases

Order 1	Order 2	Order 3
1. Emotional Stroop task	1. Dot-probe task	1. Anagram stress task
2. Dot-probe task	2. Anagram stress task	2. Emotional Stroop task
3. Anagram stress task	3. Emotional Stroop task	3. Dot-probe task

Appendix C

WORD STIMULI SETS

Practice Stimuli

Dot-probe Practice Stimuli

Word Pair	Length	Frequency
Team - Ship	4	83
Rock - Vote	4	75
Shirt - Grain	5	27
Grass - Loose	5	53
Peak - Rail	4	16
Suggest - Walking	7	54
Cup - Ice	3	45
Shoe - Yarn	4	14
Commerce - Exercise	8	58
Desk - Join	4	65
Code - Goal	4	40
Timber - String	6	19

Emotional Stroop Practice Stimuli

Word	Length	Frequency
Event	5	81
Carry	5	88
Avenue	6	46
Deck	4	23
Directed	8	68
Enter	5	78
Looks	5	78
Projects	8	68
Lock	4	23
Decade	6	46
Cover	5	88
Index	5	81

SET A1

Word Pair	Length	Frequency	Negativity	Neutrality
Hospital - Standard	8	10	2.8	4.8
Deformity - Clockwise	9	3	1.8	5.2
Risk - Seat	4	54	3	5
Disembodied - Householder	11	1	2.6	5.2
Lonely - Parade	6	25	2	5.8
Clumsy - Finale	6	6	3.4	5.6
Discouraged - Connections	11	15	2.6	5.4
Trauma - Enjoin	6	1	2.4	5.4
Turmoil - Foliage	7	12	3.2	5.6
Destroy - Quietly	7	48	2.6	5.2
Disgrace - Transact	8	3	2.2	5
Orphan - Bridle	6	1	2.8	5
Torture - Canvass	7	3	2	4.6
Vicious - Counted	7	17	1.4	5.2
Annihilation - Semicircular	12	6	2.2	5
Battlefield - Periodicals	11	5	3	5.4
Insulting - Featuring	9	4	2.4	5.4
Carcass - Pricing	7	7	3.4	4.8
Disease - Remarks	7	53	2	4.8
Pickaxe - Upriver	7	1	2.8	5
Combat - Define	6	27	2.4	5.2
Virus - Tries	5	13	1.8	6
Damned - Packed	6	19	2.4	4.8
Mangled - Nodular	7	1	2.8	4.6
Trespassed - Campground	10	3	3.4	5
Rejection - Linguists	9	11	2.2	5.4
Damage - Campus	6	33	2.8	5.8
Leukemia - Coconuts	8	3	1.6	5.6
Nuclear - Forward	7	115	3	5.8
Punch - Batch	5	5	3.2	4.8
Distraught - Midmorning	10	1	2.2	5.4
Explosion - Readiness	9	15	3.2	6
Haunted - Potters	7	8	3.4	5
Axe - Jam	3	6	2.8	5.8
Kidnapped - Projector	9	1	2	5
Conflict - Detailed	8	52	2.8	5.2
Grim - Bush	4	14	3	5.2
Sinister - Integral	8	13	2.2	5.2
Feverish - Extracts	8	4	3.6	5
Maimed - Ratify	6	1	2	5
Ruined - Trains	6	16	2.2	5

Anxiety - Journal	7	42	2	5.2
Estrangement - Subparagraph	13	1	2.8	5
Contaminated - Matriculated	12	3	3	4.8
Lethal - Racket	6	5	2.2	4.8
Haggard - Canteen	7	2	2.8	5.2
Insane - Fusion	6	13	2.4	4.8
Hostile - Rolling	7	19	2.4	4.6

SET A2

Word Pair	Length	Frequency	Negativity	Neutrality
Scorned - Eclipse	7	2	2.2	4.8
Punishment - Dedication	10	21	2.4	6
Prosecution - Orthodontic	11	9	2.6	4.8
Massacre - Manikins	8	1	2	5
Sword - Enact	5	7	3.4	4.8
Agitation - Fireplace	9	6	2.8	6.2
Inadequate - Transition	10	32	2.2	5.2
Desperate - Variables	9	26	2.8	5
Cancer - Saddle	6	25	1.6	5.2
Shame - Skirt	5	21	2.6	4.8
Undesirable - Subdivision	11	10	3	5
Terror - Jersey	6	25	2	5
Defeated - Province	8	15	2.2	5.2
Danger - Waited	6	70	1.8	4.6
Sleepless - Retrieval	9	1	3.4	4.8
Paralysed - Goodnight	9	2	2.2	5.6
Poison - Render	6	10	2.6	4.6
Criticism - Automatic	9	40	3.2	5.2
Malicious - Motioning	9	2	1.8	5
Harsh - Gauge	5	12	3.2	4.8
Impaled - Orbital	7	2	2.6	5.2
Examination - Transferred	11	29	3.2	4.8
Uneasy - Novels	6	22	3.6	6.2
Pain - Laws	4	88	2.2	4.6
Flustered - Dualities	9	1	3.2	5.2
Isolated - Sequence	8	35	2.4	4.8
Gnarled - Pivotal	7	1	3.4	5.2
Perish - Gypsum	6	2	2.4	5.2
Creepy - Blazer	6	1	3	5
Harm - Pond	4	25	2.6	5.8
Tragic - Rector	6	33	2	4.8
Aghast - Spares	6	1	3.4	5
Downtrodden - Biophysical	11	2	2.8	5
Suffer - Parked	6	33	2.2	5
Unstable - Westward	8	8	3	5
Toxin - Dials	5	1	2.6	5.4
Gunfire - Polymer	7	7	3	5
Ordeal - Deduce	6	3	3	4.6
Detest - Tonics	6	1	2	5.2
Asylum - Ascend	6	1	2.4	5.2
Cemetery - Daylight	8	15	2.2	6.2

Devastated - Stagecoach	10	3	2.2	5
Contempt - Novelist	8	15	1.6	5.8
Molest - Staple	6	1	1.8	5
Gloomy - Pastel	6	3	2.8	5.8
Impotent - Saturday	8	2	2.6	5.8
Disturbing - Telephoned	10	16	2.4	5
Depressed - Histories	9	11	2	5

SET A3

Word Pair	Length	Frequency	Negativity	Neutrality
Grieving - Hallmark	8	3	2.4	5.4
Incriminating - Continentally	13	1	3	5
Hate - Ease	4	42	1.8	6
Dumb - Boot	4	13	2.6	5
Ostracism - Dichotomy	9	1	2.4	4.8
Altercation - Banquetings	11	1	3.4	5.4
Plague - Opener	6	6	1.8	5.4
Disgust - Crayons	7	1	2.8	5.2
Butchered - Evaporate	9	1	2.4	4.8
Hopeless - Feathers	8	14	2	5.8
Quarrel - Figured	7	20	3	5
Smother - Quintet	7	3	3.4	5.2
Maniac - Nozzle	6	4	2	4.8
Bitter - Handle	6	53	3	4.8
Frail - Palms	5	8	2.4	5.2
Inferior - Shearing	8	7	2.8	4.6
Useless - Seasons	7	17	3.2	6.2
Wound - Dried	5	28	2.4	4.8
Hatred - Fitted	6	20	1.8	5
Harassed - Passport	8	6	3	5.6
Neurotic - Forecast	8	10	2.6	5.4
Divorce - Samples	7	29	2.6	5
Assassin - Launcher	8	6	1.4	5
Infected - Circuits	8	4	3	5
Strangled - Signatures	9	6	2.2	5
Unsettling - Courtyards	10	1	3.4	5.8
Invaded - Pausing	7	6	2.2	4.6
Scream - Suburb	6	13	2.4	4.8
Execution - Dimension	9	15	2	4.8
Gnashing - Cushions	8	2	3.4	6
Ignorance - Translate	9	16	2	5
Panicky - Clarets	7	1	2.8	5.8
Scornful - Cabinets	8	5	2.2	5
Tearfully - Discerned	9	2	3.4	5
Unattractive - Choreography	12	3	2.8	5.4
Kill - Shop	4	63	1.4	5.2
Blade - Files	5	13	2.6	4.6
Deserted - Stimulus	8	15	3	5.2
Corpse - Piston	6	7	2.2	5
Surgery - Shipped	7	6	2.6	4.8
Defenceless - Categorical	11	3	2.2	5
Antagonism - Addressing	10	9	3.2	5

Lifeless - Windfall	8	2	2.2	5.6
Devil - Suits	5	25	2	5.2
Stress - Cities	6	107	2.6	5.2
Peril - Cooks	5	8	3	5.6
Threat - Varied	6	42	2.4	5.2
Incompetent - Inferential	11	2	2.6	5.2

SET B1

Word Pair	Length	Frequency	Negativity	Neutrality
Degrading - Fortnight	9	1	2.4	5
Stupid - Weekly	6	24	2.4	5
Worried - Context	7	35	2.8	4.8
Slaughter - Employing	9	10	1.8	5.6
Infested - Eggshell	8	1	3	5
Grovel - Lagers	6	1	2.6	4.6
Emaciated - Tidewater	9	3	2.8	4.6
Infirmity - Brushwork	9	1	3.6	5
Trouble - Evening	7	134	2.2	5.8
Insecure - Fetching	8	3	2.8	5
Howling - Plateau	7	3	3.2	4.8
Malformed - Balancing	9	4	2.4	5.2
Incurable - Reclaimed	9	2	1.6	5.6
Prowlers - Rivulets	8	1	2.8	5.2
Looming - Framing	7	10	3.4	4.8
Oppressed - Milligram	9	5	2.4	4.8
Unhappy - Bridges	7	26	2	5
Trap - Tent	4	20	3	5.2
Devastation - Belowground	11	2	2.2	4.6
Ulcer - Swamp	5	5	2.8	4.6
Guns - Wire	4	42	2.2	4.6
Defeat - Museum	6	31	2.8	5.8
Fumbled - Skimmed	7	5	3.6	4.8
Dismembered - Evaporation	11	2	2	5
Cheat - Grape	5	3	2.6	5.4
Lesion - Outlay	6	2	2.2	4.6
Infuriate - Marinated	9	1	3.6	5.8
Assault - Bottles	7	15	2.2	5
Cry - Via	3	48	2.8	5
Inability - Followers	9	17	3.4	5.2
Slashed - Partial	7	10	2.4	4.6
Attacks - Physics	7	22	2.2	4.8
Captive - Shutter	7	5	3.2	5
Agony - Glove	5	9	1.4	5
Heartbreak - Screenings	10	1	2.2	5.2
Ashamed - Channel	7	16	2	5.2
Hacked - Herded	6	2	2.4	4.8
Coffin - Edited	6	7	1.8	4.6
Fool - Gate	4	37	3	5.4
Bludgeon - Routines	8	3	2.6	5
Ominous - Outline	7	12	3.2	5
Entombed - Solstice	8	1	3.2	5

Crisis - Agreed	6	82	2	4.8
Insomnia - Veracity	8	3	2.6	5.2
Pistol - Mirror	6	27	3	5
Hurt - Core	4	37	2.4	5
Aggravated - Balustrade	10	3	3	4.8
Disfigured - Recipients	10	5	2	5

SET B2

Word Pair	Length	Frequency	Negativity	Neutrality
Heartless - Signposts	9	1	2.4	5.2
Doom - Sown	4	3	2	5.2
Inept - Sails	5	2	3	5.4
Guilt - Stems	5	33	2.2	5.4
Powerless - Multitude	9	3	2.6	4.6
Disabled - Allotted	8	10	3	4.8
Aggression - Embodiment	10	10	2	4.6
Unsafe - Chalky	6	1	2.6	4.8
Terrifying - Mouthpiece	10	7	1.6	5.2
Cholesterol - Commodities	11	21	3.6	5
Despised - Tomatoes	8	3	2.2	5
Fear - Note	4	127	2	5.2
Coward - Recipe	6	8	3	5
Shot - Cars	4	112	3	5.2
Sabotage - Necklace	8	3	2.6	6
Fight - Claim	5	98	2.6	4.6
Unprepared - Technician	10	6	3.6	5
Smashed - Texture	7	15	2.4	5
Shotgun - Sailors	7	8	2.2	4.8
Bleak - Merge	5	10	2.8	4.8
Pitiable - Resolves	8	3	3.2	5.2
Ambulance - Centrally	9	6	2	5
Raid - Coin	4	10	2.8	5.2
Disdain - Guitars	7	3	3	5.6
Humiliated - Waterproof	10	2	2	5.2
Denounce - Latitude	8	5	3.2	5.2
Dying - Lists	5	34	1.6	4.8
Victims - Smelled	7	19	2.2	4.6
Bombardment - Administers	12	1	3	4.8
Pathetic - Cleaners	8	8	2.2	5
Exterminate - Cultivating	11	2	3.2	6.2
Dole - Hare	4	1	2.8	5
Perverse - Boarding	8	5	2.6	5.4
Feud - Jade	4	1	3.4	5.8
Loathe - Arenas	6	3	1.8	4.8
Intruder - Swimsuit	8	1	2.8	5.4
Dull - Flew	4	27	3.4	5
Lacerate - Roommate	8	1	2.4	5.8
Curse - Juice	5	11	2.6	5
Afraid - Detail	6	57	2.6	5
Meaningless - Expressions	11	15	3.6	5.6
Demented - Baseline	8	1	2.4	5

Starving - Supplier	8	6	2	4.8
Abandoned - Component	9	25	1.8	5
Miserable - Sentences	9	13	2.4	5.2
Treacherous - Assessments	11	6	2.2	5
Enemy - Check	5	88	2.4	4.8
Robbed - Button	6	10	2.4	5

SET B3

Word Pair	Length	Frequency	Negativity	Neutrality
Idiot - Jumps	5	2	2.4	5
Cadaver - Paddock	7	1	2.8	5.6
Failure - Clothes	7	89	2.4	6.2
Sickly - Tokens	6	2	3	5.2
Tragedy - Request	7	49	2	4.6
Separation - Reflecting	10	17	3	5.6
Snubbed - Slipper	7	3	2.8	5.4
Disgusting - Percussion	10	4	2.8	4.6
Torrid - Resale	6	2	3.6	4.8
Anguish - Whereof	7	8	2.2	5.2
Cruelty - Handful	7	13	1.8	5
Fright - Sipped	6	2	2.8	4.8
Dread - Salad	5	9	2	5.6
Mutilated - Decanting	9	3	1.6	4.6
Errors - Origin	6	44	3.6	5
Nervous - Chances	7	24	2.8	5.8
Fugitive - Fronting	8	3	3	5
Distress - Creature	8	15	2.2	4.8
Fracture - Mudguard	8	1	2.6	5
Tormented - Mythology	9	3	2	6
Defective - Economies	9	7	3.4	4.6
Critized - Organise	8	14	2.4	5.4
Excluded - Hearings	8	8	3.2	4.6
Crippled - Paradigm	8	6	2.2	5
Firearms - Awaiting	8	7	2.6	4.8
Coronary - Junction	8	7	3.2	5.2
Bleed - Bugle	5	2	2.4	5.2
Woeful - Tandem	6	1	3.2	5.2
Abduction - Haystacks	9	1	2	5.2
Severe - Recall	6	39	2.6	5.2
Intolerable - Positivists	11	3	3	5.6
Alienated - Enrolment	9	6	2	5.2
Stalked - Listing	7	7	2.4	4.8
Negligent - Pavements	9	2	2.8	4.8
Missile - Speaker	7	48	3.2	5.2
Acid - Hull	4	13	3.6	4.8
Violated - Pavilion	8	4	2.6	5.4
Downfall - Enjoined	8	5	3.2	6
Henpecked - Stopovers	9	1	3.4	5
Worthless - Batteries	9	3	2.2	5
Brutal - Bucket	6	7	1.4	5
Flogged - Magenta	7	2	2.8	5.2

Belittling - Parachutes	10	1	2.2	4.8
Gruesome - Landings	8	2	1.8	5
Misery - Client	6	15	2.2	5.4
Deprive - Monitor	7	3	2.2	4.8
Firing - Barrel	6	24	2	5
Militant - Mobility	8	8	3.6	5.6

SET C1

Word Pair	Length	Frequency	Negativity	Neutrality
Derelict - Headland	8	1	2.4	5.2
Repulsive - Clustered	9	4	1.8	5
Noose - Valve	5	3	2.6	4.8
Accused - Glanced	7	25	2.8	5
Traitor - Matting	7	2	2.4	5
Lurking - Queries	7	3	3	4.8
Rejected - Quantity	8	33	2.2	5.2
Embarrassing - Manufactured	11	8	3	5
Flood - Gains	5	19	3.6	6
Terrorists - Traversing	10	1	2.2	4.6
Dismal - Midway	6	8	3	5
Decompose - Constance	9	1	2.8	4.8
Injury - Holder	6	27	2.4	4.8
Obliterate - Supervises	10	2	3.2	4.6
Lost - Read	4	173	2.8	5.6
Slanderous - Numerology	10	1	2	5
Fraud - Knelt	5	8	2.8	4.6
Deteriorate - Exemplifies	11	1	3.2	4.6
Nightmare - Formulate	9	9	2.4	5.4
Discredited - Variability	11	3	2.8	5.6
Earthquake - Similarity	10	9	3.4	5.2
Betrayed - Imported	8	8	2	5.4
Inaccurate - Downstream	10	5	3.6	5
Rape - Pies	4	5	1	5.2
Pulverised - Visualised	10	2	3	5.4
Sad - Pat	3	35	2.2	5.4
Artillery - Framework	9	11	3	5.4
Ghoul - Skips	5	1	3.2	4.8
Sadistic - Commutes	8	2	1.8	4.8
Collapse - Semantic	8	7	2.6	5
Casualty - Carpeted	8	3	2.2	5
Reexamination - Intermissions	13	1	3.6	5
Horror - Wagons	6	17	2	5
Confrontation - Commissioners	13	16	2.8	4.8
Violent - Thereby	7	33	1.6	5
Expelled - Biscuits	8	5	2.8	5.4
Jail - Loop	4	21	2.4	5
Discord - Floater	7	1	3.2	4.6
Hazard - Ballot	6	12	2.6	5
Incest - Outset	6	13	1.4	5
Forlorn - Keyhole	7	3	3.6	5
Rage - Flag	4	16	1.8	5

Mockery - Flicker	7	2	2.6	5
Drown - Tuned	5	3	2	5.2
Illness - Package	7	20	2.4	5.2
Destroyed - Furniture	9	39	1.8	5.6
Poor - Stay	4	113	2.4	4.8
Burial - Dozens	6	11	2.2	5

SET C2

Word Pair	Length	Frequency	Negativity	Neutrality
Mourn - Scans	5	2	2.2	5
Numb - Hike	4	4	2.6	5
Persecution - Illustrates	11	7	1.8	5.4
Worry - Inner	5	55	2.6	4.8
Derision - Pictured	8	4	3.2	5
Enraged - Beehive	7	1	1.8	5.2
Poverty - Founded	7	20	2.2	5
Ugly - Port	4	21	2.2	5.2
Surgeon - Poultry	7	11	3.2	4.6
Ridicule - Mechanic	8	5	2.8	5.2
Cremated - Broccoli	8	1	2.6	5.8
Futile - Attire	6	6	3	5
Slavery - Charter	7	33	2.4	5.2
Suffered - Recorded	8	43	2.2	5
Derogatory - Transistor	10	1	2.4	5
Criminals - Dialectic	9	6	2.8	5
Deathbed - Softener	8	2	1.6	5.6
Scapegoat - Firsthand	9	1	3.2	5.2
Scandal - Veranda	7	8	2.8	5.6
Exploit - Benches	7	9	2	4.8
Condemned - Assurance	9	19	2.6	6.2
Squeamish - Billboard	9	1	3.4	5.2
Intimidated - Coefficient	11	3	2.6	4.6
Grave - Filed	5	33	2	5
Incarcerated - Orientations	12	1	2.4	5
Shriek - Towers	6	5	3.2	4.8
Bomb - Crew	4	36	2.2	5
Gagged - Grocer	6	1	2.6	4.6
Revulsion - Riverside	9	10	2.2	5.6
Ignored - Players	7	29	2.6	5
Dead - Data	4	174	1.8	5
Inattentive - Supermarket	11	1	3.6	5
Venom - Nudge	5	2	2.4	4.8
Breakdown - Electoral	9	13	3	5.2
Gnawing - Hauling	7	4	3.2	4.8
Irresponsible - Apportionment	13	9	2.6	4.8
Carcinoma - Grassland	9	1	1.6	5.6
Dissect - Inflate	7	1	3	4.6
Bloodshed - Correlate	9	3	2	5.2
Merciless - Summarise	9	3	3	5.6
Abuse - Crops	5	18	1.8	5
Apprehension - Instrumental	12	11	3.4	5

Whipped - Descent	7	12	2.4	4.8
Cannibals - Parallels	9	2	2.2	5.2
Perplexed - Outlining	9	2	3.6	5
Murder - Junior	6	75	1.2	4.8
Disliked - Rotation	8	11	3.6	5
Stab - Clam	4	3	2.2	4.6

SET C3

Word Pair	Length	Frequency	Negativity	Neutrality
Despair - Pitcher	7	21	2.4	5
Outcast - Gullies	7	1	2.8	4.2
Death - Quite	5	277	2.2	4.8
Contagious - Hyperbolic	10	2	2.8	4.6
Gouge - Cluck	5	3	3.2	5.4
Petrified - Corridors	9	2	2.2	4.8
Mortality - Occupants	9	9	3	5.2
Evil - Hill	4	72	1.8	5.2
Daunt - Fuels	5	1	3.6	5.4
Unemployed - Measurable	10	5	2.8	5
Detrimental - Floorboards	11	4	2.6	5
Blackmail - Storyline	9	2	1.8	5.8
Scared - Planet	6	21	2.4	5.4
Frenzied - Messhall	8	1	3	4.8
Crazy - Roles	5	34	3.6	4.8
Burden - Amount	6	44	3.2	5
Angry - Curve	5	45	2	5.2
Ridiculed - Catalysts	9	2	2.2	4.8
Hearse - Rafter	6	1	2.6	4.8
Crucifying - Paraphrase	10	2	2	4.8
Nausea - Confer	6	3	2.6	4.6
Manslaughter - Environments	12	4	1.6	6
Struggle - Agencies	9	8	2.6	4.8
Impoverished - Necessitates	12	3	2.8	4.8
Disaster - Inherent	8	26	2	4.8
Ghastly - Rotunda	7	6	2.8	4.8
Threaten - Invested	8	11	2.2	4.8
Tease - Aisle	5	6	2.6	5.2
Ruin - Fork	4	14	3	5
Unsatisfactory - Implementation	14	8	3.4	5.8
Suicide - Motions	7	17	1.6	5.2
Crash - Solve	5	20	2.2	6.2
Condescending - Mathematician	13	2	3	5
Switchblade - Wholesalers	11	1	2.4	5.2
Dismayed - Roadways	8	1	3.6	5
Catastrophe - Approximate	11	11	2.2	4.8
Ailing - Cloves	6	2	3.4	5.2
Fatal - Dairy	5	19	1.8	5.4
Ammunition - Hypothesis	10	18	3	5.6
Revolver - Diagonal	6	14	2.4	5
Brawl - Affix	5	1	2.6	4.6
Awful - Tract	5	17	2.6	5

Shocking - Performs	8	4	3.2	5.8
Funeral - Thermal	7	33	2	5.2
Suspicious - Spectators	10	13	2.4	5.2
Inhuman - Sloping	7	7	2.2	4.6
Worst - Owned	5	34	2.4	4.8
Restless - Mutually	8	13	3.4	6

Appendix D

ANOVA RESULTS ON WORD SUBSETS

Table 1

Table of Mean Frequency, Length, Negativity and Neutrality for Each Word Subset, and ANOVA Results on Comparisons of Subsets

Subset	Frequency Mean (S.D)	Length Mean (S.D.)	Negativity Mean (S.D.)	Neutrality Mean (S.D.)
A1	15.02 (20.89)	7.52 (2.15)	2.56 (.52)	5.17 (.38)
A2	14.56 (17.85)	7.45 (1.94)	2.55 (.52)	5.15 (.42)
A3	13.95 (19.50)	7.52 (2.08)	2.54 (.52)	5.17 (.38)
B1	15.39 (23.85)	7.22 (1.90)	2.58 (.54)	5.01 (.32)
B2	17.60 (29.37)	7.29 (2.29)	2.57 (.52)	5.12 (.38)
B3	11.25 (16.74)	7.47 (1.50)	2.60 (.56)	5.15 (.38)
C1	15.54 (29.38)	7.50 (2.42)	2.55 (.60)	5.05 (.30)
C2	15.06 (28.06)	7.62 (2.27)	2.54 (.57)	5.06 (.33)
C3	18.02 (40.82)	7.66 (2.52)	2.58 (.54)	5.08 (.42)
	F (8,423) = .27, *ns*	F (8,423) = .27, *ns*	F (8,423) = .08, *ns*	F (8,423) = 1.11, *ns*

Appendix E

ROTATION OF WORD SETS

Table 1.

Rotation of word sets.

	ROTATION								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
TASK									
Pre-Stroop	A1	A2	A3	B1	B2	B3	C1	C2	C3
Pre-Dot	A2	A3	B1	B2	B3	C1	C2	C3	A1
	A3	B1	B2	B3	C1	C2	C3	A1	A2
*Training	B1	B2	B3	C1	C2	C3	A1	A2	A3
	B2	B3	C1	C2	C3	A1	A2	A3	B1
	B3	C1	C2	C3	A1	A2	A3	B1	B2
Post-Stroop	C1	C2	C3	A1	A2	A3	B1	B2	B3
Post-Dot	C2	C3	A1	A2	A3	B1	B2	B3	C1
	C3	A1	A2	A3	B1	B2	B3	C1	C2

* **Note** - Each of the 3 subsets which total 144 word pairs in training, were given 4 times during training to make up the 576 training trials (i.e., the word sets in training were repeated).

Appendix F

INSTRUCTIONS

Greeting –

Thank you for coming. First I would like you to read this form and sign it if you agree to participate in the experiment (give information and agreement form). I would also like you to fill out these questionnaires (give STAI, BDI).

Practice –

Now we are going to start with some practice.

First, this scale will appear throughout the experiment (visual analogue scale). To see the scales you must first press the three mouse buttons together. Then, you need to move the mouse along the scale and click the button, as to where you feel on the scale *right at the moment* you are doing the scale. There are two different scales. This one measures anxiety, and you rate how you feel along the scale from relaxed to anxious (do anxiety scale). This one measures depression, and you rate how you feel along the scale from happy to depressed (do depression scale). Remember, it is important that you rate where you feel right at the very moment you are doing the scale.

Now you are going to get a practice at the tasks you are going to complete in the experiment. There are three tasks that you are going to receive throughout the

experiment, and you will receive blocks of each task, which will be given in various orders.

One task is COLOUR NAMING. Here are the colours of the words you will see (show colours on screen). Your task is to name the colour of the word by speaking aloud, as quickly as possible, while ignoring the content of the word. The throat mike picks up your response so you need to be as quiet as possible in other ways (coughing etc) during the colour naming task. Also, the first sound you make must be the response that you wish to give, so try not to say "umm/err" before the colour. Press return and you will get a practice at the colour naming trials (participant does 12 practice trials).

Another task that you will do is a DOT-PROBE task. You will see two words, which will disappear, and following these a probe will appear where one of the words was. It will be either one or two red dots. If it is one red dot then press the left key on the response box. If it is two dots press the right-hand key on the response box. This is a reaction time task, so you need to respond as quickly and as accurately as possible whether one or two dots appeared. Press return and you will get a practice at the dot-probe trials (participant does 12 practice trials).

Another task that you will do is an ANAGRAM task. Have you done anagrams before? So you know that they are jumbled words, and your task is to unscramble them. This task is a part of the psychology department's ongoing research program into the relationship between academic performance and cognitive tasks. An association has been

established between intelligence and the ability to solve anagrams. You will be presented with anagrams on the screen. When you have unscrambled it, press the YES button, and write your answer down on this sheet of paper. If you cannot solve the anagram, press the NO button, and the next anagram will appear on the screen. In the experiment you will be given three minutes to solve as many anagrams as you can. Don't spend too long on any one set of letters, if you are stuck, just press NO and go on. The task will be videotaped, and I will just turn it on (turn video camera on, adjust lens and point it at participant), and you will be rated according to your performance on the task. Although it is not likely, if your score is in the upper or lower ten percent, you will be asked whether you are prepared to give you permission for the videotape to be used in the research examining the link between intelligence and anagram solving ability. Press return and you will get a practice at the anagrams (participant does 4 practice anagrams).

Just before we start the real experiment, I would like you to do a self-rating scale yourself (participant does visual analogue scale).

Now you are ready to begin the experiment. Just before I leave, have you got any questions? I will leave now, press return to begin when I am out of the room.

DEBRIEFING STATEMENT

Thankyou for completing the experiment. There is not going to be another anagram task. In fact the anagram task was a bogus task. The anagrams you received were mostly impossible to complete due to letters being removed from them so that they were not

solvable. Everyone was told they were in the bottom 10%, and the anagram task is not a measure of intelligence. There was no tape in the video camera, and there is no real research looking at the link between intelligence and anagram solving ability. The reason why I got you to do this task was as a measure of how you react to a stressful situation. Do you have any questions you would like to ask about the experiment? Did the anagram task seem legitimate to you, or were you suspicious? Did you detect any relationship between the probes and the words?

Thankyou, you can go now, but please make sure you do not tell anyone else about this experiment, it is very important you do not tell any of your classmates about it.

Appendix G

INFORMATION AND AGREEMENT FORM

This experiment involves investigating how attention is allocated when people process information.

You will be asked to follow a computer program, where you will do different tasks including detecting whether a one or two dot probe appears on screen, and naming the colours of words presented on screen. You will be given practice trials at the beginning to familiarise yourself with these tasks.

All information will be kept strictly confidential. I am interested only in group results and not information relating to any individual, so please do not put your name on any of the questionnaires. Information from the computer program and the questionnaires will be identified only by a code.

The experiment will take approximately 1 hour to complete. You are free to withdraw from the experiment at any time.

I (the participant) have read the information above. Any questions I have asked have been answered to my satisfaction. I agree to participate in the experiment, realising that I can withdraw at any time.

I agree that research data gathered for the study may be published provided my name is not used.

_____ _____

Participant Date

_____ _____

Investigator Date