UNIVERSITY OF SOUTHAMPTON

A Multi-Method Study of Anxiety

Christine Pett

Doctor of Philosophy

Department of Psychology, Social Science Faculty

September 2000

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF SOCIAL SCIENCE
PSYCHOLOGY

Doctor of Philosophy

A MULTI-METHOD STUDY OF ANXIETY

by Christine Pett

Anxiety can be seen as an enduring personality trait or a situationally dependent state. It is manifest in a variety of ways, through physiological changes, as a subjective experience and as an attentional bias for threatening information. Up until this point these three different types of indicators had not been used simultaneously.

Experiment 1 used the Spielberger State Trait Anxiety Inventory (STAI) to record subjective perception of anxiety. In order to measure attentional bias two methodologies were used concurrently. A computer-administered emotional Stroop was used which tested participants' attention to physical and social threat words, both when presented subliminally and supraliminally. A picture dot probe technique directly measured attention to and avoidance of severe and moderately threatening pictures (taken from the IAPS). 40 undergraduate participants attended two sessions two weeks apart in a test-retest design. No significant attentional bias effects were found.

Experiment 2 employed the same design as Experiment 1 with an additional dependent variable of electrodermal activity (EDA). Again, participants were tested twice, with a two week interval. No significant attentional bias effects were found on a sample of 29 undergraduate students and there were no effects of anxiety found on the physiological measure.

Experiment 3 investigated the source of negative findings on the cognitive measures further by using a sample of 33 non-student participants and comparing the convergent validity of a paper version and a computer version of the Stroop task used in studies one and two. Again, no significant attentional bias effects were found with either the computer or paper version.

The effect of elevation of state anxiety was investigated in Experiment 4 by testing 43 undergraduate participants two months and one week prior to their final exams. These participants were selected for extreme scores on the trait scale of the STAI and for low scores on the Marlowe-Crowne index of defensiveness. The high trait participants showed a mean elevation of 5.4 points on the state scale of the STAI, the low trait participants showed an elevation of 6.2 points. Even in the high state situation, one week before exams, there was no evidence of attentional bias. Additionally there was no effect of state or trait anxiety on the dependent physiological variables.

In the fifth and final experiment, 40 undergraduate participants completed the STAI, dot probe and Stroop measures prior to and immediately following the administration of a combined public speaking and mental arithmetic stressor. An additional dependent measure used was salivary cortisol concentrations. No significant effects of state or trait anxiety were found on the attention or physiological measures although the public speaking task did elevate state anxiety by 14.8 points in the high trait group and 11.1 points in the low trait group.

In studies one to five the Marlowe-Crowne Social Desirability scale was used to measure defensiveness. These data were pooled and it was found that there was no evidence of an impact of repressors on the data. To conclude, no attentional bias or physiological effects were found. The lack of physiological effects were explained with reference to the literature which indicated that the effects were often elusive, particularly when only one dependent physiological measure was used. The lack of attentional bias effects were explained by re-analysis of the existing literature. Following Rosenthal (1995) it was calculated that the existence of 22 unpublished, non-significant studies would render the overall effect non-significant and that the existence of this number of studies was highly probable.

Contents

List of Tables

Note

All reaction times are in m.s. per word unless otherwise stated.

Standard deviations are shown in subscript parentheses unless otherwise stated.

List of Figures

Acknowledgements

First and foremost my thanks go to Professor Jim Stevenson. He showed me that adherence to the principles of empiricism is its own reward and above all else taught me the value of perseverance. I will carry the lessons he taught me throughout my career.

Particular thanks go to Dr. Andrew Mathews and Bundy Mackintosh who were so generous in giving access to their methodologies and so supportive when I couldn't get them to work. Thanks also to Southampton General Hospital Endocrinology Unit.

Also thanks to Martin Hall for his technical expertise. Dr Paul Morris and Professor Tony Gale for inspiring me to get interested in psychology enough to want to do a PhD in the first place.

Personal thanks go to Mum and Dad, Candy Medusa, the Amazing Tess Roberts, Donal Campbell, Simon Hett, Dave Roberts, Debbie Pye, Simon Walton, Susie Bennie, Jan LaPorte, Chris Warry, Charlie Sutherland, Lee Sutherland and Grumpy, who each supported me in some way and at some point during this process.

Most of all to Steve Buckley, I couldn't have done it without you. Thank you.

Foreword

Originally this PhD was planned as a Behavioural Genetic study of anxiety. The aim was to examine the genetic and environmental contributions to the different aspects of anxiety: physiological, cognitive, subjective and behavioural. However, twin study methodology, necessitates reliable measurement techniques. Thus, when studies one and two showed that the physiological and cognitive measures had no significant test-retest reliability, the focus of the study was changed, and the behavioural genetic approach was abandoned.

Overview

Each of the five studies reported here investigated the phenomenon of anxiety, using a variety of different indicators, with the overall aim of explaining in more detail the precise nature of the phenomenon. The poet W.H. Auden said that, "The twentieth century is the age of anxiety," (Auden & Mendelson, 1977) an observation that holds true at the start of the 21st. Quotes such as this and reports, which indicate that, "Anxiety disorders are the most common of all the mental disorders" (Akiskal et.al., 1997), formed part of the impetus behind this thesis.

Although the prevalence rates of clinical anxiety are very high, the studies in this thesis focused on normal populations. This was because, although, at extreme levels anxiety can be seen to be maladaptive, from an evolutionary perspective it serves a useful function which is to alert the individual to potential sources of danger. Since the aim of this thesis was to flesh out the understanding of the nature of anxiety it seemed reasonable to begin by looking at anxiety as it occurs in a normal population before looking at extreme cases. Clinical anxiety disorders have therefore deliberately not been made a focus of investigation, and are only discussed in relation to "normal" levels of anxiety.

Literature review

This narrative review is separated into two parts, theoretical issues and methodological issues. The first section covers subjects such as what the term "anxiety" is used to mean, and what theoretical viewpoints have been suggested to explain the construct. The second section deals with issues relevant to the use of subjective, cognitive and physiological methodologies that were employed in studies one to five. It should be noted that this second part of the literature review section concentrates mainly on conceptual explanations rather than empirical evidence. That is because more detailed analyses of empirical findings is placed in the introductory sections of studies one to five where it is more relevant.

Theoretical review

What is anxiety?

Since the purpose of this thesis is to aid understanding of the nature of anxiety it is worth spending time describing what is meant when the term is used and examining dominant theoretical models which attempt to explain the phenomenon.

Problems with definition

In order to talk usefully about the measurement of any phenomenon, that construct must be operationalised. But, as Sarason and Spielberger (1975) noted, "Clarification of the nature of anxiety as a scientific concept has generally followed the development of new procedures for the assessment of anxiety." Their argument was that the process should be the other way around, measurement procedures should be developed on the basis of a clear definition of the variables to be measured but that this process is, "seldom realised in psychology or psychiatry," (Sarason & Spielberger, 1975).

The study of anxiety is not confined to one branch of psychology or even to psychology alone, and problems with definitions often arise as a result of the different perspectives. Between disciplines there is a degree of consensus on general definitions of anxiety, there is almost an unspoken accord about the nature of the concept. The disparity arises when specific indicators are considered. For example, a physiologist is comfortable to define anxiety in terms of an increase in palmar conductivity and heart rate, whereas a

cognitive theorist may define anxiety in terms of information processing deficits. Alternatively, health psychologists generally see the extreme of anxiety as an emotion which can impair mental and physical functioning and thus the individual's ability to function normally within society.

In the words of Levitt (1968) "None of these definitions is the ultimate definition. Rather each is a partial definition, a paradigm or typical instance of anxiety." If the problem of a definition cannot be overcome, this is prima facia grounds for the subsequent inconclusive nature of research results and implications.

There are two ways in which anxiety as a construct is harder to "pin down" than other comparable constructs, firstly, due to the confusion of boundaries between other constructs such as fear or arousal (discussed in more detail below), secondly, because anxiety can take the form of a state or trait variable.

The state/trait anxiety distinction - Anxiety as a mood, emotion or temperament.

Cattell and Scheir (1966) described the distinction between state and trait anxiety most clearly as follows, "The term anxiety can be used to refer either to a transitory state or as a habitual anxiety proneness or stable personality trait." Thus an anxious state is caused by aversive (anxiety inducing) stimuli - it is a situation dependent reaction. Trait anxiety is, like other personality traits, a description of a person's underlying disposition. The trait is perceived to lie on a continuum from low to high, a very high trait anxious individual may display so many anxious symptoms that they are classed as clinically disordered.

Fridhandler (e.g. 1986) went further and distinguished state and trait anxiety in terms of three dimensions, duration, manifestation and causality, this is shown in Table 1 below.

Table 1 Fridhandler's state and trait anxiety descriptors

Dimension	Trait anxiety characteristic	State anxiety characteristic
Duration	Long	Short
Manifestation	Continuous	Reactive
Causality	Personal	Situational

Although Fridhandler makes a clear distinction between these two forms of anxiety he does not clarify what, if any, the relationship between them might be. It would seem reasonable to assume that an individual's reactions to situational stressors (state anxiety

reactions) are in some way influenced by the dispositional nature of that individual. Spielberger (1972) stated that, "Persons who are high in trait anxiety are more vulnerable to stress and respond to a wider range of situations as dangerous or threatening. Since individuals who are high in trait anxiety are more disposed to see the world as dangerous or threatening, they experience state anxiety reactions more frequently, and often with greater intensity than do people with lower trait anxiety." This has important implications for studies 4 and 5 of this thesis since they involved manipulating levels of state anxiety. If, as Spielberger suggests, high trait participants are more likely to respond with greater intensity to a stressor, then it will be difficult to compare the effects of a stressor on a low trait group and a high trait group since they will be affected differently by the same stimulus. There is no way around this problem, the best that can be done is to monitor state anxiety elevations in different trait anxiety groups and to incorporate the findings when interpreting any results.

The terms "state" and "trait" anxiety are used throughout this thesis, and throughout the published literature. However, anxiety should also be seen in relation to the wider arena of all emotions and personality traits (or "affective constructs"). Researchers of other affective constructs do not have such well-defined and useful terminology as researchers of anxiety do in the simple and parsimonious "state" and "trait". The terms mood, temperament, disposition, personality trait, sentiments, and others are used in relation to other affective constructs in a variety of contexts, often meaning different things. Should these terms be used in relation to anxiety also? Is it simplifying things too greatly to rely on two words "state" and "trait" when other constructs seem to require a more extensive lexicon? Ekman and Davidson, in their 1994 book, devote a chapter to replies from researchers such as Frijda, Kagan, Lazarus and Panksepp to the question "How are emotions distinguished from Moods, Temperaments and other related affective constructs?" Each of the researchers, in one-way or another distinguished not two (state and trait) but *three* levels of affective construct.

Generally there is acceptance of the need to distinguish affective reactions which go under the general heading of "emotions" from other affective constructs. These are characterised as reactions to external stimuli which are brief in duration (a few minutes) and are often accompanied by physiological change. The second level of affective reaction is distinguished from emotions by virtue of duration, the term which seems to be most commonly used for this type of reaction is "mood". This affective construct is, like an emotion, caused by external stimuli, but lasts longer than a few minutes, it may extend to

days or weeks. It will arise as a result of repetition of the same emotion again and again, thus, if someone repeatedly feels angry that may result in an irritable mood. Finally, the third type of affective construct was often referred to by the terms temperament and trait, they were used almost interchangeably to describe an enduring characteristic of an individual's character. The possible difference between the two terms "temperament" and "trait" is that temperament is usually used with the caveat, 'as a result of developmental experience' and the term trait is generally ascribed a genetic basis.

The consensus seems to be that there are three levels of affective constructs, emotions, moods and personality traits. As discussed previously, Fridhandler used three dimensions to distinguish between state and trait anxiety, duration, manifestation and causality, these three dimensions have been applied to the three affective constructs identified from the literature, this is shown in Table 2 below.

Table 2 Fridhandler's state and trait anxiety descriptors applied to the constructs of emotion, mood and personality.

Dimension	Personality characteristic	Mood characteristic	Emotion characteristic
Duration	Long	Medium	Short
Manifestation	Continuous	Reactive	Reactive
Causality	Personal	Situational	Situational

Personality characteristics are long in duration, they are continuous in manifestation and are personal in causality, these characteristics are all in common with trait anxiety. Emotions share the same characteristics as state anxiety since they are short in duration, reactive in manifestation and caused by situational events. Moods fall between these two phenomena on the basis of duration. Duration is the only dimension which separates moods from emotions, both moods and emotions are caused by situational variables and are reactive in manifestation but moods last longer than emotions. Nevertheless, purely in terms of duration, moods are still more similar to emotions than traits. Trait lasts the course of an individual's life span with only slight variations while a mood would need to last a number of years before it could be considered closer to a personality trait in duration than a fleeting emotional reaction. This may be why only two terms have emerged in the anxiety field, trait and state. It would seem that trait anxiety shares all the characteristics of any other personality trait and that state anxiety acts as a blanket term to refer to the reactive constructs of both moods and emotions. State anxiety

is supposedly accompanied by a physiological response similar to flight or fight responses, and is elicited by discrete, situational stimuli, such as being called on to speak in public, in the same way an "emotion" is. In the literature the term state anxiety is also used to indicate a mood which lasts a few days at least. For example, MacLeod and Mathews (1988) tested an undergraduate sample when their state anxiety was low, at the beginning of term, and when it was high, one week before final exams. Thus the clear implication is that the term 'state anxiety' indicates a state which lasts at least as long as a week.

The distinction between emotion and mood that is made in the individual differences literature is not apparent in the anxiety literature. Certainly in the literature on cognitive biases associated with anxiety, comparisons are drawn between studies which look at anxiety elevated over a period of days and those in which anxiety is elevated over a period of minutes (e.g. Mogg, Bradley & Hallowell, 1994). In which case it seems reasonable to conclude that both types of studies are looking at state anxiety, but that the former pertains to chronic state anxiety and the latter acute.

The main criterion which Clark, Watson, and Mineka (1994) use to distinguish between moods and emotions is duration. They further define emotions as responses "to specific types of events, and each gives rise to characteristic forms of adaptive behaviour," and moods as "transient episodes of feeling or affect." In this, emotions and moods are distinguished in terms of the clear functionality. However, they do consider them under one heading "transient affective episodes" or the alternative term coined by Cattell and Scheir (1961) "State affect". The other heading, under which they discuss enduring individual characteristics, is "Trait Affect and Temperament". In other words, they consider mood and emotions to be more similar to each other than to emotional traits or temperamental dispositions.

In summary, the term 'state anxiety' should be viewed as a descriptor for those aspects of anxiety which are relatively transient and not of a dispositional nature. But it should not be taken to equate solely with either the concept of mood or of emotion. Thus, even researchers such as Clark, Watson and Mineka, who are concerned with making a distinction between mood and emotion still revert to the term "state affect" to distinguish these types of reactions from temperament. In the five experiments which are reported in this thesis, and in most other research concerned with anxiety, this is the crucial distinction. Thus for practical reasons the terms state and trait anxiety are deemed sufficiently accurate to investigate the phenomenon that is anxiety.

Attempts at defining state anxiety

Epstein noted that anxiety was often confused with fear and general arousal. This may have been the reason why he gave two interpretations for anxiety, "As a state of diffuse arousal following the perception of threat, or alternatively as unresolved fear." (Epstein, 1982) However, he neglected to make clear the fact that here he is describing state anxiety alone. Theoretical orientation frequently dictates the definition of anxiety, there are however a few basic aspects of anxiety which the majority of researchers agree upon.

State anxiety has been well recognised as specific and different from similar emotions. Anxiety is generally regarded as distinguishable from its closest "relation" fear. Certainly, anxiety has a fear component but it is generally distinguished by the focus of the emotion. Fear is centred on something real, tangible, objective; anxiety characteristically lacks focus, with a less obvious source, it is far more subjective (and as a consequence more difficult to examine empirically). Thus, anxiety is generally accepted as a discrete construct, with a number of defining characteristics. Anxiety is uniformly regarded as a negative emotion, for example, where joy is positive, pleasant and agreeable, anxiety is negative, distressing and unpleasant. Yet for all that anxiety is a negative affect, it is almost universally agreed to be a necessary feature of the human condition. Stokvis and Bolten (1963) described anxiety as, "The mother of the drive to know, without which there would be no impetus to learning or improvement." Anxiety is seen by the majority of researchers (e.g. Levenson et al., 1992) as having evolved to serve a variety of survival related functions, for example, to recruit physiological change (recalling the fight/flight response) and ready the individual for action. More recently, Mathews (e.g. Mathews, 1997) in focusing on the associated attentional biases has highlighted how the functional aspect of anxiety is not limited to bodily changes but applies to cognitive changes also, "Perceptual cues need to be identified rapidly and attended to vigilantly." (Mathews, Mackintosh & Fulcher, 1997.)

To recap, state anxiety has been conceptualised as a specific emotion which is negative but functional and is characterised by a subjective fear of what may be an objectively non-threatening stimulus. Unfortunately that is as far as inter-disciplinary research agreement extends, further attempts to characterise the precise nature of anxiety are divided.

An argument has been put forward by Hallam (1994) that anxiety does not exist as an entity at all, echoing that made by Sarbin in 1964. Sarbin proposed that the word anxiety is derived from the Old French anguisse. "It represented a state of spiritual suffering and was therefore an aspect of religious faith." (Hallam, 1994) "The implication of Sarbin's argument is that we should revert to regarding reference to "anxiety" as metaphorical - as a way of communicating, in a shorthand way, about a more complex dislocation in a person's life, but not the manifestation of a unitary state of anxiety or inbuilt emotion" (Hallam, 1985). However, it is hard to conceive of a way in which anxiety could be removed from general usage and returned to the more abstract nature which Sarbin seems to wish to ascribe it (Sarbin, 1968). Maybe in it's original guise it did lack substantiation, but in the centuries which have passed it seems to have assumed palpable existence, perhaps this echoes Auden's observation that, "The 20th Century is the age of Anxiety."

Attempts at defining trait anxiety

The preceding section which dealt with state anxiety is useful for a discussion of the nature of trait anxiety since trait anxiety can be considered as a tendency to experience state anxiety symptoms. A person high in trait anxiety will experience state anxious reactions more frequently and to a greater degree than a person who is low in trait anxiety. Thus, when considering a definition of trait anxiety the main characteristics have been already been described. However, an outstanding question is how trait anxiety has been distinguished from other similar traits. Although it has frequently gone by another name, in essence anxiety as a trait is regarded as distinct from other traits to a much greater degree than anxiety as a state is regarded as different from other emotions such as fear. When confusion occurs it is generally at the level of labels, so for example, Eysenck's "neuroticism" dimension may be linked with anxiety, or, anxiety may go by the label "emotional stability" as in the "big five" taxonomy.

In Eysenck's model (Eysenck, 1967) he makes a distinction between neuroses and anxiety on the basis of cause and manifestation. Eysenck distinguished between different levels of description, see Figure 1.

He describes level 4 as the general level of an individual's anxiety and level five as the liability of that person to suffer neuroses and ultimately neurotic breakdown. Thus Eysenck does acknowledge that general anxiety levels are a feature of an individual's personality.

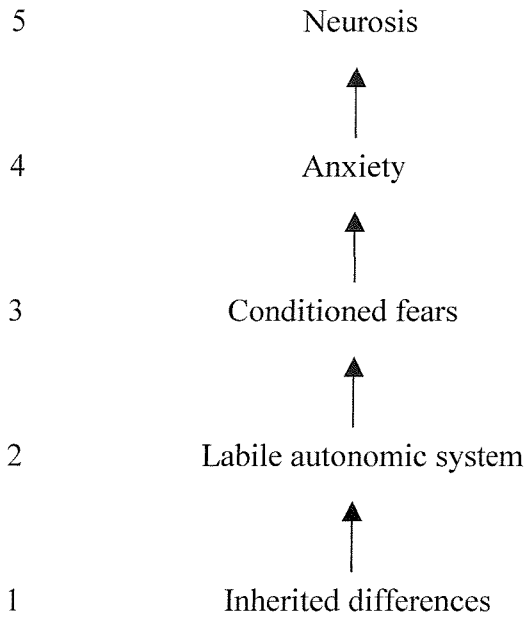


Figure 1 Anxiety in terms of Eysenck's five levels of description

In summary, when the term "state anxiety" is used in this thesis it will be used in the same way as MacLeod and Mathews (1988) implied, a short lived mood which can last up to a week and can be influenced by external events. "Trait anxiety" will refer to an enduring, stable personality characteristic.

Theoretical explanations of anxiety

The aim of the previous section was to describe how the terms state and trait anxiety differ and what researchers use them to refer to. This was done in order to arrive at a clear understanding of what is meant by the terms state and trait anxiety when they are used subsequently in this thesis.

The focus of this section is the theoretical explanations of anxiety which have been suggested.

Spielberger's theory of state and trait anxiety

Spielberger (1966) tried to explain anxiety taking into account the dual nature of state and trait manifestations. The following diagram is taken from his 1966 book and shows the pathway between perception of an external stimulus to an externally manifested behaviour (see Figure 2).

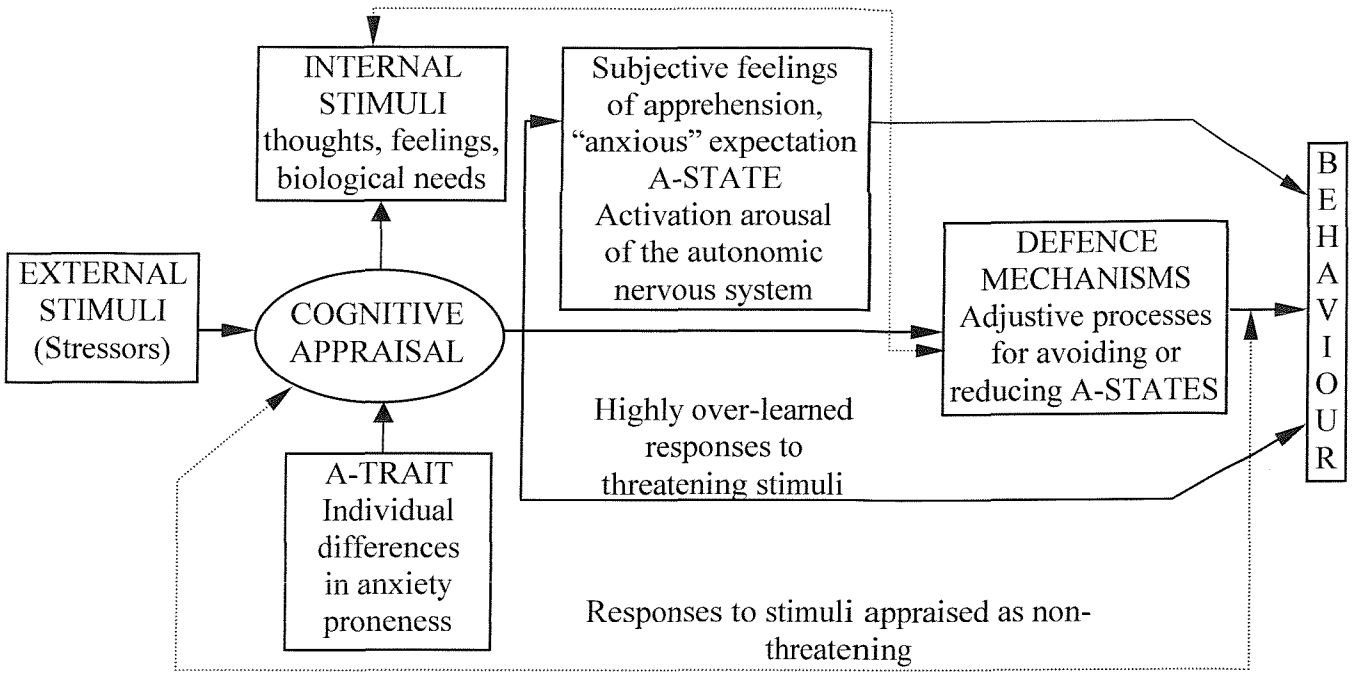


Figure 2 Spielberger's conception of the relationship between state and trait anxiety

Spielberger accompanied this diagram with the following explanation: "A trait-state conception of anxiety in which two anxiety concepts, A-trait and A-state, are posited and conceptually distinguished from the stimulus conditions which evoke A-state reactions and the defences against A-states. It is hypothesised that the arousal of A-states involves a sequence of temporally ordered events in which a stimulus that is cognitively appraised as dangerous evokes an A-state reaction. This A-state reaction may then initiate a behaviour sequence designed to avoid the danger situation, or it may evoke defensive manoeuvres which alter the cognitive appraisal of the situation. Individual differences in A-trait determine the particular stimuli that are cognitively appraised as threatening." (Spielberger, 1966, p.17)

Spielberger's detailed model of anxiety can be classed as an appraisal theory. The conception of trait anxiety as an individual difference which mediates cognitive appraisal has been supported in the literature by attentional bias experiments examining the relative roles of state and trait anxiety. (The cognitive biases associated with anxiety are discussed further on page 29.)

Cognitive appraisal is a central feature of this model and mediates all inputs and outputs. This model is particularly relevant to this thesis because Spielberger recognises

that four outputs concerned with anxiety can be measured at any one time, autonomic arousal, subjective feelings, behaviour, and "over-learned responses" which, when viewed along the role of cognitive appraisal, could be perceived as an early conception of attentional bias. This mirrors the multi-measurement approach adopted in this thesis.

Spielberger's theory was included here because it is one of the most comprehensive of its time, and probably still deserves that label, even though it is not current in the literature. It at least is an acknowledgement of an attempt to interpret the varied facets of anxiety.

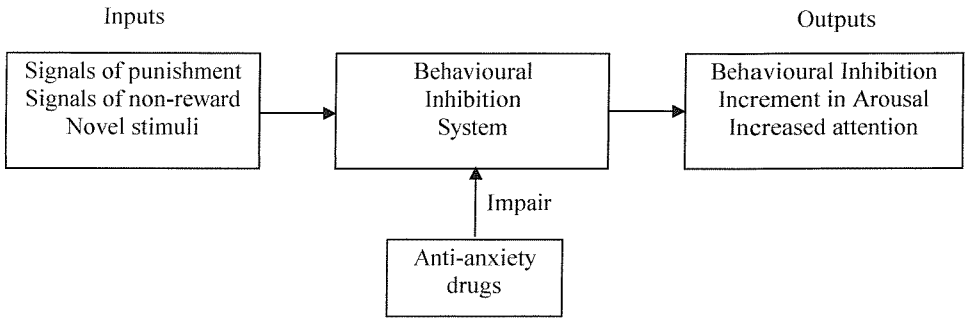
Gray's theory of Behavioural Inhibition

James-Lange, Cannon and Schachter's physiological approaches to emotion research were neatly coined in an anecdote reported by Gray (1994):"There is an old story, set for some reason in a street in Amsterdam, where one night a policeman sees a man looking for his watch under a lamp-post. The following dialogue ensues. 'Where did you loose the watch?' 'Over there,' replies the man, pointing to a spot fifty yards away. 'Then why are you looking over here?' 'Because the light is brighter.' "

In other words, Gray is suggesting that the early theorists were limited to studying what the methods of the day could shed light upon, namely autonomic and endocrine system reactions.

Perhaps as a result of equipment refinement, physiological theories nowadays manifest themselves in studies concerning brain function. In particular, Gray's (1971) theory of behavioural inhibition/activation system is regarded as the forerunner of the neuropsychological field.

Figure 3 Gray's behavioural inhibitions system, taken from Rawlins, Feldon, & Gray, 1980)



The behavioural inhibition system is viewed as an anxiety system which inhibits behaviour in response to potentially threatening information and anti-anxiety drugs. Gray

proposes that the septo-hippocampal region of the brain is responsible for the behavioural inhibition system and that activation of this system prepares the individual for action, accompanied by heightened awareness of the surrounding environment (see Figure 3 above).

Gray acknowledges that support for his theory mainly comes from drug studies. Fowles (1987) says that Gray's work stemmed from an attempt to understand, in learning theory terms, the effects of anti-anxiety drugs such as alcohol, barbiturates and tranquillisers. Gray found that the activation of the septo-hippocampal region results in an increase in levels of seratonin and noradrenaline and anxiolitic drugs act to lower the levels of these neurotransmitters.

The implications for autonomic responses were discussed by Fowles (1980). He noted that Gray proposed that the behaviour inhibition system had input to a non-specific arousal system, which Gray identified as the reticular activating system which results in an increase in electrodermal activity.

The implication for cognitive measurement is that the heightened awareness of surrounding environments (arousal) will be reflected in attentional measures such as dichotic listening tests and allocation of visual attention tests, which echoes the Stroop task results mentioned in the following sections.

Oatley's appraisal theory

Oatley (e.g. Oatley & Johnson-Laird, 1987; Oatley, 1992) suggested another emotion appraisal theory. They suggested that the role of emotion is to signal an event which is relevant to desired or undesired outcomes and suggest that the data are best explained by a prioritisation model. Oatley and Johnson-Laird hypothesised that there are two pathways by which emotions regulate the priority assigned to events, and that the two systems differ in terms of evolutionary age. The older system consists of "pure" emotional signals which have no propositional structure they just "set" the system into a certain state. The second type of signal is propositional and guides the fine action of prioritisation. Also central to their theory is the concept of there being five basic emotions, happiness, sadness, anger, disgust and anxiety or fear, and that all emotions are derivatives of each of these five (Johnson-Laird & Oatley, 1989).

The concept of emotions acting as tools for prioritisation is echoed by research in the field of anxiety and attention, "Emotions elicit changes in information processing modes to deal with a potentially new situation that may require action to be taken."

(Williams, Mathews & MacLeod, 1996) In the case of anxiety, this means a shift into a hypervigilant state. In this mode the cognitive system prioritises attentional search and perceptual encoding of threatening material, but not of rehearsal of that material. Thus the pattern of attentional biases associated with anxiety are accounted for and the general absence of memory biases also.

It's also worth noting that Oatley and Johnson-Laird's theory incorporates ideas which reiterate previous theoretical and experimental observations. Their five basic emotions are the same as those found by Ekman in his studies of the stone aged South Fore people of Papua New Guinea (e.g. Ekman & Friesen, 1971). And their concept of a basic emotional reaction mediated by a cognitive appraisal is very similar to Schachter and Singer's (1962) two factor theory of emotion which is also supported by neuropsychological evidence which has shown the existence of a dual pathway response system in which physiological responses are initiated by the amygdala and mediated by the cortex (e.g. Bremner, Randall, Vermetten & Staib, 1997).

Essentially, the theories and evidence discussed here serve to illustrate the complex nature of anxiety. Edelmann (1992) summarises the difficulty facing theorists, "The central issue is whether one adopts a linear model of anxiety in which learning processes lead to cognitively based reactions and behaviour change or whether anxiety is viewed as a complex multifaceted phenomenon in which different components are interactive." The second and probably more representative view of anxiety obviously makes a comprehensive model of anxiety particularly problematic.

Methodological review

As mentioned previously, anxiety is manifest in a variety of different ways. Since the aim of this study is to try to integrate the study of these different facets, the central feature is the use of a variety of different measurement techniques in order to capture as many dependent variables as possible.

Spielberger's model for the interaction of state and trait anxiety can be interpreted as suggesting at least four measurable aspects of anxiety: behavioural patterns, autonomic arousal, subjective feeling and defence mechanisms/ adjustive processes. For the five studies in this thesis a total of four categories of anxiety indicators were used, subjective report, behavioural displays, autonomic variability and cognitive biases.

The following sections report experiments on anxiety which have used one or more of the methods adopted in the five studies. The first section reviews the use of self report measures, the second the use of cognitive attention allocation measures and the third section deals with autonomic measures. A section on behavioural measures is not included here, they are discussed as part of Experiment 5 since the primary motivation for their inclusion was not as a dependent measure per se, but as an additional stressor. Within each of the three methodology sections are subsections dealing with the specific methodologies used, since more than one from each class was employed. The review of methodologies and empirical evidence has been kept deliberately brief, more detailed analysis has been restricted to the introductory sections of each individual study where it is more relevant.

Self report measures

When conducting research into trait anxiety, participants have to be allocated to the between group conditions of either low or high trait anxiety. This can be done by comparing between a clinically anxious and normal group, or, as in the case of the studies reported in this thesis, by using scores on a questionnaire to fix cut off points for membership. Sometimes a specific figure is fixed, e.g. Richards et al. 1992; Richards and Millwood, 1989; and Richards and French, 1990, the STAI is used to divide samples into high and low trait anxious by using a cut-off score of 40, more usually however, the cut-off is the median score for the sample.

In the field of anxiety a variety of psychometric questionnaires have been developed, e.g. The Hamilton Rating Scale for anxiety (Hamilton, 1960); the Endler Multidimensional Anxiety Scales (Endler et al., 1989); The Anxiety and Arousability

Inventory (Hocevar & El-Zahhar, 1988); The Taylor Manifest Anxiety Scale (Taylor, 1953); and the Hospital Anxiety and Depression Inventory (Zigmond & Snaith, 1983).

The two which are used most frequently with non-clinical populations are the Taylor Manifest Anxiety Scale (TMAS) and the Spielberger State Trait Anxiety Inventory (STAI) (Spielberger et.al. 1983). Arguably, the TMAS appears to be preferred in the USA and use of the STAI is more prolific on this side of the Atlantic. The research which is most comparable to that reported in this thesis has taken place in the UK and the researchers have used the Spielberger Inventory. The STAI was therefore chosen as the preferred scale to be used in the work carried out for this thesis in order to aid comparisons.

The Spielberger State Trait Anxiety Inventory

The STAI was developed by Spielberger as a self report measure which would give reliable measures of state and trait anxiety. (See Spielberger et. al. (1983) for details on item selection and validation.)

The STAI trait scale consists of twenty statements that ask subjects to describe how they "generally feel." Statements include items such as "I worry too much over something that doesn't really matter" and "I am a steady person". Subjects respond by ticking one of four boxes next to each statement, either "almost never", "sometimes", "often" or "almost always". The responses to individual items are relatively stable over time and impervious to stress. (Spielberger, 1972)

In the same way, the state scale of the STAI consists of twenty statements which ask people how they are feeling at that precise moment. Again there is a choice of four possible responses from, "not at all" to "somewhat", "moderately so" or "very much so". Examples of statements are "I am jittery", "I feel content" etc. Essentially the statements in the state anxiety scale involve feelings of tension, worry, apprehension and general nervousness.

It has been demonstrated that scores on the STAI state scale increase in response to stressors and decrease through relaxation procedures (Spielberger, 1970).

The Marlowe- Crowne Social Desirability Scale

Self report scales, by definition, are subjective measures, and hence are open to possible bias in reporting. In recent literature which focused on studies testing normal subjects, an additional group, apart from high and low trait anxious, has emerged:

Repressors. Repressors can be defined as participants who may not mean to respond falsely but are actually highly anxious individuals who cope by repressing their anxiety and hence respond as if they were low anxious to psychometric questionnaires. Weinberger, Schwartz & Davidson (1979) were the first to report on the concept of repressors as a category of responders who should be considered separately in anxiety research, "A long standing problem in stress research has been that individuals' reports of their tendencies to become anxious are often inconsistent with relevant behavioural and physiological indices." Kreitler and Kreitler (1990) state that the concept of repressors as a particular group has, "A broad based psychological reality."

Repressors are operationally defined as subjects who score low on a trait anxiety questionnaire but high on (typically) the Marlowe-Crowne Social Desirability Scale, a measure of defensiveness (e.g. Weinberger et. al. 1979).

The scale was originally developed as a measure of social desirability but is more commonly used as an index of defensiveness. The scale consists of 33 items which are rated true or false by the subjects as they pertain to them. Example statements are, "I have never intensely disliked someone" and "I sometimes feel resentful when I don't get my own way". Crowne and Marlowe (1960) tested for internal consistency and test-retest reliability at one month, the values produced were 0.88 and 0.89 respectively. Attempts have been made to combine the two dimensions onto one scale (see Asendorpf, Wallbott & Scherer, 1983 for a discussion). But it was found that combining repression and anxiety measures onto one axis of repression-sensitisation (sensitisers being those who amplify their disturbance, who are hypervigilant to any aspects of the experience of anxiety) did not distinguish between truly low anxious subjects and repressors.

Repressors tend to be older than sensitisers (Gudjonsson, 1981) and at present the focus of research on this category of participants is concerned with determining precisely why repressors differ in their responding to anxious relevant stimuli, what are the underlying processes? Currently, repression is seen as inter-linked with attention allocation mechanisms. Where high anxious subjects shift attention towards threatening stimuli and low anxious subjects have no particular pattern of responding, repressors actively shift attention away from threatening stimuli (Fox, 1993a). This accounts for high response latencies to emotional stimuli for both high anxious and repressor participants on tasks such as the Stroop Emotional Colour Word Test (Dawkins & Furnham, 1989).

Myers (Myers & McKenna, 1996; and Myers, 1996) strongly recommends the practice of administering a defensiveness scale in anxiety research, this recommendation

has been followed in all of the five studies reported in this thesis. The data from this scale has been analysed separately from the main anxiety indicator data in a separate section (see page 137).

Cognitive attention allocation measures

In the section concerned with theories of anxiety, particularly network theories, reference was made to a cognitive bias associated with anxiety. The main bias associated with anxiety appeared to be an attentional one, as opposed to a memory bias. Eysenck (1992) views anxiety as facilitating the detection of environmental threat. He proposed that anxiety affects cognitive processes in the following four ways: selective attentional bias whereby anxious individuals preferentially attend to anxiety eliciting stimuli; distractibility, because anxious individuals are so sensitive to threat they are easily distracted by peripheral threatening information which may be task irrelevant; attention breadth, which predicts that anxious individuals' attention to environmental cues narrows as anxiety increases; and finally, interpretative bias, anxious individuals are likely to interpret ambiguous stimuli as threatening more frequently than normal control subjects.

There are a variety of experimental paradigms for investigating selective attentional bias. The two most widely used, and the ones which were used in the present study are the emotional Stroop word colour task and the dot probe task.

The emotional Stroop word colour task

The emotional Stroop word colour task is a direct measure of attentional bias towards threatening information in favour of neutral information. The emotional Stroop word colour task (ESWCT) paradigm is similar to the traditional Stroop in that words are presented to subjects and they are asked to identify the colours in which those words are written. If the meaning of the word matches the colour, performance is speeded. If the two are incongruent, response latencies are larger (Mathews & Klug, 1993). Thus, for example, a subject, when asked to name the colour of the printed words, will respond slower to naming the word RED when printed in green then when printed in red (Stroop, 1935). The differences in reaction times to congruent and incongruent words are generally large and the Stroop effect is one of the most robust psychological phenomena that there is (MacLeod, 1991).

The emotional Stroop does not compare reaction times to congruent and incongruent words, instead the critical difference is between reactions times to neutral and

emotionally threatening words. Examples of neutral words used in the studies in this thesis include, cupboard, wardrobe etc.; threatening words used include foolish, mutilated etc. Generally, high anxious participants take longer to colour name threatening words than they do neutral words, low anxious participants on the other hand show no differences between the time taken to colour name threatening words and neutral words because they have no preference for threatening stimuli over neutral stimuli.

Mathews and MacLeod (1985) recorded the mean performance times of 24 generally anxious out-patients and 24 non-anxious controls. Four sets of 12 words were prepared, a physically threatening set, a socially threatening set and two control sets of frequency matched neutral words. Four cards were prepared, one for each word set. On each card the set of twelve words was duplicated eight times in random order. Of these 96 words 24 were printed in red, 24 in yellow, 24 in blue and 24 in green, the order of colours was also randomised. The participants' task was to read down the list of 96 words and say the colour of the print of each as quickly as possible.

The reaction times to each of the four sets of words were compared between groups. The control group showed similar reaction times to the threatening cards and neutral cards (65 and 65.8 seconds respectively) but the anxious group were slower to colour name the threat words than the neutral words (80.7 and 84.9 seconds respectively). The theoretical explanation given for this effect is that anxiety is associated with a "processing bias that favours the encoding of emotionally threatening information." (MacLeod, Mathews & Tata, 1986, also, MacLeod, 1991.) In other words, anxious subjects are unable to direct attention away from the threatening part of the stimuli, the words, and towards the neutral aspect of the stimuli, the colour of the words.
Williams, Mathews and MacLeod (1996) reviewed nearly all the studies conducted using the emotional Stroop word colour task on both clinical and normal high anxious subjects. The following table summarises some of the studies which have used non-clinical participants.

Table 3 Some emotional Stroop studies using non-clinical participants

Study	Method	Content of word stimuli (matching criteria)	Participants (n)	Group (s) showing interference on target vs. Control words (bias sensitive words)	Size of interference effect (in ms per word)
Dawkins and Furnham (1989)	Card	Traditional Threat Neutral (length/freq.)	High anxious (12) Repressors (12) Low anxious (12)	a) High anxious (threat words) b) Repressor (threat words)	a) 50.0 b) 96.0
Richards and Millwood (1989)	Computer	Threat Neutral (length/freq) Pos (length/freq)	High anxious (16) Low anxious (16)	High anxious (threat words)	20.0 (from figure 1, p.174)
Mogg et. al. (1990)	Card	General threat Achievement threat Neutral (length/freq)	High anxious (18) Low anxious (19) received either stress or no stress	a) High anxious b) High stress on achievement words	a) 39.0 b) 50.0 (from figure 2, p.1233)
Richards & French (1990)	Computer (central vs peripheral word presentation)	Threat Pos Neutral (length/ frequency	High anxious (13) Low anxious (14)	High anxious (threat words)	120.0
Mogg & Marden (1990)	Card	Social threat Physical threat Pos (emotionality) Neutral (freq) Household (freq) Rowing (freq)	High anxious (12) Low anxious (12) Rowing club members (12) Nonrowers (12)	High anxious (all emotional words, including positive ones)	Insufficient detail
Martin et. al. (1991)	Card	Physical threat Social threat Neutral (freq)	High anxious (12) Medium anxious (12) Low anxious (12)	No significant effects involving group	
Richards et. al. (1992), Study 1	Computer (blocked vs individual item presentation)	Threat Pos Neutral (length/freq)	High anxious (reported in Williams et. al as 20, in fact 24) Low anxious (again, reported as 20, actually 39)	High anxious (threat words and blocked presentation)	129.0

Richards et. al. (1992), Study 2	Computer (individual item presentation)	Threat Pos Neutral	High anxious (20) Low anxious (20); threat vs positive mood induction groups	High anxious a) On pos words following pos MIP b) On neg words following neg MIP	a) 117.0 b) 72.0
MacLeod & Rutherford (1992)	Computer supraliminal vs subliminal	Exam related threat Exam related pos (length/freq) General threat Neutral (length/freq)	High anxious (23) Low anxious (24); before and 6 weeks after exam	High anxious (before exam on subliminal task)	10.5
Mogg, Kentish, & Bradley (1993)	Computer supraliminal vs subliminal	Threat Neutral Categorised neutral Uncategorised neutral (length/freq)	High anxious (20) Low anxious (20); stress vs relax mood induction	Mood induced "relaxed" a)More interference on subliminal pos words b)More interference on supraliminal pos words	a) 17.0 b) 23.0 (From figure 1, p.563)
Fox (1993b)	Card	Threat Neutral (length/freq) Traditional	High anxious (18) Low anxious (18)	High anxious on a)Traditional stimuli b)Separated stimuli	a)80.0 b)50.0
Fox (1993a)	T scope	Physical threat Social threat Neutral (length/freq)	High anxious (18) Low anxious (18) "Repressor" (18)	No significant effects involving group	

The average Attentional Bias Index recorded in studies which did not use a mood manipulation procedure is 51ms per word. (The studies which were used for this analysis were Dawkins and Furnham (1989), Richards and Millwood (1989), Mogg et. al. (1990), Richards and French (1990), Martin et. al. (1991), Richards et. al. (1992), Experiment 1, Fox (1993a), Fox (1993b).) Of the 8 studies which were collated only two did not show the predicted effect, Fox (1993a) and Martin et.al (1991). Martin et.al.'s (1991) study does not have any features which are dissimilar to the other studies reported, however they do use fewer participants than most studies and may therefore suffer from a power problem.

The study by Fox (1993a) was erroneously reported by Williams, Mathews and MacLeod (1996). Firstly, Fox's study used the dot probe technique rather than the emotional Stroop task and so should not have been entered into the table at all. Secondly, Williams et.al. report that there were, "No significant effects involving group." In fact, Fox found that the task did distinguish between the three groups of high trait anxious, low trait anxious and repressors. This error of inclusion may explain why Fox is cited only once in Williams, Mathews and MacLeod's reference section for her 1993b paper.

The dot probe task

The dot probe task serves the same function of the emotional Stroop in that it provides a quantitative indicator of the extent of a participant's bias for threatening stimuli over neutral stimuli.

The dot probe was developed in response to criticisms levelled at the Stroop task. The problem with the Stroop paradigm is that if a participant takes longer to colour name a threat word than an emotional word it could be due to two processes and there is no way of distinguishing between them. The participant may take longer to respond to threat words because their attention is captured by the threatening information, alternatively, they may be directing their attention away from stimuli they perceive as threatening, this would produce the same effect but requires a different interpretation.

Another explanation for the findings using the emotional Stroop is that it engenders a response bias, high anxious subjects confronted by anxious relevant stimuli experience an elevation of state anxiety to a point where it impairs reaction time. In response to these criticisms, MacLeod, Mathews and Tata (1986) developed a procedure which would directly measure attention allocation, in order to lay such alternative interpretations to rest.

Each dot probe trial has three phases. In the first instance a cross or dot is displayed on a computer screen, in the centre. The subject is asked to fix their gaze on this probe. This remains on screen for a short period, and then two words are briefly displayed on screen, one above the fixation cross and one below, one of the words is threat related, the other neutral. The third phase, in which the subject has to make a response, follows the removal of the two word stimuli. In this third phase an arrow, pointing either left or right is presented in the field of one of the words, i.e. either above or below the location of the original fixation cross. The task for the subject is to identify the direction of the arrow as quickly as possible using cursor keys, it is this response latency which is recorded as the dependent measure. The comparison is made between response latencies to arrows which are shown in the same fields in which the threat word appeared and response latencies to arrows which appear in the same field as the neutral stimuli.

The attentional capture hypothesis would imply that, when two words of differing valence are presented, high anxious participants selectively attend to the threatening word, and hence focus their attention on that field. If the arrow then appears in the threatening

field response times will be much quicker than if the arrow were to appear in the neutral field since high anxious individual will already be attending to the threatening field.

MacLeod, Mathews and Tata (1986) tested a sample of 16 clinically anxious and 16 control subjects on the task using socially threatening and physically threatening words as the experimental stimuli. "Probes in the upper area were detected more rapidly when preceded by a threat word in the upper (593 ms) rather than in the lower (652 ms) area; probes in the lower area were detected more rapidly when preceded by a threat word in the lower (663 ms) rather than the upper (695 ms) area." Clinically anxious (but not clinically depressed) subjects consistently shifted attention towards threat words, and not neutral words. But control subjects did not show this attentional shift, if anything they appeared to shift attention away from threat words as their response latencies were longer when the arrow appeared in the threat field than when it appeared in the neutral field.

This contrasting pattern of attention allocation has also been found in normal populations when comparing high and low trait anxious participants. MacLeod and Mathews (1988) tested normal undergraduate subjects twelve weeks before an examination and one week before the exam, in order to examine the main and interaction effects of state and trait anxiety. They found that high trait anxious participants shifted their attention towards threatening stimuli in favour of neutral stimuli and that this pattern was exacerbated by an increase in state anxiety. In contrast, low trait anxious participants directed their attention towards neutral stimuli in favour of threatening stimuli, and this effect became more extreme with an elevation in state anxiety. "Increased proximity to the examination was associated with an increase in attentional bias towards threat material in high trait subjects, but with increased attentional avoidance of such stimuli in low-trait subjects."

The technique has not been used so widely as the Stroop task, but results are comparable in that the effect appears to be robust and observed in both clinical and normal populations.

In Experiments 1-5, a picture variation of the dot probe was used, following from Yiend, Mathews, Bradley and Mogg (In press). In this case, instead of words, pictures taken from the International Affective Picture System were used (Lang, Bradley & Cuthbert, 1995). Yiend et. al. used neutral pictures paired with moderately threatening and severely threatening pictures, in total there were 48 experimental trials. 41 participants were selected for low and high levels of trait anxiety, their mean trait scores were 33.4 and 58.86 and their state scores were 36.15 and 53.76 respectively.

Initially coloured slides were used and it was found that all participants attended to the threatening fields irrespective of trait anxiety levels (measured using the Spielberger STAI). Using digitised black and white pictures, as in Experiments 1-5, resulted in patterns of attentional avoidance of threat in low trait participants and attention to threat in high anxious participants. This finding was demonstrated at low levels of state anxiety and hence, because of this, and due to the contrast in stimulus materials with the Stroop task, this variation of the dot probe was selected for use in the five studies which follow.

Test-retest reliabilities of attentional bias measures

Franzen et.al. (1987), in an experiment to specifically examine test-retest reliability, administered the traditional Stroop Colour-Word Test to a group of 60 undergraduates at time 0, 1 week later and 2 weeks later. Results indicated a high degree of stability with a test-retest coefficient of 0.8. Uechi (1972) reported a test-retest reliability coefficient for the traditional Stroop ranging from .6 to .89 for a sample numbering 86 in total tested at time 0 and after one year.

These studies indicate that the traditional Stroop displays a high degree of test-retest reliability. However, the emotional Stroop test-retest reliability has only been tested once by Kindt et.al. (1996), with an inter-test interval of 3 months the test-retest reliability r=0.2 (n.s.).

The effect of practice and instruction on attentional bias measures

The traditional and emotional Stroop effects rely on the fact that, because we are so highly practiced at reading, this process occurs without intention, thus awareness of the content interferes with the primary task of identifying the colour. One implication of this is that, given enough practice, participants will develop strategies for inhibiting their word reading such as unfocussing their eyes.

Connor, Franzen and Sharp (1988) investigated the effects of practice types and instruction types on 40 undergraduates performance on the traditional Stroop Colour Word Test. Scores increased with repeated trials but the types of instruction given to subjects, either "standard" or "facilitative", had no significant effect, lending support to the robustness and reliability of the test. (Facilitative instructions were suggestions to the participants which enabled them to perform the task more effectively, these included focussing on only one letter at a time, going at an even steady pace, etc.) The fact that

scores increased on repeated trials does not in itself mean that the emotional Stroop effect would be affected by practice.

Practice effects for the emotional Stroop task have not been studied explicitly. Only one study has used the emotional Stroop more than once within the same session. In their analysis Chen et.al. (1996) did not find any evidence of main or interaction effects for the independent variable of order of testing and so concluded that there was no practice effect. This issue is dealt with in greater detail in Experiment 5, page 114.

The effect of gender on attentional bias measures

The previously cited study by Connor, Franzen and Sharp (1988) also looked at the effect of sex on traditional Stroop responses and found no significant differences in responding. MacLeod's (1991) extensive review of research using the traditional Stroop paradigm concluded that "There are no sex differences in Stroop interference at any age." He reported the findings of Jensen, (1965) who suggested that although women are slightly faster at colour naming than men, this is probably due to general response speed not a difference in the effect of the task per se. To date there has been no report of a main effect of gender in the cognition and emotion field.

The effect of age on attentional bias measures

There has been an interest in establishing the developmental course of attentional biases, for example, Martin, Horder and Jones (1992) tested spider phobic children in age ranges from 6 to 13. Phobics took significantly longer to colour name threat words compared to neutral words than non-phobics but the magnitude of the effect did not vary significantly as a function of age. They inferred from this finding that these cognitive biases emerge at a very young age. To date, like the issue of gender, no effect of age has been found in the literature on adult attentional biases to anxiety.

The physiological measurement of anxiety

In 1961 Cattel and Scheir, in a review of the psychophysiological measurement of anxiety in their book, "The Meaning and Measurement of Neuroticism and Anxiety", wrote,

> "A major difficulty in proceeding to sure inference from studies now in the literature is that the vast majority of researchers use univariate designs, relating one dependent to one (or more) independent variables.

> Usually the main concept, such as, say, anxiety, stress, or Neuroticism, is, by some naive fiat of the experimenter, alleged to be properly represented by one test variable. Since only a fraction of the variance of any one variable can be ascribed to anxiety (single factor pure measures being at this point unknown), and vice versa any connection found between the first and second variable is open to conceptual explanation in a variety of ways. A succession of univariate researches, each claiming to be on the concept of anxiety, but each using its own particular representative variable (tremor, symptom checklist, clinic attendance, corticosteroid secretion, etc.) cannot be brought to coherence but remains an intrinsically non-fitting jigsaw puzzle."

The reason for including this long quote from such a relatively old source is so that the reader can establish a comparison with the next extract, written twenty five years later and yet uncannily similar.

> "A difficulty for any reviewer of the psychophysiology of individual differences is that the field that exists is barely more than a catalogue, and a vast catalogue at that. The research is characterised by one shot studies, is usually focused on only one variable, and rarely exceeds more sophistication in design than a correlation or two, or a 2 x 2 analysis of variance." (Gale & Edwards, 1986)

This observation made in 1986 is still true today, as yet no reliable way of measuring individual differences in anxiety using physiological methods has been identified.

Physiological methodology has the clear advantage of objectivity, an important goal for empirical research. As Levitt (1968) noted, "Because of the common use of denial as a defence against awareness of anxiety" the validity of subjective reports of feelings of anxiety is sometimes doubtful. This echoes the points made concerning repressors (see page 27). Autonomic nervous system reactions can seldom be controlled voluntarily and are thus immune from denial.

Lader (1983) wrote that "psychophysiological studies have been particularly useful in studying anxiety because of the variety of bodily symptoms accompanying the subjective feeling." This discussion will explore which symptoms, if any are indicative of anxious response, and what are the most suitable physiological measurements to reflect those responses.

Several cultures developed crude lie detection techniques based on the observation that saliva production decreases under stress. The Chinese, for example, required a man accused of a crime to chew a mouthful of dry rice; if he could spit it out he was judged innocent. The Anglo-Saxons employed a similar ritual: if the accused could easily chew and swallow a piece of dry bread (known as conjured bread and administered by a priest), he was freed. Both of these tests of innocence are crudely based on the physiological fact that the sympathetic nervous system is activated by stress and one of its responses is to slow down salivation. In retrospect, the theory underlying these techniques is that the guilty party would be anxious, his mouth would be dry, and thus he would find it difficult to swallow or spit. Unfortunately, it ignores the fact that an innocent man might also very well be scared spitless. The question posed by these anecdotes from history is has the physiological study of anxiety progressed significantly since Anglo-Saxon times?

Interaction between physiological measures and state/trait anxiety

State anxiety occurs in everyday situations, everyone has experienced accompanying physiological changes, sudden stomach lurches, increased sweating and heart rate. Trait anxiety is an indicator of a stable level of anxiety and is generally investigated quasi-experimentally, comparing clinical and normal groups, or normal high and low anxious groups.

State anxiety induction and the monitoring of subjects' physiological responses is a prolific field, since it is of clinical importance (for example because of a proposed link with hypertension) and can be experimentally manipulated. It has been noted (see Hodges 1976) that of the two dimensions (state and trait anxiety), physiological variables are constantly loaded on the state anxiety aspect and subjective variables on trait anxiety. For example, a question from the State/Trait Anxiety Scale may be worded so as to distinguish state anxiety using physiological aspects such as - I blush when I try to do something. Whereas trait anxiety variables look for how a person generally feels in terms of psychological well-being rather than physiological reactivity.

The explanation for this is likely to be due to biological foundations. In 1934 Cannon suggested that the universal reactions of emotions, and in this case anxiety, are as a result of evolution and adaptation. "These are fundamental emotions and instincts which have resulted from the experience of multitudes of generations in the fierce struggle for existence and which have their values in that struggle." He saw emotions as functional

adaptations, the purpose of which is to prime the physical body, as in the flight/fight fear reaction, and which therefore have physical manifestations.

These reactions are characterised by changes in physiology in order to ready the individual for defensive behaviours. A defensive reaction to threatening stimuli is characterised by an increase in heart rate and skin conductance, whereas, for orienting behaviours, produced in response to novel or interesting stimuli, heart rate decreases and skin conductance increases (Fredrikson & Ohman, 1979).

High trait anxiety can be thought of as the tendency for state anxiety reactions to occur more frequently and to a greater degree. Therefore trait anxiety can also be examined using physiological techniques, since high trait anxious subjects will evidence more frequent and more extreme physiological reactions associated with state anxiety than low trait anxious subjects. The details of analysis of the EDA record are discussed in the introduction to Experiment 2 which was the first of the five studies to use EDA as a dependent variable.

Reliability of physiological measurements

It is an essential requirement that a measurement technique produces results which are reasonably replicable over different situations. There are numerous studies which have investigated the test-retest reliabilities of physiological measures, for example, Arena and Hobbs (1995) tested 17 subjects over four sessions on heart rate responses to a baseline condition and two stressors. The subjects were divided into high and low trait anxiety groups using the STAI and results indicated that test-retest correlations were highly significant ($r \approx 0.7$) for both groups on both the baseline conditions and stressor conditions. Manuck et.al. (1989) showed a temporal consistency for resting values of heart rate and blood pressure of approximately $r \approx 0.75$.

Anxious state responses habituate to repeated presentation of a stimulus, thus adaptation occurs both within and between test sessions. The magnitudes decrease over sessions and this complicates the calculation of reactivity reliability coefficients.

Reactions to stressors, state anxiety responses, are essentially the difference between resting and task change scores. Resting levels may vary according to a variety of variables not related to the experimental conditions, and so reactivity rates are often recorded and used as dependent variables in favour of basal levels.

Pruneti, Vogele and Steptoe (1991), in a meta-review, analysed the results of nineteen studies which examined cardiovascular reactivates to mental stressors. The

intervals from time 1 to time 2 ranged from 1 day to 2 ½ years and a variety of populations were sampled. Essentially, the accumulated results showed reliability coefficients for responses to mental stress of 0.62 for heart rate, 0.52 for systolic blood pressure and 0.31 for diastolic blood pressure. Steptoe and Johnston (1991) suggest that the higher reliability for heart rate is as a result of sampling techniques: Heart rate is taken continuously and blood pressure only every 1 or 2 minutes.

Wilder's (1957) Law of Initial Values has implications for the use of reactivities as indicators of anxiety. In it's simplest terms it says that any autonomic nervous system response is a function of pre-stimulus resting levels, much like a response ceiling for example, however, there are statistical procedures which take this into account should it be evident in the data.

Specificity of physiological measurements

A further complication to reliability of physiological responses is the issue of specificity. Specificity research has been the focus of Jochen Fahrenberg's work for approximately thirty years (e.g. Fahrenberg & Myrtek, 1966 and Fahrenberg, 1996) and so this part of the discussion will, to a large extent, rely on his data and conclusions, simply because they present such a coherent picture.

Specificity is a concept which has dogged physiological research into individual emotional differences since the fields' inception. The concept of specificity can be seen to have carried over into physiological research from Izard (1971) and others work on facial muscle patterning (Eckman et al., e.g. 1969, 1972). It has been shown that basic emotions can be effectively differentiated on the basis of facial expression. In other words there are specific expressions which are universally recognised as indicative of underlying emotions, smiles for happiness, frowns for displeasure etc. When this is applied to physiological indicators however the results are not so conclusive.

Theorists such as Ax (1953) have stated that specific physiological patterns are associated with specific emotional states. Others, such as Cannon (1927) and Schachter and Singer (1962), hold the view that an emotion such as anxiety, or fear, is merely characterised by generalised arousal of physiological systems.

Fahrenberg's has concluded that "peripheral autonomic functions exhibit little systematic and substantive differences between emotional states" (Fahrenberg et al., 1986). He implies that when measuring physiological indicators of emotions, it invariably means that general measures of physiological arousal are being measured. And that from

those general measures of arousal caution must be used when proceeding to inference of emotion. Fortunately for this study, anxiety is one of the emotions which is most closely governed by the autonomic system, since it has a direct bearing on fight and flight situations.

Specific methodologies and their reliability

There are a variety of autonomic indicators which can be used as dependent variables, however, like the discussion on cognitive measures, the focus here remains on the three methodologies which have been used most frequently and which were used in studies 2,4 and 5.

Electrodermal activity

Electrodermal activity (EDA) or skin conductance is one of the most commonly utilised measures of anxiety, since it is relatively easy to administer, and the apparatus is readily available.

Recording of electrodermal activity can be divided into tonic and phasic categories. Tonic responses describe slow drifts over the course of minutes of the background resting rates of basal levels. A phasic response is a rapid increase or decrease in activity which occurs in a matter of seconds, either as a response to stimuli or as a random fluctuation.

The relationship between state anxiety and electrodermal reactivity is self evident. A link between anxious state and sweating is seen frequently in everyday situations. Controlled manipulation has shown that an increase in state anxiety, by using mood induction techniques for example, is mirrored by an increase in levels of electrodermal activity as measured by a polygraph.

Lader (Lader & Wing, 1964) was among the first to suggest a link between trait anxiety and measures of EDA. He observed that there are a wide range of individual differences in the rate of random fluctuations of EDA. (Lacey & Lacey, 1958, also, Chattopadhyay et.al., 1975). High trait anxious subjects have more frequent and larger random fluctuations in their EDA readings. Dimberg, Fredrikson and Lundqvist (1986) found differences in habituation rates and frequency of non-specific skin conductance reactions between groups of participants who were high and low in public speaking fear.

Lader and Wing (1964) observed that trait anxiety differences were also reflected in habituation rates to neutral stimuli. 20 clinically anxious subjects were compared with

20 control subjects matched for sex and age. They were given a 20 minute calming period and then 20 auditory tones were presented at random intervals. They found that habituation rates (the number of trials it took until there was no reaction to stimuli) were significantly higher for clinically anxious subjects in comparison to normal controls. Also, they displayed significantly more random fluctuations (non-specific skin conductance reactions, n.s. SCR), supporting Lacey and Lacey. And finally, they displayed a higher resting (tonic) level of EDA.

This phenomenon has been found in a variety of studies, both when comparing clinical subjects to normals, and in comparisons of high trait anxious normals with low trait anxious normals. For example, Dreikus and Ferguson (1987) compared habituation rates to 2 second tones repeatedly presented until three zero responses occurred in 9 high anxious normals and 9 low anxious normals. The first habituation trial of non-responding occurred significantly sooner for low trait anxious subjects compared with high trait anxious subjects, $F(1,12) = 5.69$, $p<.05$.

However, there is a history in the literature of a failure to replicate these findings. Hart (1974) following the work of Lader and Wing, failed to find a number of effects that they reported in the classic 1964 paper. Hart compared two groups, 18 clinically diagnosed anxious patients and 18 normal controls, on measures of habituation to auditory tones presented two seconds apart. He found that, in contrast to Lader and Wing's results, tonic resting levels did not distinguish between groups. Using the frequency of spontaneous, non-specific, EDAs as a dependent measure Hart found that although Lader and Wing's anxious participants showed three times as many non-specific SCRs as the low anxious group, Hart's high anxious group showed less than twice as many. Most significantly of all, Hart found that there was no difference in habituation rates between the two groups.

For every study which reports a difference between groups on measures of habituation there is another which has found no significant difference. For example, Ashcroft, Guimaraes, Wang and Deakin (1991) found no difference in rates of habituation to tones between 30 clinically anxious patients and 30 controls. Ashcroft et.al. report the STAI scores for their participants, and it is worth noting that these values are comparable to those given in studies one to five, the mean trait scores were 48.5 for the clinically anxious group, and 34.2 for the control group. Ashcroft et.al. did not find a difference in habituation rates or tonic levels, but they did find a difference in the number of non-specific SCRs.

The literature seems to suggest that there is a pattern of electrodermal activity associated with anxiety but that the effects may sometimes be hard to reproduce, a caution echoed by Gale and Edwards (1986).

Heart rate

Heart rate is the other frequently chosen indicator of autonomic activity. However Fowles (1983), in a meta-review of seven studies which used heart rate as an indicator, concludes that anxiety is associated with the activity of the aversive system and the literature contradicts this link with heart rate. He concludes that in fact heart rate is not an index of anxiety at all but is more closely linked to appetitive motivational states. Miyawaki and Salzman's (1991) alternative criticism of the use of heart rate as an indicator of anxiety is simpler, "Heart rate variability has traditionally been considered to be an index for parasympathetic nervous system activity, although recent methodological advances suggest that heart rate variability may reflect other influences on the control of heart rate as well including humoral, sympathetic, limbic, and higher cortical inputs."

However, the majority of studies continue to use heart rate as an indicator and results indicate a similar pattern to that found with GSR measures in that heart rate is a good measure of anxiety. Heart rate is a continuous measure and as such the dependent variable recorded is not, number or magnitude of responses as with GSR measurement since that would not be appropriate. Instead basal levels and heart rate fluctuations in response to stimuli are recorded.

Beidel, Turner and Dancu (1985) assessed twenty six high anxious subjects and twenty six low anxious subjects heart rate responses. The high anxious group's mean score on the STAI was 46.5 and they also had a high score on a social anxiety scale, the Social Avoidance and Distress Scale (SAD). The low anxious group scored below the mean on the SAD and the mean STAI score of that group was 34.8. Subjects' baseline measures were taken and recording also took place during two socially stressful situations where they had to make a public speech and engage in role playing activity.

To account for the law of initial values, difference indices were calculated by subtracting elevations during stress situations from base levels. High anxious subjects demonstrated significant increases in reactivity in response to the tasks compared to the low anxious group.

Salivary cortisol concentration

As well as autonomic system variables such as heart rate and electrodermal activity, hormone secretion is an indicator of external stimulation.

Among the steroid hormones which are affected by stress cortisol is considered the chief hormonal indicator of physiological responses to stressful stimuli (Kirschbaum & Hellhammer, 1989). Cortisol is produced in the adrenal cortex and, because it is highly soluble in lipids, it diffuses rapidly through cell membranes and hence can easily pass into saliva. It is for this reason that saliva flow (in terms of actual volume produced over time) has no effect on cortisol concentrations. The effect on flow volume on cortisol concentration was found to be non-significant when saliva flow was increased by administration of citric acid to the tongue (Vining et al., 1983), and when it was decreased following medication (Cook et al., 1986). This is particularly important in light of the observations made on the phenomenon of dry mouth under stress due to high sympathetic nervous system arousal (see page 38).

Cortisol is subject to circadian rhythms, it is higher in the morning and decreases towards the evening (Walker et.al. 1984). However, this is significant for studies which compare resting rates, but for designs such as that adopted in Experiment 5 (page 114), which examine elevations from baseline as a result of a stressor being applied, it does not present a problem.

The technique of sampling saliva rather than blood plasma was dogged by methodological limitations in the early work and it was only when highly sensitive radioimmunoassay techniques became more sophisticated towards the end of the 1970s that the interest in salivary cortisol sampling grew. Using salivary cortisol is only useful if it is an accurate representation of the free (unbound) cortisol in plasma since that is the component by which the mechanism of physiological change occurs. There have been a series of papers on this topic but Kirschbaum and Hellhammer (1989) summarise them by noting that correlations between cortisol levels for blood and saliva generally produce coefficient values of $r \geq 0.9$.

Like the EDA literature, research on cortisol secretion is mixed. The general picture is that cortisol secretion increases in response to situational stressors (e.g. Kirschbaum, Pirke and Hellhammer, 1993), however there are studies which report decreases or no significant effects (e.g. Hubert & de-Jong-Meyer, 1992).

To summarise, salivary cortisol concentrations are a relatively new area of physiological research, specific details of how the technique is used in relation to measuring state anxiety elevations is included in the introduction to Experiment 5 (page 114) but, like the EDA literature, there is a suggestion that the results may not be as robust as would be hoped.

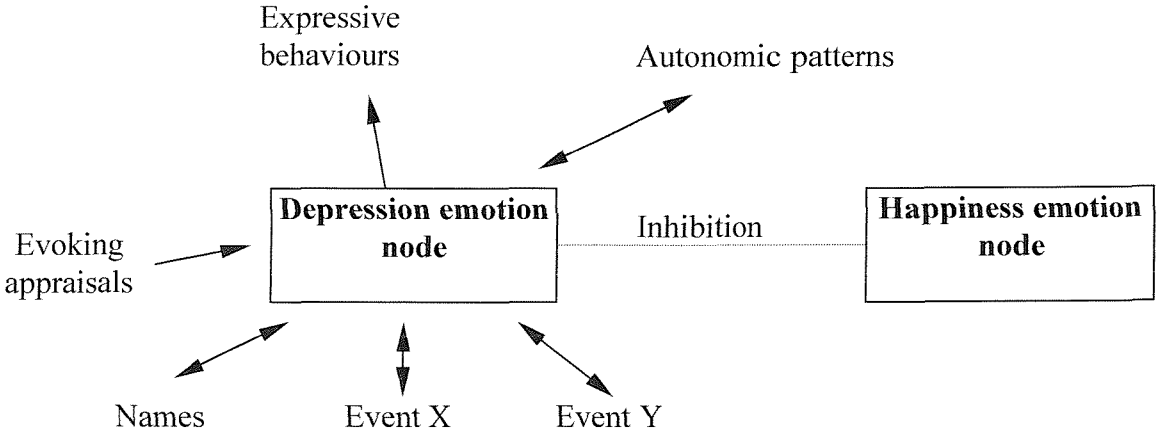
The relationship between different measures of anxiety

Gale (1973) said, "There are three different aspects of the person which may be studied concurrently along a common time scale: performance or behaviour, verbal report of subjective experience, and physiological state....This is essentially a correlational approach. It does not necessarily involve discussion of cause nor is it a commitment to reductionism.. this approach.. is merely a recognition that man may be viewed in different ways, but at the same time, and that none of the three ways is necessarily superior or primary."

Since the early eighties cognitive biases associated with anxiety have been a topic of intense investigation, since even earlier subjective reports of anxiety and the associated physiological responses have been scrutinised. This thesis attempted to marry the relatively new field of cognitive biases and the well established field of physiological responses. This had never been done before and has important conceptual implications, if anxiety is construed as a unitary phenomenon. Thus, cognitive, physiological and subjective measures were combined in a series of five studies, the results from each of which informed the design of the next.

Bower was the first to stimulate research into cognitive biases associated with emotions.

Figure 4 A representation of a semantic network (taken from Bower & Cohen, 1982)



In Bower's (1981) semantic network theory he hypothesised that emotions are conceptualised as nodes within a network. Activation of one node, sadness for example will activate all nearby nodes such as despair, anxiety etc. (and the attached semantic concepts).

Bower's theory provides numerous testable hypotheses. For example, the model suggests a mood state dependent recall effect where recall of information will be enhanced if the mood at the time of recall is the same as at the time of learning. Simultaneous activation of the to be remembered material and the emotion node at the time of learning acts to form a link between the two. When the emotional node is activated in the recall phase, activation flows down that previously formed bond and activates the previously learned material, thus making it more likely to be recalled.

Mood state dependent recall and other effects such as mood congruity effect have been consistently supported in the literature (see Williams et. al., 1988, and MacLeod & Mathews, 1991 for reviews), but it became increasingly apparent that there were a number of patterns in the data which did not conform to the theoretical predictions.

The main empirical problem, which is also most relevant to the present study, was that the extent to which the effects were found was dependent on the type of emotion. Bower's theory would imply that memory biases found in depressed patients for depressed words would also be found in subjects who underwent happy mood induction techniques and would preferentially recall happy related words, anxious subjects would preferentially recall anxiety relevant information etc. However, this was not the case, "it became clear that different types of biases became associated with different mood states" (Power & Dalgleish, 1997).

In investigations of memory biases and depression there is consistent evidence of a strong bias to recall negative information. For example, Clarke and Teasdale (1982) tested a group of depressed patients and found that their recall of their positive childhood events was at it's highest when their level of depression was at it's lowest and vice versa. However, these memory bias effects were not found to be so robust when investigating anxious patients and using anxiety mood induction techniques. In fact Mogg, Mathews and Weinman (1987) found that clinically anxious subjects exhibited the opposite effect, they recalled anxious relevant material more poorly than normal controls. Some memory biases were found for anxious subjects but often they were not replicable (e.g. Mathews, Mogg, May, & and Eysenck, 1987).

Other biases which would be predicted by the model, in common with memory biases, are perceptual biases. For example, it would be predicted that attention would be biased towards material which was mood congruent. A variety of paradigms were adopted to test this prediction, which will be reported in a subsequent section, these included the Emotional Stroop Word Colour test, a dot probe test and dichotic listening tests. The

summary of findings from these tests indicate that anxiety is indeed associated with an attentional bias for anxiety relevant information, but this bias did not apply to studies on depression. For example, Gotleib, McLachlan, and Katz (1988) using a dot probe technique with depressed patients found that there were no differences in subjects' attention to depressive, manic or neutral words.

"A review of the findings for memory bias and attentional bias indicates that anxiety and depression appear to have different effects on cognitive processing" (Mineka & Sutton, 1992). In other words, depression is associated with a memory bias and anxiety with an attentional bias.

Bower's network theory is not able to explain these differential effects. In Bower's theory each emotional node functions just like any other and there is no reason why there should be different phenomena attached to each. This, coupled with the failure to replicate earlier mood-state dependent recall experiments lead Bower (1987) to write, "The effect seems a will-o-the-wisp that appears or not in different experiments in capricious ways that I do not understand."

Lang and Cuthbert (1984) viewed emotions in a similar way to Bower, as an associative semantic network. Activation of propositions within the network would result in measurable outputs such as psychophysiological responses.

Like Gale, Lang viewed anxiety as consisting of three components:

1. verbal reports of stress
2. fear-related behavioural acts, e.g. compulsive mannerisms and deficits in attention and performance
3. patterns of visceral and somatic activation, e.g. increases in heart rate and sweating

However, in various studies Lang failed to find strong associations between these three indicators (e.g. Lang, Levin, Miller & Kozak, 1983). He concluded that the indicators were only loosely coupled. This finding was mirrored by other research such as Rachman and Hodgson (1974) who found that the three systems were only loosely coupled and changed desynchronously. Lang and Cuthbert (1984) used this to suggest that at all times a multi-dimensional approach should be taken, "Thus it is important at the present state of our knowledge that all three systems are sampled. The assumption that a single measure of fear is sufficient for diagnosis and analysis is not currently tenable." (Lang & Cuthbert,1984, p.371)

Since that point Rachman appears to have adopted a different perspective on the problem, rather than attempt to measure all three systems at once he suggests an alternative approach in his 1998 book, "The existence of these three components of fear, and the fact that they do not always correspond, makes it helpful to specify which component of fear one is describing."

Even though, as Rachman (1998) observes, Lang's three-component approach to anxiety is very useful there has been surprising little research into the precise nature of how the three systems relate, if indeed they do. More recently Cano and Calvo-Vindel (1997) and Kenardy, Oei, Weir and Evans (1993) have tackled the question.

The two papers are similar in that they have both taken a multi-faceted approach, although neither have directly referred to Lang's original hypothesis.

Kenardy et al. (1993) studied the relationship between cognition, physiological arousal and subjective anxiety in panic disorder patients. As an index of subjective anxiety they used a scale of 10 where 0 meant completely relaxed and 10 meant total panic. The physiological measure was an ambulatory heart rate monitor. "Cognition" was indexed by content of thoughts, patients were asked to report the percentage of positive, negative and neutral thoughts they were having. They found some correlations between measures but concluded that relationships between the three components of anxiety were very "complex and dynamic".

Calvo and Cano-Vindel (1997) suggested that there could be two types of theories to explain anxiety, either physiological or cognitive, and that objective measures would be an indicator of a physiological basis and that subjective measures would indicate the cognitive aspect.

They used the Spielberger STAI as an index of trait anxiety and then asked participants to self-report a variety of other measures such as perceived self-efficacy and somatic symptoms. Biological measures included heart rate and tonic skin conductance levels and, like Experiment 5, they used Lamb's (1978) indices of behavioural anxiety.

Their index of "cognitive characteristics", was the Cognitive and Somatic Anxiety Scale (Calvo, Alamo & Ramos, 1990). This scale measures cognitive anxiety using questions such as, "I am worrying about my performance", versus somatic anxiety which is measured using questions such as, "My hands feel moist." This is a good example of the common conception of "cognitive anxiety" in multi-method research. Rather than use an objective index of information processing such as attention allocation, cognitive anxiety is conceptualised as something more akin to worry. In other words, cognitive anxiety is

considered to describe the types of thoughts that accompany anxiety, rather than the patterns of information processing which may mediate it.

This is where the present study departs from the previous literature. In previous studies such as Calvo and Cano-Vindel and Kenardy, "cognition" is seen as analogous with content of thoughts, in other words a by-product of anxiety. Lang included cognitive processes such as performance in his behavioural category of anxious responses. This concept of anxiety could be represented as figure 5 where anxiety is manifest in three different ways.

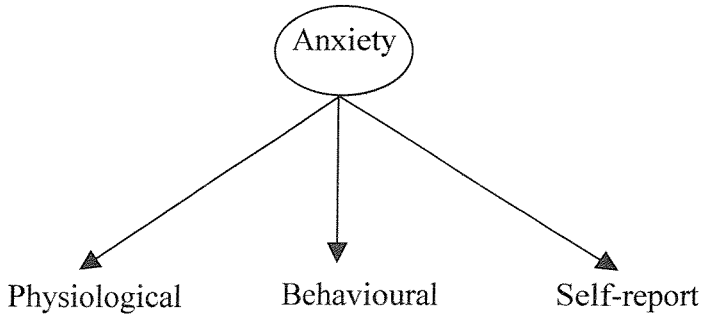


Figure 5 Hypothetical relationship between the three response components of anxiety

Recently MacLeod, Ebsworthy and Rutherford (in press and also MacLeod, 1995, cited in Harris and Menzies, 1998) showed that attentional bias can causally mediate emotional vulnerability. They showed this by using a variant of the dot probe procedure, for half of their participants the response cue always appeared in the threat field, for the other half the probe always appeared in the neutral field. This was followed with a stressful anagram task, participants trained to develop attention to threat stimuli displayed larger responses to the stress phase than those trained to avoid threat. Through the use of self report scales it was found that the training phase itself did not act to change state anxiety, but that trait anxiety was altered. MacLeod et. al. take this as evidence to support the popular notion that attentional biases play a causal role.

The only other study to have followed this procedure (Harris and Menzies, 1998) found that the self report of anxiety was not altered following the training. However, this study concentrated solely on spider phobia, it may be that the training procedure is not effective of extremes of trait anxiety such as phobias, hence this does not necessarily preclude MacLeod et.al.'s conclusion.

Thus this alternative way of measuring "cognitive" aspects of anxiety suggested an alternative conception of anxiety, as shown in figure 6. It may be that cognitive *processes*

should not be merged into the behavioural indices category, but that they mediate anxiety and hence the external manifestations. This has important implications for Lang's theory of anxiety, since he suggests that cognitions are simply another index of anxiety. However, if cognitive processes such as attention allocation actually mediate anxiety these objective measures of cognitive processing should show a relationship to both subjective and physiological measures, even if they show only a loose coupling with each other.

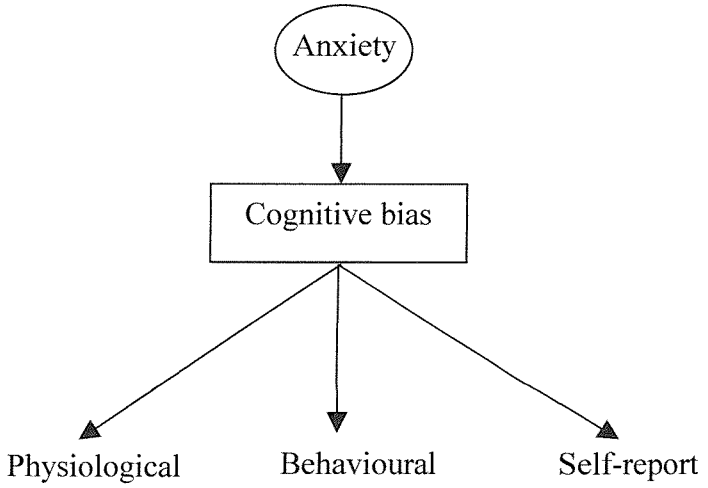


Figure 6 Hypothetical relationship between cognitive processes and anxiety responses

This partially follows on from Lang's suggestion that there are three separable anxiety systems, if this is stated with the caveat that these are "response" systems.

This suggestion therefore suggests that there should be an association between the physiological measures and the objective attention measures, and also that there should be an association between the attention measures and the self report measures.

Conclusion

This narrative review served two general broad purposes, to give an overview of relevant theoretical issues and to give an introduction to the methodologies which were used in Experiments 1 to 5.

The general impression that has emerged from this research is that anxiety is an important and complex topic of investigation. Anxiety can be viewed as both a stable personality trait and a fluctuating, situationally dependent emotion, and it is this dual quality which makes implications of research so diverse. Anxiety is also fascinating due to the multi-faceted nature of manifestation. To date, subjective reports have been used in conjunction with either physiological measures or the more recently developed cognitive methods. As yet there have been no studies which have attempted to measure these three components concurrently.

The construct of anxiety is perfectly suited for a study with such a design and so the studies reported here attempted to use as wide a variety of measurement techniques as possible. As will be seen, there were repeated failures to replicate on individual measures which meant that correlations between measures were rendered inappropriate. However, the methodological issues were explored more thoroughly than they might have been were the results as expected and as a result a novel interpretation of the cognition bias literature was expounded.

Experiment 1

Introduction

Traditionally the fields of cognitive and emotion research have been independent from one another. However, since the mid 1980s research on information processing biases associated with emotional states and personality traits has caused the two domains to converge. Colin MacLeod has described this alliance between clinical and cognitive psychology as one of the most inspiring and potentially important products of the study of psychology in the latter half of the 20th Century. "This shared interest has resulted in the emergence of a new nexus between these hitherto rather independent facets of our discipline and has served to spawn a wealth of research studies addressing the hypothesis that high levels of emotional vulnerability are characterised by idiosyncratic patterns of selective information processing." (MacLeod, 1998)

These "wealth" of research studies have generally taken methods used to assess processing biases in the cognitive fields, added an affective component to the stimuli and applied the modified task in a quasi-experimental manner to groups of individuals chosen for the emotional characteristics they display. The dichotic listening test is an example of a technique which has been modified in this way. This approach is appropriate up to a point but issues of reliability and validity are often neglected. In fact they become even more important in the new setting, particularly when these techniques are used for assessment purposes, i.e. when they are analysed at the level of individual differences. It becomes vital to know how stable over time these measurements are and whether or not the underlying processes can be modified, in other words, are the information processing biases responsive to intervention. Yet the literature indicates that these issues have not yet been thoroughly investigated. To date only one published study has reported test-retest reliabilities of the emotional Stroop task. Kindt et.al. (1996) examined test-retest reliabilities of attentional bias indices to spider phobic words in a group of 48 undergraduates with an inter-test interval of three months. Attentional bias indices indicate the degree to which attention is allocated to threatening material in favour of neutral material. They found test-retest correlations of approximately 0.2 which were non-significant.

Because the eventual aim is to apply a correlational analysis to the three types of indicators, it was necessary to establish that they each display good degrees of reliability within themselves. Any significant correlation between physiological and cognitive measures will not be observed if the physiological measures are not reliable, or if the cognitive measures do not correlate with each other. Rather than using all the measures in one study, separate studies were conducted to examine the reliabilities of each type alone, before bringing all the different methodologies together. In this way, problems with each "class" can be addressed and modifications made, in preparation for the culmination of using all the indicators at once. This first study explored the self-report and cognitive measures.

Within the Emotional Stroop Word Colour Test (ESWCT) and dot probe programs, additional within subject variables were manipulated, other than time (session one or two) and word or picture valence.

The dot probe used picture stimuli rather than word stimuli. The pictures were taken from the International Affective Picture system (Lang et. al., 1995). The dot probe experiment used two different levels of threatening emotional pictures, moderate threat, and severe threat, in order to determine if the attentional bias effect increased as a function of severity of the stimuli.

The ESWCT used four differently valenced word sets, neutral, positive, physically threatening and socially threatening. The predicted relationship was that high anxious participants response times would be higher for threatening words than neutral or positive words. The use of two anxiety relevant categories was in order to distinguish possible effects of the focus of the potential anxiety. When using a student population, it is difficult to predict which category would be of greater significance. Students deal with socially threatening situations all the time as a result of continuous academic assessment, but this could mean that the rarely encountered physically threatening situations provoke more potential anxiety.

The ESWCT program used in the experiment also investigated three methods of presentation of words. Masked presentation, where words are presented so briefly as to be unavailable for conscious processing, was compared with conscious presentation in order to examine if the effect of word valence occurs in both situations. The conscious presentations were further divided into blocked valence presentation and mixed valence presentation. Richards et.al. (1992) hypothesised that there may be a greater interference effect for block presented words because of the mood manipulating nature of the words

themselves. They found a significant interaction between word valence and type of presentation for the high trait anxiety group, blocked presentation produced an interference effect for high trait participants. Mixed presentation did not result in attentional bias effect in either high or low trait anxious participants. This issue is dealt with further in Experiment 3 (page 82).

In other words, this study served an exploratory function, and was designed to identify the most appropriate methodologies to carry onto the combination study when the three classes of cognitive self-report and physiological measures were used. Results from this study determined the specific nature of the cognitive measures, which were to be used in subsequent studies.

Rather than include at this point a list of expected effects, hypotheses will be dealt with in a logical order within the results section.

Method

Design

This experiment took the form of a repeated measures test-retest design. Dot Probe, Stroop, and self reported state and trait anxiety levels were recorded on two occasions, separated by approximately two weeks.

Participants

A total of 40 volunteer undergraduate participants attended both experimental sessions, for which they received course credit. Their ages ranged from 18 to 36 with a mean age of 22.5 years. The group comprised of 5 males and 35 females.

Materials

Self report measures

The questionnaires used were the Spielberger State Trait Anxiety Inventory (STAI) (Spielberger et. al., 1983) and the Marlowe-Crowne Social Desirability Scale (MC) (Crowne & Marlowe, 1960). See appendices 1 and 2 respectively for copies of the questionnaires.

The STAI state scale consists of 20 questions asking participants to respond to statements according to how they feel "right now at this moment" (state). The response to

each statement is given on a four point Likert scale. This response is scored according to whether the statement is positive or negative with respect to anxiety. These scores are then summed to give a single figure index of state anxiety; the lowest score possible is 20 (a score of 1 for every statement), the highest 80 (a score of 4 for every statement). The higher the score, the higher the level of state anxiety. The trait anxiety scale is very similar but asks participants to rate statements according to how they feel "generally".

The Marlowe-Crowne scale consists of 33 statements to which participants are asked to respond true or false. According to the valence of the statement the responses are given scores of either 1 or 0. Therefore the highest possible score is 33 and the lowest 0. The higher the score, the higher the level of defensiveness. This was used in order to identify "repressors", this issue is dealt with in the literature review (page 27) the data are analysed in a separate section (page 137).

Cognitive measures

Stroop

The Stroop program presented participants with a word, written in uppercase, in the centre of the screen on an Opus P200, 32MbRAM PC. The characters of the word were randomly coloured either all red or all blue and were approximately 12mm high. The word remained there until participants pressed either the left or the right cursor button to indicate blue or red respectively, additionally a cut out coloured template was placed around the cursor keys as an aide memoir. Responding to each word cued the appearance of the next.

Firstly, each participant received verbal and then onscreen instructions about the format of the experiment and which keys to press, he or she then completed 20 practice trials (naming the colour of words such as button, screen, fingers etc.). There followed seven blocks of presentations (see below for list) with rest breaks in-between, the duration of these breaks being controlled by the participant. The order of presentation of the blocks was randomised.

The masked trials consisted of presentation of the stimulus word so briefly as to only allow subliminal processing (duration 15ms). The stimulus was then covered or "masked" with a random number string of 12 characters to which the participants made their response. It was not possible to test, post-experimentally, whether participants were

subjectively or objectively unaware of the masked words since they were taken from the pool of non-masked words.

In order to minimise the effects of outliers any responses which were larger than 1000ms were discarded and the convention of calculating median response latencies for each participant was used (following, for example, Duchek & Neely (1989)).

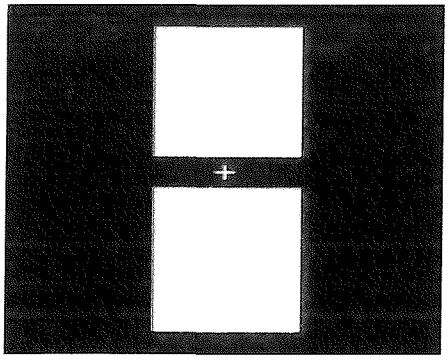
Table 4 Stroop word categories used in experiment 1

Description	Number of trials	Examples
Blocked presented all positive words	40	excellent, darling
Blocked presented all neutral words	40	sweep, refrigerator
Blocked presented all physical threat words	40	fracture, strangled
Blocked presented all social threat words	40	hopeless, despised
Mixed and masked (1)	80, 20 of each of the 4 categories above.	serene, towel, coffin, sneer
Mixed and masked (2)	80, the remaining 20 of each of the 4 categories above.	delight, chimney, choking, stupid
Traditional Stroop	20, randomised so that half the words were congruent with ink colour and half were incongruent.	red, blue

(See Appendix 3 for the full list of all words used.)

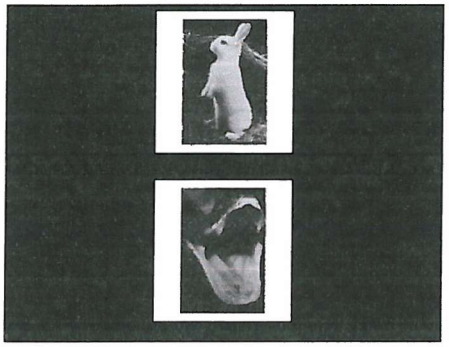
Dot probe

Like the Stroop program, the Dot Probe program presented trials on the Opus P200, 32MbRAM PC. Each trial consisted of three phases that followed in quick succession and there were 72 experimental trials in total (plus 28 practice trials), the methodology replicated that used by Yiend, Mathews, Bradley and Mogg (in press).

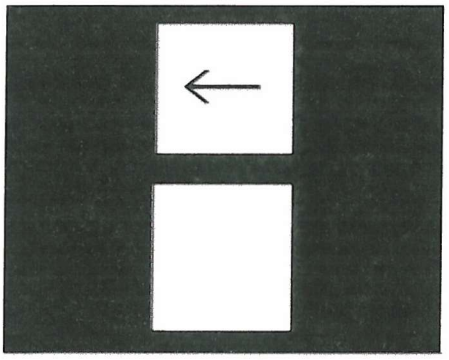


First, two white rectangles were shown, one above the other, on a black background. Participants were asked to fixate their gaze on a white cross shown in the centre of the screen. This phase lasted for 1000 ms.

In the second phase, in place of the white fields, pairs of pictures were shown. These pictures were all taken from the International Affective Picture System (IAPS; Lang, Bradley & Cuthbert, 1995) and measured approximately 60mm by 80mm. The full set of pictures are shown in Appendix 4. According to Lang et al. (1995) the mean valence rating of the severe, mild and novel set of pictures was 2.05, 3.58 and 7.01 respectively. The matched sets valence ratings were 6.42, 6.45 and 6.47 respectively. Additionally, Yiend et.al. used threat and novelty ratings made by 8 independent student raters to allocate the pictures to groups.



One of the pictures of each pair was always a neutral picture (in this example the rabbit). In 24 pairs the neutral picture was teamed with another neutral picture, which was considered novel because it had an unusual composition, for example, it may have been taken from a close or unusual angle. In 24 pairs the neutral picture was paired with a moderately threatening picture and in 24 pairs the neutral picture was paired with a severely threatening picture. This phase of the trial lasted 500ms, which is the standard exposure time used with clinical and non-clinical samples (e.g. Fox, 1993a). Also Mogg, Bradley, de Bono and Painter (1997) have shown that attentional bias is not significantly affected by exposure times between 100 and 1500ms.



The third and final phase of each trial consisted of showing the same white rectangles as in the first phase. In one of the fields a black arrow was shown pointing either left or right, it was the participant's task to respond to this by pressing the corresponding cursor key as quickly as possible and thus cueing the start of the next trial. The position (in either the upper or lower field) and the orientation (left or right) of the arrow was controlled so that it appeared in either the neutral or threat field and pointed either left or right an equal number of times. These factors were not randomised thus each pair of pictures had a corresponding arrow, the position and orientation of which was fixed.

Each participant was given instructions via the computer screen with examples of the fields that they would see and directions on which buttons to press. A block of 20 practice trials followed these instructions. The participant was then given a break, the

duration of which they controlled. 75 trials were then shown without break. The response times from the first three buffer trials following the rest period were not recorded to allow participants to settle back into the task. Any responses over 1000ms were discarded.

The laboratory was arranged so that the participant was seated in a soundproof room and the experimenter was seated outside. An electrical link ran through the wall to connect the two computers so that the experimenter could see when the participant had finished the trials.

Procedure

The participant was welcomed and asked to sit at the desk in the soundproof room. The participant was then given copies of the Marlowe-Crowne and Spielberger Questionnaires and asked to fill them in.

When the participant had completed the questionnaires they were told that the computer would take them through the rest of the tasks. The soundproof room door was then shut.

The participant initiated the first of the Stroop trials which were followed by the dot probe trials. When all the trials were completed the experimenter opened the soundproof room door and thanked the participant and asked them to return for the second session in two weeks time.

At the second session exactly the same procedure was followed and at the end the participant was thanked and debriefed.

Results

Self report data

The questionnaire data was used to determine the spread of trait and state scores and the degree of variation between time one and time two. It was also necessary to divide the sample into high and low trait anxiety groups on the basis of their STAI trait scores at time one. The cut off point for this split is usually deemed as either the median of the sample scores or 40 (40 being the mid point between zero and the highest possible score of 80.) (For examples, see MacLeod & Rutherford (1992) who used a median split of 36.5, or Richards et. al. (1992) who used a score of 40 as the cut off.) In the present study a median split (score of 43) was chosen as it resulted in a more even distribution of participants between the two groups.

Table 5 Self report data from Experiment 1

Trait group	N	Mean trait score	Mean state score at time 1	Mean state score at time 2
High	18	49.6	42.7	44.6
		(6.1)	(9.1)	(10.1)
Low	22	37.1	32.2	34.6
		(4.2)	(5.3)	(9.0)
All Ss	40	42.7	36.9	39.1
		(8.1)	(8.9)	(10.7)

The other questionnaire used in the study was the measure of defensiveness - the Marlowe-Crowne Social Desirability Scale. These data are dealt with on page 137, where all participants' data are pooled.

Cognitive data

Stroop data

Mean and median data are shown in Appendix 5.

Before considering the test-retest reliability of the ESCWT it is necessary to establish that the expected effect occurred. In other words, that the between subject factors of state and trait anxiety and the within group factors of the nature of the stimuli had an effect on the dependent variable of response latencies.

The between subject variables of state and trait anxiety, although measured continuously, were used to divide participants into high and low scoring groups (on the basis of a median score split, as discussed previously). This is because the within subject variable of word valence was expected to have a differential effect on high and low trait anxiety groups and possibly on high and low state anxiety groups.

The three within subject variables were time (two levels, time 1 and time 2), type of presentation (three levels, blocked, mixed and masked) and valence of words (four levels, neutral, positive, physical threat and social threat).

Using the variables of time and type of presentation, there were six conditions within which word valence and the effect of participant anxiety scores were examined: Blocked, time 1; Mixed, time 1; Masked, time 1; Blocked, time 2; Mixed, time 2; Masked, time 2.

There are three possible ways of examining differences in response latencies as a result of emotional valence of words, one is to directly compare response latencies between each category (e.g. Mogg, et. al. 1990). It would be predicted that for high anxious participants (state or trait) compared to low anxious participants, responses to anxiety valenced words would be significantly longer than to neutral or positive words. Alternatively, since the point of comparison for each participant is their response to neutral words, a difference index can be calculated by subtracting response latencies to neutral words from response latencies to emotionally valenced words. This is essentially subtracting a baseline measure of reactivity for each participant, and producing a direct indicator of latency as a result of emotional valence (e.g. Richards et. al., 1992), henceforth known as an attentional bias index or ABI.

Thirdly, to eliminate between subject variations, as a result of basic speed of reaction, residuals were calculated on the basis of a linear relationship between reaction time to neutral words and anxiety relevant words. However, in preliminary data analysis on two thirds of the participant's data, this manipulation produced no differences in statistical analysis results and so was discarded as an additional dependent variable. (An additional possible manipulation, specific to this experiment, was to collapse the dependent reaction time measures to socially threatening and physically threatening words into one category representing reaction time to anxiety relevant words in general. However, socially threatening and physically threatening words appeared to have slightly different effects. In general, reaction times were longer to physically threatening than socially threatening words. Because of this difference, the option of collapsing the two categories into one "anxiety words" category was not used.)

A 2 x 4 repeated measures ANOVA on collapsed data from all the conditions was performed. If this had shown the expected significant effect the different conditions could be unpacked to determine which produced the effect.

Initially the data from time one and time two were collapsed, as was the data from each presentation type (blocked, mixed or masked). These data are shown in Table 6 below.

Table 6 Mean reaction times (in ms.) in experiment one to Stroop words by trait group, collapsed across time and presentation.

		Valence			
	N	Neutral	Positive	Phys.Threat	Soc. Threat
High trait	18	529 (54)	525 (52)	533 (53)	530 (54)
Low trait	22	516 (43)	516 (51)	519 (48)	520 (45)

As Table 6 shows, the trend for longer latencies to anxiety relevant words in the high trait anxiety group compared to the low trait anxiety group is present. High trait participants take between 10ms (social threat) and 14ms (physical threat) longer to colour name threatening words than low trait participants, this is in the expected direction. However, high trait participant's response latencies were also longer than low trait participants on neutral words. In other words, high trait participants displayed longer response latencies to all stimuli, regardless of valence. These data show that high trait participants took between 1 and 4 ms longer to colour name threat words than neutral words, but low trait participants took between 3 and 4 ms longer to colour name threat words than neutral words.

In other words, without unpacking the effects of presentation and time it would appear that there is little evidence that high trait participants took longer to colour name threat words than neutral words compared to low trait participants.

This observation was confirmed using a 2 x 4 mixed ANOVA with a between subjects independent variable of trait anxiety group (high or low) and a within participants variable of word valence (neutral, positive, social threat or physical threat) (presentation and time conditions were collapsed). The ANOVA showed that there was no main effect of word valence, $F(3,38) = 2.18$, ns, no main effect of anxiety, $F<1$ and no interaction effect $F<1$.

Using raw reaction times as the dependent measure a 4 x 3 x 2 x 2 x 2 mixed ANOVA was conducted with two between subjects independent variables of trait anxiety group (high or low) and state anxiety group (high or low); within subjects variables were valence (neutral, positive, physical threat or social threat), mode of presentation (blocked, mixed or masked) and time (one or two). No significant main effects of trait anxiety group, $F(1,36) = 1.870$, ns, valence, presentation, time, state anxiety, or interaction effects were found.

The main aim of this experiment was to establish the test retest reliability of these effects. Test-retest correlations were calculated on mean reaction times and ABIs.

Pearson's correlations were calculated on participants' response latencies at time 1 and time 2, in each of the different conditions. When using raw reaction times, responses in every condition significantly correlated at time one and time two.

Table 7 below summarises the correlation calculation results. Every coefficient is significant to the .01 level.

However, calculations on attentional bias indices did not show any significant positive correlations (see Table 8 below). This result is not surprising in light of the ANOVAs calculated previously. By using the ABIs, a comparison is being made between an individual's reaction time to neutral words and valenced words. The expected relationship, that reaction times are significantly longer to negatively valenced words, is not evidenced when comparing valence conditions. Thus when comparing between conditions, time one and time two, correlations cannot be expected to be significant however.

Table 7 Pearson's correlations between reaction times to Stroop stimuli at time one and time two in experiment one.

Presentation and valence of words	N	Time 1 Mean RT	Time 2 Mean RT	Correlation
Block neutral	40	520 (57)	502 (58)	.701**
Block positive	40	519 (62)	507 (63)	.649**
Block physical	40	530 (70)	509 (65)	.647**
Block social	40	525 (63)	510 (53)	.594**
Mixed neutral	40	544 (65)	506 (56)	.604**
Mixed positive	40	533 (55)	513 (61)	.698**
Mixed physical	40	539 (64)	523 (63)	.579**
Mixed social	40	540 (67)	521 (62)	.611**
Masked neutral	40	553 (72)	520 (65)	.557**
Masked positive	40	541 (73)	519 (54)	.630**
Masked physical	40	552 (71)	520 (65)	.479**
Masked social	40	537 (70)	528 (64)	.552**

Table 8 Pearson's correlations between ABIs to Stroop stimuli at time one and time two in experiment one.

Presentation and valence of words	N	Time 1 Mean RT	Time 2 Mean RT	Correlation coefficient
Block pos diff	40	-1 (42)	5 (50)	.182
Block phys diff	40	9 (42)	7 (42)	.170
Block soc diff	40	4 (56)	8 (42)	.217
Mixed pos diff	40	-10 (46)	6 (35)	-.154
Mixed phys diff	40	-5 (53)	16 (43)	.242
Mixed soc diff	40	-4 (50)	14 (38)	.170
Masked pos diff	40	-12 (50)	-1 (44)	.057
Masked phys diff	40	0 (51)	0 (39)	-.231
Masked soc diff	40	-15 (49)	7 (44)	-.171

Dot Probe Data

Mean and median data for all conditions are shown in Appendix 6.

There were three types of stimuli pairs used in the dot probe tasks: severe threat and neutral; moderate threat and neutral; and novel and neutral. The novel/ threat pair data are dealt with separately.

Novel/ neutral pairs

The novel stimuli were included in order to test the hypothesis that any attentional bias effects were due to the interest the stimuli generated rather than their threatening nature.

The mean reaction time to probes in neutral fields was 490ms; the mean reaction time to probes in novel fields was 495ms (collapsed over time one and two). This difference was non-significant, t (39) = -1.53, ns.

Threat/neutral pairs

Raw reaction times to probes in threat and neutral fields are shown in Table 9.

Table 9 Mean reaction times in experiment one to dot probe conditions by trait group.

			Time 1		Time 2	
	N	Severity of pictures	Probe in threat	Probe in neutral	Probe in threat	Probe in neutral
High trait	18	Severe	484	488	484	486
			(53)	(54)	(54)	(64)
		Moderate	482	484	474	471
			(51)	(43)	(51)	(58)
Low trait	22	Severe	509	514	490	496
			(61)	(50)	(40)	(55)
		Moderate	498	493	493	494
			(39)	(49)	(46)	(55)

Low trait participants show little difference in reaction times to probes in neutral and threat fields at time one or time two, irrespective of the severity of the stimuli. This lack of effect was predicted for this participant group, however, the high trait participants, who were predicted to show a significant effect, responded only slightly faster to probes in threat fields than neutral fields. When time one and time two and severe threat and moderate threat conditions are collapsed, the data show negligible differences in reaction

times to probes in threat and neutral fields by either participant group (see Table 10 below).

Table 10 Mean reaction times in experiment one to dot probe conditions by trait anxiety (Time one and time two, severe threat and moderate threat conditions collapsed.)

	Probe in threat	Probe in neutral
High trait	481	482
	(46)	(49)
Low trait	498	499
	(38)	(42)
All	490	492
	(42)	(45)

A 2x2x2 mixed ANOVA with within subjects factors of severity (moderate /severe) and time (one/ two) and a between subjects factor of trait anxiety group (high or low) was performed on the ABI scores. There were no significant main effects of trait anxiety group, severity of stimuli or time and no significant interaction effects, Fs<1.

Pearson's test-retest correlations at time one and time two for raw scores on each of the five conditions (both neutral, probe in moderate threat, probe in moderate neutral, probe in severe threat, probe in severe neutral) were calculated (see Table 11).

Table 11 Pearson's correlations between reaction times to dot probe conditions at time one and time two in experiment one.

Condition		Time1 mean	Time 2 mean	Correlation coefficient	N
Moderate	Probe in neutral	489	484	.662**	40
		(46)	(57)		
	Probe in threat	491	485	.600**	40
		(45)	(49)		
Severe	Probe in neutral	503	492	.508**	40
		(53)	(59)		
	Probe in threat	498	488	.535**	40
		(58)	(46)		

Correlation coefficients are high for all conditions however, this is merely an indication that baseline reactivity is stable over time. This does not test for the test-retest stability of the dot probe effect however. To test for the reliability of the dot probe effect, difference indices were calculated by subtracting times for responses to probes in threat fields from response times to probes in neutral fields. Hypothetically, for low anxious participants the difference index will approach zero. For high anxious participants the larger the difference index the greater the attention given to threat fields over neutral

fields. Mean attentional bias indices (ABIs) and correlations between these difference indices are summarised in Table 12 below.

ABIs to moderate threat stimuli reported in Table 12 are negative, this implies that in general the participants allocated their attention to neutral rather than threatening stimuli. ABIs to severe threat stimuli are around 4ms, this implies that participants are attending to threatening information in favour of neutral stimuli but the bias is very slight, thus it is not surprising that test-retest correlations are not significant.

Table 12 Pearson's correlations between ABIs to dot probe conditions at time one and time two in experiment one.

Picture severity	N	Time 1 mean ABI	Time 2 mean ABI	Correlation coefficient
Moderate	40	-2 (33)	-.9 (32)	.296
Severe	40	4.7 (45)	4.0 (33)	.136

In summary, the dot probe effect was not displayed in the data. The expected trend of vigilance to threat related material was not reflected in longer response latencies to probes appearing in neutral fields and quicker responses to probes appearing in threat fields. However, data from the forty participants who were tested at time one and time two suggests that baseline reactions to each condition, irrespective of attentional bias, are stable over time.

In addition to these analyses, residuals were calculated and used instead of ABIs, this had no effect on the direction or magnitude of effects.

Discussion

The data collected using the questionnaires was very encouraging. Participants displayed a wide range of anxiety scores, some very high indeed. It was a potential problem that the participant sample of undergraduates would not contain individual's who scored either very high or very low on the STAI. However, results indicate that the spread of scores is comparable to other studies that have used normal participants divided into high and low groups on the basis of STAI scores.

The Stroop data were discouraging. The expected effect, i.e. that high trait anxious participants take longer to colour name threat words was not found. In fact, there were no significant effects of word valence, anxiety score or presentation. (Presentation modes

were blocked, mixed or masked, and since the effect was not found in general it was not expected to occur as a result of a specific mode of presentation.)

Since the effect was not in evidence at time 1 or at time 2, a test-retest correlation of reaction time difference indices, looking at the stability of the effect of valence over time, predictably did not produce significant results.

The dot probe data, like the Stroop data, were disappointing. The predicted effect, that high anxious participants respond faster to probes presented in the threat field than the neutral field, was not evidenced in the data. And hence, test-retest correlations of difference indices were non-significant.

In general the results are very disappointing, similar studies, using very similar techniques have robustly found this effect. The effect does occur to a greater extent when using clinically anxious participants compared with normal controls but many studies have been conducted which found this effect in normal populations (see Williams, Mathews & MacLeod, 1996 summary Table 13).

Williams, Mathews and MacLeod, summarised studies using the following participant samples, compare the mean ABIs for each type of participant sample:

Table 13 Mean ABIs by participant group from studies cited in Williams, Mathews and MacLeod (1996)

Subject group compared to normals	Mean interference effect in ms per stimulus item	Number of groups showing interference, and number of studies with null results
Clinical anxious	38	8, no null findings
High trait anxious	60	11, 2 null findings
PTSD (mostly rape victims)	265	5, no null findings
Panic disorder patients	39	4, no null findings
Obsessive-compulsive disorder	52	3, no null findings
Social phobics	87	5, no null findings
Specific phobics (e.g. spiders)	136	8, 1 null finding

The findings from this study are that high trait anxious participants showed a mean interference effect of 4.5 ms on physical threat words compared to neutral, and 1.4 ms on socially threatening words. These figures do not even approach those cited in other studies. However, the reason for this is not obviously apparent. One characteristic of the

present study, which suggests that the results should not be abandoned, is the participant numbers used. The number in each group of high anxiety and low anxiety is 18 and 22 respectively, the average number of participants in each group in the studies cited in Williams MacLeod and Mathews (1996) is 18. Using Cohen (1988) and Hendrickx et.al. (1997) average statistical power for these studies was calculated using a=.05, u=1, n=18, f=.25 (medium effect size according to Cohen, 1988), power= .31. However, for the present study power = .34 which is comparable.

This study provided the basis for the next study where physiological measures were added to the design.

Experiment 2

Introduction

As mentioned in the literature review, anxiety is manifest in a variety of different ways. Since the overall aim of this thesis was to try to integrate the study of these different facets, the central feature is the use of a variety of different measurement techniques. Anxiety consists of at least four components, facial and behavioural patterns (which will be called visible body changes), physiological/autonomic variability, subjective feelings and cognitive biases. This study builds on the work begun in Experiment 1 and in this study, three categories of indicators of anxiety were chosen, subjective feelings, autonomic variability and cognitive biases.

Subjective responses and cognitive biases were measured using the same methodologies employed in Experiment 1. Electrodermal activity and heart rate were recorded over the experimental session but due to a data retrieval problem the heart rate data were lost.

Lader (1983) wrote that "psychophysiological studies have been particularly useful in studying anxiety because of the variety of bodily symptoms accompanying the subjective feeling."

There are two types of variables that can be extracted from EDA records, they are firstly, general, non-reactive indicators, and secondly, patterns of response to stimuli.
In the first category are variables such as basal skin conductance level, high trait anxious participants generally have higher resting levels than low trait anxious participants (Boucsein, 1992). Basal level is constantly fluctuating and one indicator of trait anxiety is the frequency of non-specific responses (i.e. those which are unrelated to stimuli), high trait anxious participants display more frequent and larger non-specific responses.
In the category of stimulus specific responses it has been shown that trait anxiety is related to the amplitude of reaction. Also in this category is rate of habituation. Lader and Wing (1964) have shown a distinction between high and low trait anxious groups on the basis of their rates of habituation, high trait anxious participants take significantly longer to habituate to a series of tones than low trait anxious participants. Finally within this category, the amplitude of the first response in a series of stimuli has been shown to indicate trait anxiety.

In essence this study attempted to add to the findings of Experiment 1 by examining the relationships between the three sets of measures, self-report, cognitive and physiological.

Method

Design

This experiment was a repeated measures, test-retest study. Dot Probe, Stroop, electrodermal activity, and self reported state and trait anxiety were recorded at two time points, separated by approximately two weeks.

Participants

A total of 29 volunteer undergraduate participants attended the first experimental session, for which they received course credit. Their ages ranged from 18 to 51 with a mean age of 24.6 years. The group comprised of 6 males and 23 females.

Because of equipment failures and non-attendance a variety of data were lost, Table 14 below summarises the data available for each participant. In total complete data sets were collected on only eight participants. There was a large-scale failure of the dot probe experiment at time one, due to a programming error the data were not recorded accurately. The number of participants with complete data, apart from dot probe at time one, was 12. A total of five participants did not return for the second testing session. Additionally, there was one participant with missing dot probe and EDA data at time one and three participants with no dot probe at time one or time two and no blocked presentations of Stroop stimuli at time one.

Table 14 Data available for each participant in Experiment two.

Subject Number	STAI time 1	Stroop time 1	Dot P. time 1	EDA time 1	STAI time 2	Stroop time 2	Dot P. time 2	EDA time 2
1			x	x				
2			x					
3			x					
4			x					
5		not b	x				x	
6		not b	x				x	
7		not b	x				x	
8			x		x	x	x	x
9			x					
10			x					
11			x					
12			x					
13			x		x	x	x	x
14								
15								
16			x		x	x	x	x
17			x					
18			x					
19			x					
20			x					
21								
22								
23			x					
24								
25			x		x	x	x	x
26								
27								
28			x		x	x	x	x
29								

(x- indicates data missing, "not b" – indicates masked and mixed presented Stroop data were recorded but block presented stimuli are missing.)

Materials

Self report measures

The questionnaires used were the Spielberger State Trait Anxiety Inventory (STAI) (Spielberger et. al., 1983) and the Marlowe-Crowne Social Desirability Scale (MC) (Crowne & Marlowe, 1960). See Experiment 1, page 53 for further details.

Cognitive measures

The Stroop and dot probe methodologies used in Experiment 1 were re-used in the present study, refer to Experiment 1, page 53 for details.

Physiological measures

Electrodermal activity (EDA) was measured exosomatically by applying a constant 0.5 D.C. voltage across domed (Beckman type) Ag-AgCl electrodes in conjunction with a 0.05 NaCl electrolyte (Johnson and Johnson K-Y jelly). Electrodes were attached to masked areas on the distal flanges of the participant's index and second finger of their non-preferred hand. The masking collars were placed such that the centres of the whorls of the fingerprints were left exposed. The area from which conductance was measured was 0.392 cm^2. A standard Skin Conductance Response (SCR) unit made by Electronic Developments was modified so that it could be directly linked to an eight-channel analogue to digital board for data acquisition via computer. The settings on the SCR unit were mapped to the computer as follows. For each sample of SC data the switch settings were also recorded, providing a complete record that could be automatically reconstituted for analysis.

Channel 1- skin conductance range (1-11 micro-Siemens or 11-110 micro-Siemens)

Channel 2- sensitivity (the sensitivity selection switch was replaced with a dual pole version which allowed varying potential dividers to indicate the sensitivity selected at time of sampling).

Channel 3- SCL (the 10 turn potentiometer used by the experimenter to "back-off" SCL was buffered with a unity gain operational amplifier and then amplified by a dc amplifier (gain=10) to provide an analogue of SCL).

Channel 4 - SCR (the balanced output to the SCR display was also buffered and multiplied by 10, to provide an analogue of SCR).

Procedure

The laboratory was arranged so that the participant was seated in a soundproof room and the computers and EDA recording equipment were linked via an electrical link through the wall, as indicated in Figure 7 below.

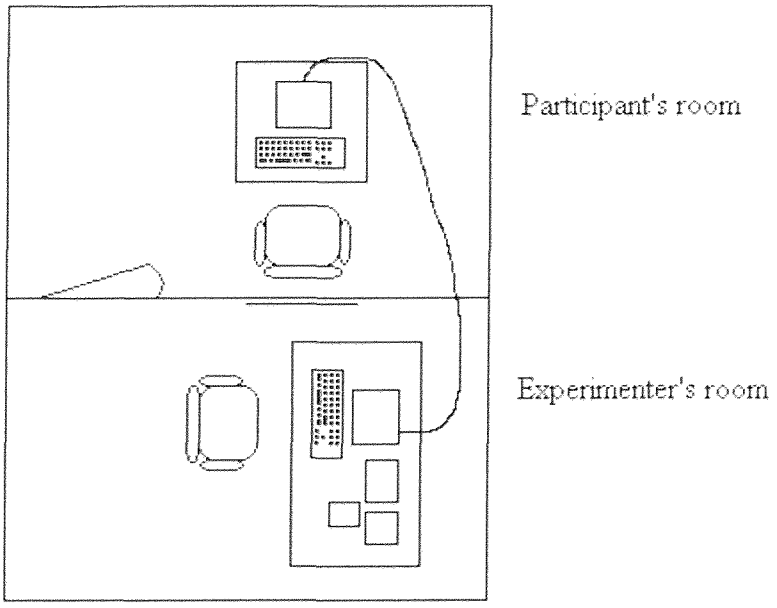


Figure 7 Arrangement of laboratory in Experiment two

The participant was welcomed and asked to sit at the desk in the soundproof room. The EDA electrodes were attached to the fingers of the participant's non-dominant hand and they were given then given copies of the Marlowe-Crowne and Spielberger Questionnaires and asked to fill them in.

When the participant had completed the questionnaires they were told that the computer would take them through the rest of the tasks. The soundproof room door was then shut.

First a series of 20 tones was presented in order to measure rates of habituation. A loudspeaker was placed inside the soundproof room and controlled by the experimenters' computer via a cable link through the wall. Twenty 60dB tones of 1 sec duration with a rise time of 150 ms were projected into the soundproof room with a fixed interval of 20 seconds between each one.

Then a series of 33 timed mental arithmetic sums were presented to the participants via the computer screen. These sums took the form of addition, multiplication, subtraction, or division of two integers. The problem was shown in the centre of the upper half of the screen. Two alternative answers were presented on the left and right hand fields of the bottom half of the screen. Along the very bottom of the screen a time elapse counter was displayed, graphically indicating the total time available (a fixed period of 20 seconds for each trial) and the proportion of time elapsed and time remaining. The participant had to choose either the left or right cursor key to indicate which answer they considered

correct. If they chose the wrong answer or did not answer in time the display flashed to a blank white screen with the word INCORRECT printed in the centre. The participant choice prompted the presentation of the next trial. This phase was included in order to give a sufficient recording time for the physiological measures.

The participant initiated the first of the Stroop trials and the dot probe trials. When the trials were all completed the experimenter opened the soundproof room door and thanked the participant and asked them to return for the second session in two weeks time. At the second session exactly the same procedure was followed and at the end the participant was thanked and debriefed.

Results

Self report data

Because of the variety of causes of drop outs the descriptive questionnaire data for all participants is shown in Table 15 below with numbers of participants in each group, this means that there are unequal numbers of participants in each group at time one and time two but it serves as a general insight into the levels of state and trait anxiety.

Table 15 Self report data from Experiment two.

Trait group	Trait at time 1	N	State at time 1	N	State at time 2	N
High	47.8	13	30.0	13	38.9	9
	(8.1)		(11.1)		(12.4)	
Low	33.9	16	30.9	16	31.7	15
	(4.4)		(8.1)		(7.0)	
All Ss	40.1	29	34.6	29	34.4	24
	(9.4)		(10.2)		(9.8)	

An independent measures T-test showed that trait anxiety scores were significantly different in the high trait and low trait groups ($t(27) = 5.827$, $p<.001$). At time one high trait and low trait participants' state scores were significantly different ($t(27) = 2.262$, $p<.05$) but at time two the p value was .083, only approaching significance ($t(22) = 1.817$, $p>.05$).

Cognitive data

Stroop data

Mean and median reaction times are shown in Appendix 7, analyses of these data showed the same patterns as analyses using ABIs.

Attentional bias indices were calculated using the following formula:

ABI = rt. to colour name threat words - rt. to colour name neutral words

Summary data for time one and time two are shown in tables 16 & 17 below. A 3x2x2x2 mixed ANOVA with a between participants variable of trait anxiety group (high and low) and within participants variables of time (one or two) presentation (blocked, mixed, masked) and threat type (social or physical) was carried out on Attentional Bias Indices. No significant main or interaction effects were found, for example there was no main effect of trait anxiety, $F<1$. The main effect of time did approach significance, $F(1,19) = 3.337$, $p=.08$. Across all conditions and collapsing trait anxiety groups, the mean ABI at time 1 was –2, at time 2 it was 9. Participants therefore took relatively longer to colour name emotional words compared to neutral words at time two than time one. In other words their attention was captured by the emotional words to a greater extent at time two than time one.

Table 16 Mean ABIs for physically threatening Stroop words by presentation type (blocked, mixed or masked) and time (one or two) in Experiment two.

	N		Blocked		Mixed		Masked	
	T1	T2	T 1	T 2	T 1	T 2	T 1	T 2
High trait Ss	13	9	9 (42)	-3 (37)	-9 (69)	16 (54)	5 (54)	17 (38)
Low trait Ss	16	15	15 (36)	-2 (28)	1 (51)	15 (37)	13 (44)	-1 (31)
All Ss	29	24	12 (39)	-2 (31)	-3 (59)	15 (43)	9 (48)	5 (34)

Table 17 Mean ABIs (in ms per word) for socially threatening Stroop words by presentation type (blocked, mixed or masked) and time (one or two).

	N		Blocked		Mixed		Masked	
	T1	T2	T 1	T 2	T 1	T 2	T 1	T 2
High trait Ss	13	9	-1 (46)	-6 (54)	-26 (36)	12 (47)	-28 (51)	27 (34)
Low trait Ss	16	15	-7 (36)	18 (46)	4 (52)	15 (36)	-14 (38)	3 (56)
All Ss	29	24	-4 (40)	9 (50)	-9 (47)	14 (39)	-20 (44)	12 (49)

Dot probe data

Mean and median data are shown in Appendix 8, analyses of these data showed the same patterns as analyses using ABIs.

Again, attentional bias indices were calculated using the following formula:

ABI = rt. to probe in neutral field-rt. to probe in threat field

Summary data for time one and time two are reported in Table 18 below.

Table 18 Mean ABIs for dot probe presentations at time 1 and time 2 in Experiment two.

	N		Moderate threat		Severe threat	
	T1	T2	Time 1	Time 2	Time 1	Time 2
High trait group	4	8	12 (9)	-50 (39)	-17 (29)	-25 (30)
Low trait group	4	13	4 (32)	15 (29)	-43 (16)	-18 (33)
All participants	8	21	8 (22)	-9 (34)	-30 (26)	-21 (31)

The data would have been subject to a 2x2x2 mixed ANOVA with a between subjects factor of trait anxiety group (high or low) and within subjects factors of time (one or two) and severity of stimuli (moderate or severe) but there were not enough participants at time one to carry out this test. Instead a 2x2 mixed ANOVA was carried out on time two data only with a between subjects factor of trait anxiety and a within subjects factor of severity of stimuli. There was no main or interaction effect of severity of stimuli, $Fs<1$.

There was no significant main effect of trait anxiety either although this did approach significance, F (1,19) = 3.457, p= .079, but the trend was not in the expected direction. High trait participants displayed an average ABI of -20ms while low trait participants displayed an average ABI of –10ms, it was expected that high trait anxious participants would take longer to respond to probes in neutral fields than probes in threat fields in comparison to low trait anxious participants. In other words, the high trait anxious participants' ABIs should have been more positive than the low trait anxious participants.

Physiological data

A variety of parameters were extracted from the EDA records prior to statistical analysis: (All amplitudes are in μS)

- Measure of habituation (number of trials until three null responses are obtained).
- Estimate of SCL, from an average of SCL at response onset.
- Frequency of n.s.-SCR (window set at 1-5 seconds).
- Mean amplitude of responses.
- Magnitude of first SCR.

There are two questions to be asked of these data: What are the test-retest correlations of these indicators of anxiety? And how do the anxiety groups (on the basis of questionnaire scores) differ in terms of these physiological indicators?

The data required to answer the first question is shown in Table 19 below. Pearson's correlations were performed on the raw data.

Table 19 Correlations between EDA measures at time 1 and time 2 in Experiment two.

Measure	N	r	Sig
Mean amplitude of responses	23	.278	.199
Number of n.s.-SCR	19	.500*	.029*
Number of tones to habituation	22	.399	.066
Amplitude of first response	22	.436*	.043*
Mean SCL	23	.069	.755

Two of the indicators do correlate significantly at time one and two, that is number of n.s.-SCR and amplitude of first response. The number of tones to habituation correlates to .399, which is significant to the .066 level. Mean SCL and mean amplitude of responses do not correlate with each other at time one and time two.

The second question that examines the effect of anxiety on EDA responses was examined. Median splits of the questionnaire scores were used to divide the participants into high and low anxious groups. Independent sample t-tests were carried out on each of the data types and at both time points. No differences were found between anxiety groups on any of the physiological measures. The only measure that approached significance was the number of n.s.-SCR during the tone phase of the experiment at time one. In the expected direction, high trait participants showed more ns-SCRs than low trait anxious participants (high trait mean – 29.38 (s.d. 14.15), low trait mean – 19.0 (s.d. 14.08)), but this difference was only significant to the .063 level, $t(1,26) = 1.942$, $p=.063$.

Discussion

To summarise the results, there were no expected findings from the physiological measures or the cognitive measures.

There were only two results that approached significance, the first was the finding that participants' attention was captured by the emotional words compared to the neutral words to a greater extent at time two than time one. This is in opposition to a practice effect which would result in participants being able to ignore the emotional words better on subsequent testings and hence having lower ABIs. This effect did not interact significantly with trait anxiety levels however, and so should not be over emphasised.

The second effect which approached significance was that high trait participants showed more ns-SCRs than low trait participants, this mirrors the findings of Dimberg, Fredrikson and Lundqvist (1986) among others.

The lack of expected findings mirrors the results of experiment one in that there were no significant effects in the expected direction found using the cognitive measures. This may be for two reasons. Either the cognitive methodology used in studies 1 and 2 is different enough from methodologies used previously in the literature that it has produced differential effects, or alternatively, it is not picking up on the effect present. This issue is dealt with in the next study where a review of previous methodologies is made in detail and an alternative methodology is tested for convergence with that used in this study and Experiment one.

The other possible reason for a lack of significant results is that these cognitive biases only occur when the participants are subjected to extreme levels of stress. There have been studies cited in the literature where attentional bias effects have been found in

normal populations at low state anxiety levels but it is a fact that these biases are more extreme in clinical populations or in normal populations where state anxiety is elevated. For this reason studies 4 and 5 examined the attentional biases under a chronic and acute stress situation.

The physiological data are disappointing. Originally heart rate was also recorded and it may have been that this shed some light on the source of the null effects. However, these data were lost due to computer difficulties and so cannot aid explanation. It may be that the participant numbers are too small to result in significant effects, in Experiment 4 where EDA is used as a dependent measure again more participants were recruited.

As noted in the literature review, physiological measures do not have very high reliabilities so this lack of positive findings was not as unexpected as the lack of cognitive findings.

An additional factor, which may have resulted in trait anxiety having no main effect in any of the ANOVAs, is that the spread of scores was not sufficient. For this reason, in Experiment 4 extreme trait responders were selected.

Studies 1 and 2 were primarily intended to explore the test-retest reliabilities of the cognitive and physiological measures. Instead what they demonstrated was that the effects may be more elusive than the literature suggested, particularly in the case of the cognitive measures. And so the focus of the subsequent studies became to find explanations for the lack of findings and to use methodologies which would stack the odds in favour of finding them.

Experiment 3

Introduction

In this study the issue of convergent validity of Stroop methodologies was examined. No attentional bias effect was found using the Stroop methodology adopted in the studies 1 and 2, a possible explanation is that it may be due to methodology.

At present there are two ways of administering the Stroop test to participants. Firstly using cards as in the original methodology used by Stroop (1935). 100 words per card were printed in rows and participants were asked to turn over the card and read out either the colour of the words or the words themselves according to the experimental condition. The dependent variable was the time it took to read from the beginning to the end of the list. This card based presentation method remains the most common method used in emotion research.

Studies 1 and 2 have utilised the alternative, slightly less common methodology of single word presentations via a computer screen, each word is presented and the latency to press a button or make a vocal response corresponding to the colour of the type of the word is measured. In this way word types can be mixed or presented in blocks one after another.

The implicit assumption in the literature is that these two methods, card and computer presentation, measure the same underlying process. In fact, apart from one study Kindt et.al. (1996), the question has never been directly addressed. If it had not been for the disappointing null findings from studies 1 and 2 the issue of convergent validity between the card and computer presentation methods would probably not have been put forward for consideration.

At this point it is helpful to examine the existing literature to see if there are indications that results from studies using card presentations differ in a systematic way from those which have employed computer presentations. What follows is a table to compare the attentional bias indices (ABIs) obtained using card or computer presentations, see tables 20 and 21.

Table 20 Summary of studies which have used card presentations of Stroop tasks

Study	Group showing effect	ABI in ms per word
Mathews and MacLeod '85	Clinical	44
Mogg et. al. '89	Clinical	28
Martin et. al. '91 exp. 2	Clinical	20
Martin et. al. '91 exp 4	Clinical	72
Golombok et. al. '91	Clinical	40
Mathews & Klug '93	Clinical	28 (av.)
Mathews et. al. '95	Clinical	45
Dawkins & Furnham '89	High trait	50
Mogg et. al. '90	High trait	39
	High state	50
McNally et. al. '90a	PTSD	300
McNally et. al. '93	PTSD	290
Ehlers et. al. '88	Panic disorder	38
Lavy et. al. '94	OCD	108
Hope et. al. '90	Social phobia	77
Watts et. al. '86 Study 1	Spider phobic	190
Watts et. al. '86 Study 2	Spider phobic	189
Martin et. al. '92	Spider phobic	137 (average)
Mathews et. al. '93 Study 2	Snake phobic	45
Mathews et. al. '93 Study 3	Snake phobic	50

Table 21 Summary of studies which have used computer presentations of Stroop tasks

Study	Group showing effect	BDI in ms per word
Mogg, et. al. '93a	Clinical	14 (av.)
Richards & Millwood '89	High trait	20
Richards & French '90	High trait	120
Richards et. al. '92 Study 1	High trait	129
Richards et. al. '92 Study 2	High trait/high state	72
MacLeod & Rutherford '92	High trait/high state	10.5
Foa et. al. '91	PTSD	400
Cassiday '92	PTSD	175
Kaspi et. al. '95	PTSD	115
McNally et. al '90b	Panic disorder	57
McNally et. al. '92	Panic disorder	24
McNally et. al '94	Panic disorder	36
Foa, et. al. '93	OCD	25 (av.)
Lavy et.al.'93	Spider phobic	39

Rather than only taking an overall average ABI for computer presented tasks and an average ABI for card presentations the data have been categorised on the basis of sample characteristics. For example, PTSD studies are notorious for the high ABI's they produce, if more of these studies were conducted using computer presentation than card presentation the mean ABI for all computer presentations would be disproportionately inflated. See Table 22 below for a summary of mean ABIs by sample.

As can be seen from the summary table it appears that of the two alternative methodologies card presentations yield larger mean ABIs. What possible explanations exist for this phenomenon? The obvious difference between card and computer versions is the presence of additional, non-target words in the card method, instead of single word presentations by computer. This additional information may act in one or both of two ways, either by elevating the perceived emotionality of the word or by elevating the situational anxiety of the participant. In other words, it may be that the words surrounding the target stimuli act as distractors, in that they cannot be ignored and so reinforce the awareness of the emotional nature of the target word and it's "anxiety relevant" properties. Or it could be that the block of words acts as a mood induction technique and hence elevate the participant's state anxiety levels. Both of these explanations would give rise to a larger mean ABI when using the card method as opposed to the computer method.

Table 22 Summary of mean Stroop ABIs by participant group, comparing between studies which have used card and computer presentations.

Subject group	Mean ABI for card presentations (number of studies)	Mean ABI for computer presentations (number of studies)
Clinical GAD	39 (7)	14 (1)
Normal high anxious	46 (3)	70 (5)
PTSD	295 (2)	230 (3)
Panic disorder	38 (1)	39 (3)
OCD	108 (1)	25 (1)
Specific phobia	114 (6)	39 (1)
Overall mean	106 (20)	69 (14)

Richards et. al. (1992) were the first to suggest that there could be an emotional induction effect of blocked presentations of words. They were prompted to investigate this

issue because of the possibility of mixed presentations which computer presentation offered. Blocked presentations describes the situation under which all the words of one hedonic tone category are presented one after the other, as contrasted with mixed presentations whereby the categories are mixed randomly. Prior to the introduction of the computer method it had to be the case that words were presented in blocks since the methodology necessitated that only words of one type could be put on one card. They hypothesised that the blocked presentation of words would raise the participants state anxiety levels and that should therefore be a greater interference effect for blocked presentations compared to mixed. They did in fact find an interference effect only for the high trait participants in the blocked condition, implying that the type of presentation did have an effect and hence was due to a mood manipulation. However, Richards et. al. noted that this lack of findings of attentional bias for mixed presentations was incompatible with their own previous findings (Richards & Millwood, 1989) in which they did find an effect of negative words when they were presented mixed with neutral and positive words.

The Richards et. al. (1992) findings suggest that there maybe some truth in the hypothesis that block presentation of words has a mood manipulation effect and that it is worth considering as a possible explanation for the difference between card and computer studies. Most of the computer studies which were cited in Table 2 used mixed presentations, this may account for the elevated ABI's when using card presentations since they are all blocked presented and therefore maybe "gaining" from the additional mood manipulation effect. In the present experiment the computer presentations were both blocked and mixed so that any mood manipulation effects could be examined explicitly. Kindt et. al. (1996) found no convergence for the two methods of presentation when testing 48 psychology undergraduates. They were not able to demonstrate an attentional bias effect for spider phobic words in either card or computer presentation experiments and when those two methods were correlated a non-significant value of 0.1 was obtained. They concluded that the two formats measure different underlying mechanisms and that both mechanisms are unstable. They recommend against the application of these techniques to the level of the individual for these reasons.

Since this experiment was mainly prompted by the desire to explain previous null findings in studies 1 and 2 the opportunity was taken to vary the population sampled, this was also attractive in order to act as a counter to Kindt's study which used psychology undergraduates. Previous studies by other researchers on normal populations have not generally used psychology undergraduates, the most similar groups used have been

medical students. It may be that psychology and medical students are non-representative. The responses on the attention measures, particularly the masked presentations, are probably not affected by participants' characteristics, but responding on the questionnaires may well be. For that reason an opportunistically recruited non-student sample was used.

To conclude, the hypothesis was that method of presentation, either card or computer, would have an effect on the attentional biases measured (ABIs). It was expected, from examination of previous literature, that card presentation may result in larger mean ABIs due to a mood manipulation effect. This hypothesised mood manipulation effect was also expected to result in larger mean ABIs for blocked computer presented trials versus mixed computer presented trials. Additionally, it was anticipated that the use of a non-student population may culminate in significant attentional bias effects.

Method

Design

This experiment was a repeated measures design. A card and a computer version of the emotional Stroop were administered to participants. Self reported state anxiety and trait anxiety levels were also recorded.

Participants

33 participants were opportunistically sampled. A criterion for inclusion was that they have no previous experience of psychology. Participants were only included in the study if they could answer no to the question, "Do you have any background in psychology? For example have you ever studied for an exam in psychology or related discipline?"

Of the 33 participants, 16 were male and 17 female. Ages ranged from 20 to 46 with a mean of 28.9 (s.d 6.06).

Materials

Self report measures

The questionnaires used were the Spielberger State Trait Anxiety Inventory (STAI) (Spielberger et. al., 1968) and the Marlowe-Crowne Social Desirability Scale (MC) (Crowne & Marlowe, 1960). See Experiment 1, page 53 for further details.

Cognitive measures

Computer Stroop

The same computer Stroop program was used as in studies 1 and 2, however, so that participants could be visited at home, it was presented on a Toshiba 300 MHz laptop Additionally, the masked presentation condition was removed since there is no way to compare this method of presentation with the card method.

Card Stroop

Cards were constructed in line with previous research, see Table 23 for a summary of a review of six relevant articles. From this table the following dimensions were chosen: 5 test and 1 practise card were constructed, they were A4, laminated & white. One card was used for each word set, neutral, positive, physically threatening and socially threatening. One traditional Stroop test card was prepared with 20 words 10 "red" and 10 "blue" these were ordered so that five of each appeared in the same type colour and five in the incongruent colour. A practice card was also constructed which used the 20 practise words from the computer version, arranged in two rows of ten. The test cards used the words from the computer version of the Stroop in order that they are comparable as much as possible. Thus, each test card showed 40 words, randomly coloured red or blue (each colour appeared 20 times), in four columns of ten words. Participants were asked to read the colour of the words down the columns, and the time it took to read each card in full was recorded using a stopwatch.

Table 23 Specifications of Stroop card taken from previously published studies

Study	No. and content of cards	Size of cards	Pos. and no. words per card	Size of letters	No. colours	No. words in each set	Randomisation	Practice card used?
Mathews and MacLeod, '85	4(1 physical, 1 social, 2 matched neutral)	A4	96	0.5 cm	4	12	Each set of 12 repeated 8 times order of words randomised. Card pres. order balanced	No
Dawkins and Furnham, '89	3 (standard/ traditional, neutral, emotional)	39 x 39 cm	10 x 10 = 100	0.5 cm	5	20	Each colour 20 times (x) per card and 2 x per row	Yes, random letter strings, 2 x 10 = 20
Mogg, Mathews, Bird, Macgregor-Morris, '90	4 (standard, nonthreat, general threat, achievement threat	21 x 30 cm	100	Caps. (size not spec.)	4	20	Each word set written five times, different order each time. Card pres. Order randomised.	No
Martin, Horder, Jones, '92	4 (standard, nonwords, control, spider)	A4	1 x 37 = 37	?	5	5	Colours randomised	Yes, details not given
Woodfield, Jones, Martin, '95	3 (negative, neutral, control)	?	2 x 25 =50	?	5	?	Each colour appeared 10 times per card	No
Mathews, Mogg, Kentish, Eysenck, '95	4 (Positive, neutral, phys threat, social threat)	30 x 40 cm	120	Caps., 0.5 cm	4	10	Each colour appeared 30 times on each card each word appeared 3 times in each colour. Card pres. order balanced.	Yes, details not given.

Procedure

Each participant who was known personally by the experimenter was visited in his or her home. They were taken into a quiet room away from other people. Participants were asked, " Do you have any background in Psychology? For example, have you ever studied for an exam in psychology or a related discipline?" If the participants answered yes they were not asked to continue.

Participants were asked to complete the Marlowe-Crowne and Spielberger State Trait Anxiety Inventory (Appendices 1 and 2). Participants were then allocated to do either the computer task followed by the card task or vice versa alternately. So participant number one did the computer task first, participant number two did the card task first etc. The computer task was on a Toshiba laptop, which was placed on a table in front of the participant or on their lap if a table was not available. They were asked to respond as quickly and accurately to name the colour of the type of each word as it was presented by pressing either the left cursor (blue) or the right (red).

The participant was handed each card one at a time face down and was not told to turn it over until the experimenter said, "Go". The practice card was presented first and prior to turning it over the participant was told to expect a list of words and that their task was to read down the list and to say the colour of the type and not the word itself. The experimenter started the stop watch on the word go and noted the participant's responses until they had reached the last word of the set and stopped it as soon as that had been colour named.

Results

Self report data

A median trait score of 37 was used to divide participants into high and low trait groups. The mean values are shown in Table 24 below.

Two independent samples t-tests showed that the high and low trait groups differed significantly on their trait scores ($t(31) = 7.309$, $p<.001$) and state scores ($t(31) = 4.953$, $p<.001$).

Table 24 Self report data from Experiment 3.

Trait group	N	Trait score	State score
High trait	18	45.1	41.1
		(6.4)	(6.0)
Low trait	15	31.5	30.8
		(3.7)	(5.9)
All participants	33	38.9	36.4
		(8.6)	(7.8)

Cognitive data

Mean and median data are shown in Appendix 9, analyses of these data showed the same patterns as analyses using ABIs

Reaction times in each condition and to each valence type of stimuli were recorded. In order that the results from the card presented Stroop were comparable with the computer Stroop, these times were divided by 40 (no. words on the card) and multiplied by 1000 to give the time taken to colour name each word in milliseconds. The raw reaction times in milliseconds are given in Table 25 below.

Table 25 Stroop response times by presentation and word valence for Experiment 3.

Variable	Mean value (ms per word for r.t.s)
Computer presented Stroop	
Blocked neutral	514
Blocked positive	530
Blocked physical threat	525
Blocked social threat	526
Mixed neutral	526
Mixed positive	525
Mixed physical threat	525
Mixed social threat	532
Card presented Stroop	
Neutral	477
Positive	471
Physical threat	470
Social threat	466

ABIs were calculated using the following formula:

Attentional bias index = rt. to colour name emotion words - rt. to colour name neutral words

The effect of anxiety on attentional bias was examined by using a median split and placing participants into high and low state and trait groups. A 3x2x2 ANOVA was conducted on the ABIs with one within subject factor, valence (positive, physical and social) two between subject factors state (high or low) and trait (high or low). For card, computer blocked and computer mixed presentations there were no main effects of state, trait or valence and no two or three way interactions (Fs<1).

It was expected from the previous literature that the attentional bias indexes would be larger for the card presentations than the computer presentations and also that blocked presentations of the computer Stroop would result in larger ABIs than the mixed presentations, Table 26 shows these summary values.

Table 26 Stroop ABIs by valence and presentation for Experiment 3.

ABI	Card presented	Computer blocked		Computer mixed	
Positive	-7 (38)	11	(51)	-11	(41)
Physical threat	-6 (27)	16	(53)	4	(41)
Social threat	-10 (30)	11	(27)	9	(40)

A 3x3 repeated measures ANOVA was carried out on the data which are summarised in Table 26. There was a significant effect of presentation, F=4.663, p= 0.017, but no significant effect of valence and no interaction between the two, Fs<1. Pairwise comparisons indicated a significant difference between card and blocked computer presentations (mean difference 21.23, std err = 6.992, p = .005) but no significant difference between blocked and mixed computer presentations and no difference between card and mixed computer presentations, Fs<1.

Pearson's correlations between the three types of presentation indicated that there were no significant correlations apart from one. That was between the ABIs gained on card presented social threat words and computer presented positive threat words which were mixed with other valenced words, r= .361, p<.05. This one correlation was not expected, had the three types of presentations shown convergent validity the correlations would have been between, for example, physical threat ABIs on all three presentations or social threat ABIs on the three presentations. It was concluded therefore that there was no evidence of convergent validity between the three types of presentation.

Discussion

The initial review of the literature implied that there may be a difference in ABIs obtained from using card and computer presentations. It was hypothesised that because of a possible mood manipulation effect of block presentations card methodology would yield larger ABIs than computer presentations and that within computer presentations blocked trials would yield larger ABIs than mixed stimuli. In fact, in order of magnitude block presented computer trials resulted in the largest ABIs followed by mixed computer trials and lastly card presented trials. The present findings indicate that the two methods of presenting the emotional Stroop task do not show convergent validity and that even within the computer presentation methodologies there is no convergent validity between mixed and blocked presentations.

An explanation for the difference between computer and card presentations observed in the literature which was not mentioned previously is response modality. Responses to card presentations are necessarily vocal and reactions to computer presented stimuli are generally made using a keyboard. However, in the present experiment the use of blocked and mixed presented computer tasks controlled for that effect and it seems as if there is an additional effect which is a result of blocking which interferes with convergent validity of these two types of presentations irrespective of response modality.

The conclusions of the present study cannot be accepted without reservation however. They would be most compelling if one type of presentation had resulted in a significant effect of valence particularly if that had interacted with the between subject factor of anxiety. However, the expected attentional bias effect was not observed in any of the three conditions. The apparent lack of convergent validity of the emotional Stroop methodologies may therefore be a function of a lack of any emotional Stroop effects to measure. That is a problem particular to this series of studies, which has not been rectified by using a different population.

Although no convergent validity between card and computer presentations was observed this cannot be taken to indicate a difference in the underlying processes which are being measured since none of the methods of presentation actually recorded an attentional bias effect. Kindt et. al (1996) do draw that inference but it is not appropriate. Because neither methodology captured the expected effect it is a mistake

to try to make a judgement about whether one captures the effect any better than another.

Experiment 4

Introduction

Some literature on dot probe and Stroop studies suggests that attentional bias effects are to be found in comparisons of high and low anxious normals. However, in the data collected so far this effect has definitely not been apparent: high trait anxious participants do not preferentially attend to threatening stimuli over neutral stimuli in comparison with low anxious participants.

An interaction effect has been reported for state and trait anxiety by MacLeod and Mathews (1988) among others. At low levels of state anxiety, attentional bias effects are shown by high trait anxious normal participants in comparison to low trait anxious participants. At high levels of state anxiety, in the presence of stressors, that difference becomes even more pronounced as high trait anxious participants become even more vigilant for threat stimuli and low trait anxious participants avoid threat relevant stimuli, see Figure 8 for an illustration.

At low levels of state anxiety the difference between high and low trait participants is not as pronounced as at high levels of state anxiety. In effect it could be argued that studies 1 and 2 have sampled from data points A and B.

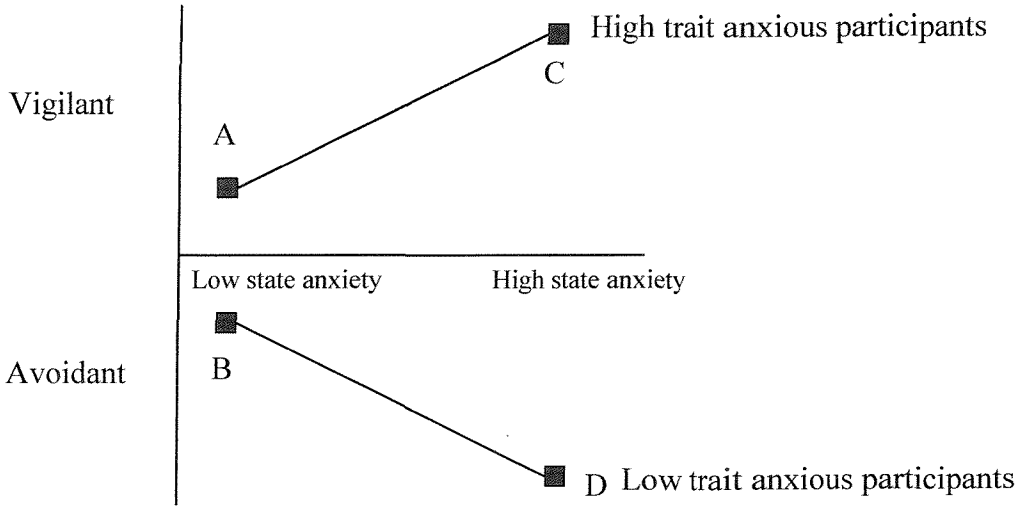


Figure 8 The hypothetical interaction effect of state and trait anxiety on ABIs.

In order to capture these larger differences - in other words, to sample from data points C and D it may be necessary to elevate state anxiety levels by manipulating external variables. What follows is a review of some of the studies which have reported the use of the dot probe or Stroop techniques and have explicitly manipulated state anxiety to measure attentional bias as a function of state and trait anxiety.

Studies which have explicitly investigated the relative effects of state and trait anxiety by manipulating state anxiety levels are not numerous. Certainly they do not appear as frequently in the literature as other methodologies, for example, the use of clinical participants is a prolific field. The first study which explicitly manipulated state anxiety, mentioned previously, MacLeod and Mathews (1988), will be described in detail in order to familiarise the reader with the general constructions of these types of experiments, some others are summarised more briefly in table form.

MacLeod and Mathews (1988) used the dot probe technique which they had developed together previously (see MacLeod, Mathews & Tata, 1986) and tested 36 medical students 12 weeks before a major exam when state anxiety was low and 1 week before the exam when state anxiety was high. (Initially 58 students were recruited, 17 did not return for a second session and 5 participants state anxiety scores were not elevated with the advent of the exam.) Participants were paid £2 for attendance at each session.

The participants completed the STAI at time 1 and the state scale only at time 2, see Table 27 below for mean scores. Participants were divided into high and low trait anxious groups on the basis of the median score for the sample which was 39.5.

Table 27 Mean STAI scores taken from MacLeod and Mathews (1988) (Standard deviations were not reported)

		High trait anxious group	Low trait anxious group
	N	18	18
Time 1	Mean trait score	45.1	34.8
	Mean state score	43.4	32.3
Time 2	Mean state score	59.7	49.0

Word lists were constructed using the ratings from 8 judges to produce 24 exam related threat words (e.g. unsuccessful), 24 general threat words (e.g. hateful) and 48 matched neutral words (example not given).

The threat words were paired with the neutral words, giving 48 critical pairs, where a threat word was presented in one visual field (upper or lower) and a neutral word in the other. All other factors, such as position of probe either upper or lower, were controlled for.

Attentional bias indexes were calculated and used as the dependent variable in a 2 x 2 ANOVA with independent variables of trait group and test time. The interaction term was found to be significant ($F(1,34) = 4.62$, $p<0.05$), the direction of results is shown in Figure 9 below.

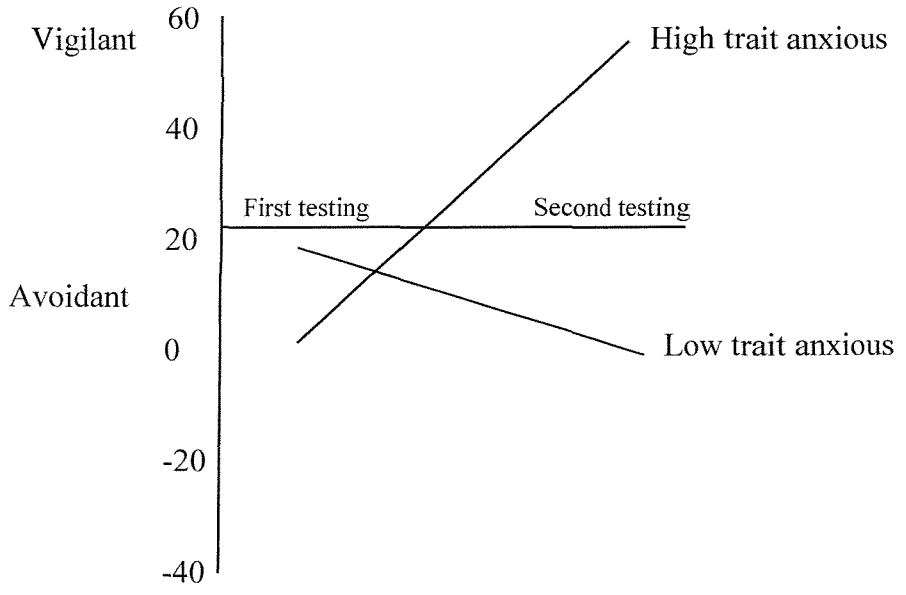


Figure 9 Effect of test time on attentional response to exam threatening words in high and low trait anxious participants. (Taken from MacLeod & Mathews, 1988, page 665.)

MacLeod and Mathews described the relationship in the following way, "The high trait subjects, as their state anxiety increased, came to show the same pattern that we have previously observed in a clinically anxious population. They appeared to direct attention *towards* the area of the screen in which the examination-related threat words had appeared, leading to a mean reduction of 44 msec to detect probes appearing in this area. However, a similar increase in state anxiety was associated with the opposite effect in low trait subjects, who apparently moved attention *away*

from examination related stimuli, resulting in a mean slowing of 27 msec to detect probes appearing in the same location." (Authors own italics.)

MacLeod and Mathews suggest that high and low trait anxious participants display qualitatively different responses to stressful stimuli and these cognitive strategies are only activated in highly stressful situations.

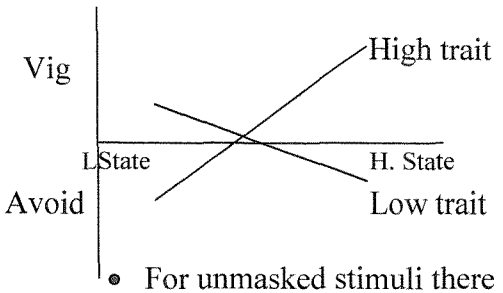
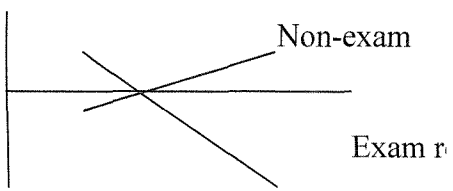
The following table summarises some other relevant studies, for example, MacLeod and Rutherford (1992). MacLeod and Rutherford also tested students when their state anxiety was elevated due to proximity to an exam, they found the same pattern of results on masked trials as found by MacLeod and Mathews. However, when stimuli were presented within conscious awareness the pattern was not as clear. For words that were related to general threat, low trait anxious participants showed avoidance at low state anxiety levels but vigilance at high state anxiety, whereas high trait participants showed vigilance to threat unchanged by state anxiety. For words that were threatening and specifically related to exam concerns both high and low trait participants displayed attention to threat at low state anxiety and avoidance at high state anxiety.

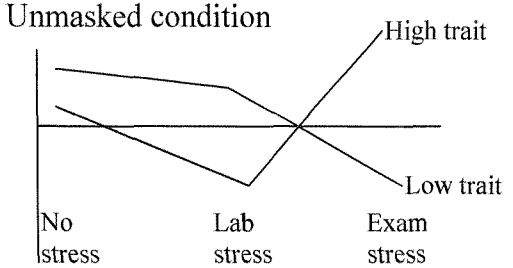
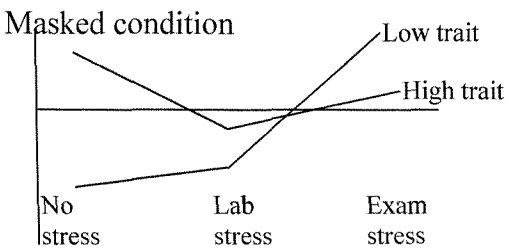
Thus it seems that mediation by conscious processes results in a different pattern of effects from those found for unconscious processing, in the current experiment both conscious and unconscious presentations of stimuli were included.

Table 28 Stroop and dot probe experiments which have examined the effect of state anxiety on high and low trait participants ABIs.

Study	Method and word stimuli	Participants	State anxiety elevation method	Results
Mogg, Mathews, Bird & Macgregor -Morris (1990) Experiment 1	Card presented Stroop. 20 general threat words. 20 achievement threat. 20 non-threat words 4 colours used (red, yellow, green, blue)	100 medical students completed STAI, 20 highest trait scorers (M=48.1) and 20 lowest trait scorers (M=28.9) were selected and randomly allocated to high or low stress condition. High trait, high stress n=9 HT/LS n=9 LT/HS n=10 LT/LS n=9	Ss told that anagram solution rate correlates with exam performance. Low stress - Ss told that correlation wasn't that strong and given easy anagrams. High stress - Ss told that they should be able to solve a lot and given hard/impossible anagrams. Attention tasks were described as filler material.	• No significant effect of condition on state anxiety. • High trait anxious Ss were significantly slower to colour name threat words compared to neutral words. Low TA Ss showed no difference in colour naming times between neutral and threat words. • High stress Ss were slower in colour naming threat (particularly achievement threat) than neutral words, irrespective of TA.
Mogg, Mathews, Bird & Macgregor -Morris (1990) Experiment 2	Computer presented dot probe. Same word sets used as exp 1. With the addition on 4 in each group to make 48 critical trials	Sample procedure repeated from exp 1. 20 high trait scoring group (M= 48.2) 20 low trait scoring group (M=29.8), equal numbers in high and low stress condition	Ss told about correlation with academic performance and attention tasks and anagram ability. Told to do anagrams, then attention task, then more anagrams. There was no second anagram session but it was included in order to maintain state A levels over the attention task. High stress- Ss told they were doing badly and would be videotaped Low stress- Ss told they were doing well and would not be videotaped.	• Significant main effect of stress on state A scores. • No main effect of trait anxiety • Effect of stress was significant. High stress subjects were faster to detect probes in threat fields. Low stress subjects showed no bias. • When state anxiety was used as a covariate the effect of stress condition persisted, independently of state anxiety.

Study	Method and word stimuli	Participants	State anxiety elevation method	Results
Richards, French, Johnson, Naparstek and Williams (1992) Exp. 2	Computer presented Stroop 20 anxiety, 20 anxiety matched neutral, 20 happiness, 20 happiness matched neutral words. 4 colours used (red, green, yellow, blue)	Population not described. Subjects divided on the basis of a score of 40 on the trait scale into high and low trait groups, randomly allocated to mood manipulation conditions. High trait, negative mood manipulation n=10 HT, positive MM, n=10 LT, NMM, n=11 LT, PMM, n=9	Negative mood manipulation - subjects were presented with three unpleasant newspaper photos and asked to rate them for whether it would attract attention, the professionalism of the photo and it's pleasantness/unpleasantness. Positive mood manipulation - as above using three positive pictures. State scale re-administered following mood induction. Stroop administered, subjects told it was a separate study.	• PMM and NMM had significant effects on state anxiety scores, PMM decreased state anxiety, NMM increased state anxiety, this was not dependent on trait anxiety group. • Positive and negative ABIs were calculated. • The low trait group did not differ in their colour naming times for valenced and neutral words under any condition. • The high trait group under PMM showed a greater interference for positive words than neutral. • The high trait group under NMM showed a greater interference for threat words than neutral. • For the negative mood manipulation trait anxiety correlated significantly with the negative ABI.

Study	Method and word stimuli	Participants	State anxiety elevation method	Results
Mac-Leod & Ruther-ford (1992)	Computer presented Stroop 384 trials using 48 words repeatedly presented, half masked and half not. ¼ were exam related threat (e.g. unsuccessful), ¼ were exam related, non-threat (e.g. achievement), ¼ were non-exam related threat (e.g. coffin) and ¼ were non-exam related, non-threat (e.g. ceiling) Vocal responses were recorded. (red, blue, green or yellow)	47 undergrad students attended 2 sessions. 24 students scoring below the median score of 36.5 were allocated to the low trait group, the remaining 23 were allocated to the high trait group.	High state anxiety condition - subjects were tested 1 week before a major exam Low state anxiety condition - subjects were tested 6 weeks after a major exam.	• State anxiety was significantly higher at session 1 compared to session 2. • Masked and unmasked results were different and therefore treated separately. • ABI's showed there was a significant interaction with state & trait anxiety for masked stimuli  • For unmasked stimuli there was no effect of trait anxiety, but there was an effect of specificity. 

Study	Method and word stimuli	Participants	State anxiety elevation method	Results
Mogg, Bradley Hallo-well. (1994)	Dot probe. Achievement threat, physical threat and positive words were paired with matched neutral words, to make 96 critical word pairs. Half of these were presented under a mask, and half non-masked.	674 undergrads at U. of Cambridge contacted, 117 completed STAI. 40 split used, with preference given to extreme scorers. 36 low trait (M=31.9) and 40 high trait (M=51.8) Ss were recruited for the first session. They received £10 for attending after the final session. 6 subjects were lost to attrition (3 from each group) and 4 subjects results were discarded because they tested as aware on the check for the masked stimuli.	1st session took place 12 weeks before end of year exams. 2nd session took place ten days later. 3rd session took place 1 week before end of year exams. Session 1 or 2 was either no stress or laboratory stress, order was randomised. No stress - State STAI and probe detection test (also, not relevant, 2 awareness checks for masked presented stimuli), also the Marlowe-Crowne Soc. Des. Scale, and the BDI. Lab stress - Ss given a practise IQ test which was probably too hard to be completed in the 5 minute time limit. Ss were told they would do a full IQ test after the attention deployment test. Ss then followed the no stress procedure and were told at the end that they would not have to do the final IQ test. Exam stress - Same as for no stress condition.	• Lab stress and exam stress produced equivalent (and significant) mean elevations from the state anxiety levels reported in the no stress condition (5.2 and 5.6 points respectively.) • There was a sig. interaction between trait anxiety stress and exposure (masked/unmasked), irrespective of type of threat word. Unmasked condition  Masked condition 

The six studies reported here send mixed messages about what results to expect when running a stress induction study. They use a variety of methods for elevating state anxiety. Four lab based state anxiety elevation procedures are reported here. Mogg et. al. (1990) exp. 1 and 2 Richards (1992) and Mogg et. al. (1994). Mogg et. al. (1990) used anagrams and told participants they correlated with exam performance. Richards et. al. (1992) used newspaper pictures to induce anxious or positive mood. Mogg et al. (1994) produced a significant elevation in state anxiety by giving participants a short IQ test under extreme time pressure. In the case of Richards et. al. (1992) it seems counter-intuitive to imagine that the primary reaction to a newspaper picture would be one of fear. Unfortunately, ratings of other emotions such as disgust or sadness were not recorded. The technique was taken from a previous study by Richards and Whittaker (1990) which investigated memory bias as a function of induced anxiety, in that study they did not administer any emotion ratings other than those employed in the attention study. This manipulation procedure, although it seemed to produce the expected results in that ABIs were elevated for high trait participants, is open to criticism on the basis of validity, i.e. the primary consequence of the method may not have been to induce anxiety, but to induce some other unspecified emotion.

Some researchers have opted to investigate the effects of chronic state anxiety by testing participants in close proximity to their exams. It is worthwhile summarising some studies which have used these two methods in order to determine which produces the greatest elevations in state anxiety.

Table 29 shows that for both high trait and low trait participants, and when looked at as a whole, exam proximity elevates state anxiety to a greater degree than lab based methodology. The mean elevation in state anxiety produced by exam proximity is almost double that induced by lab based procedures (9.57 points and 5.36 points respectively).

So, at first inspection it would seem that a proximity to exam manipulation would be preferable, however, participant attrition rates may be high for this design since participants may be reluctant to return for testing when they need to devote time to study. A table to compare the participant recruitment procedure in each study has been constructed, see Table 30.

Table 29 Summary of studies which have used laboratory and exam methods to induce STAI state anxiety elevations.

	Mean state A elevation Lab induced			Mean state A elevation Exam induced		
	High trait	Low trait	All subs	High trait	Low trait	All subjects
Mathews et. al. '88				16.3	16.7	16.5
Mogg et. al. '90 (i)	0.5	8.5	4.5			
Mogg et al. '90 (ii)	9.5	4.4	6.95			
Richards et. al. '92	1.8	7.09	4.45			
MacLeod et al '92				6.9	7	6.95
Mogg et. al. '94	5.5	5.6	5.55	4.9	5.6	5.25
All studies	4.33	6.4	5.36	9.37	9.77	9.57

From the only three studies which reported attrition rates, it can be seen that the average loss of participants from initial recruitment is 20%.

The exam stress studies, Mathews et al. (1988) and Mogg et. al. (1994), had higher attrition rates than the lab based study by Mogg et. al. (1990). However, the Mogg et. al. (1994) study did not approach the relatively high rates of attrition of the Mathews study, even though Mogg et. al. asked more of their participants since they had to attend three sessions. This may have been because of the system of reward for participation: Mathews et. al. gave their participants their £2 attendance fee after each session, Mogg et. al. withheld the £10 reward they were offering until the three sessions had been completed. This procedure cannot be adopted for the present study as the guidelines for use of the participant pool dictates that participants will receive course credits regardless of whether they complete the whole experiment or not.

Table 30 Summary table of participant recruitment details from studies which have used state anxiety manipulations.

	Population and Reward given	No. Ss selected	No. Ss discarded	No. Ss withdrew	% lost
Mathews et. al '88	Medical students £2 per session	58	5	17	38%
Mogg et. al. '90 (i)	Medical students no reward	40	0	3	7.5%
Mogg et. al '94	Undergraduates, £10 after all sessions	76	4	6	13%
Mean from all studies					20%

From this it would seem that attrition rates are not prohibitively high, and may be reduced by the withholding of monetary reward until the commitment to engage in all the testing sessions is lived up to.

As a result of this review it was decided to use a proximity to exam manipulation in the present study in order to examine the effects of state anxiety on cognitive and physiological measures. The between participants effect of trait anxiety group was also exaggerated by selecting extreme responders prior to recruitment for the main study.

Method

Design

This experiment took the form of a repeated measures design. Dot Probe, Stroop, electrodermal activity and self reported state anxiety levels were recorded whilst the participants were in a low anxious state and again approximately two months later when their state anxiety levels were higher due to the proximity of an end of semester exam. Participants' self reported trait anxiety was also recorded in order to allocate them to between subject's groups above and below the median.

Participants

A population of 122 undergraduates were screened using computer administered questionnaires and samples of extreme high and extreme low scorers on the trait scale of the Spielberger STAI were recruited. Students who scored 38 and below or 45 and above were asked to return for the main experiment. Some of those who scored below 38 on the STAI but scored above the median score of 17 on the Marlow-Crowne Social Desirability Scale were categorised as "repressors" and were not asked to return. This study, unlike studies 1,2,3 & 5, pre-selected participants, and so the opportunity was taken to eliminate repressors from the participant sample.
In total data exist at time one and time two for 44 participants. Their ages ranged from 18 to 43 with a mean of 23.5 years. 36 participants were female and 8 were male.

Materials

Self report measures

Since trait anxiety and Marlowe-Crowne scores had already been recorded at the screening phase, the only questionnaire which was used in the main study was the state scale of the Spielberger STAI (Spielberger et. al., 1983). See Experiment 1, page 53, for further details.

Cognitive measures

The Stroop and dot probe programs were taken from Experiment 1, see page 53.

Physiological measures

Again, heart rate was recorded but the data were lost during analysis. Electrodermal activity was measured using the same techniques reported in Experiment 2, page 74.

Procedure

The laboratory was arranged so that the participant was seated in a soundproof room and the computers and EDA recording equipment were linked via an electrical link through the wall.

The participant was welcomed and asked to sit at the desk in the soundproof room. The EDA electrodes were attached to the fingers of the participant's non-dominant hand and they were given then given the state scale of the Spielberger STAI to fill in.

When the participant had completed the questionnaires they were told that the computer would take them through the rest of the tasks. The soundproof room door was then shut

First a series of 20 tones was presented in order to measure rates of habituation. A loudspeaker was placed inside the soundproof room and controlled by the experimenters' computer via a cable link through the wall. Twenty 60dBel tones of a 1 sec duration with a rise time of 150 ms were projected into the soundproof room with a fixed interval of 20 seconds between each one.

Then a series of 33 timed mental arithmetic sums were presented to the participants via the computer screen. These sums took the form of addition, multiplication, subtraction, or division of two integers. The problem was shown in the centre of the upper half of the screen. Two alternative answers were presented on the left and right hand fields of the bottom half of the screen. Along the very bottom of the screen a time elapse counter was displayed, graphically indicating the total time available (a fixed period of 20 seconds for each trial) and the proportion of time elapsed and time remaining. The participant had to choose either the left or right cursor key to indicate which answer they considered correct. If they chose the wrong answer or did not answer in time the display flashed to a blank white screen with the word INCORRECT printed in the centre. The participant choice prompted the presentation of the next trial.

The participant initiated the first of the Stroop trials and the dot probe trials. When the trials were all completed the experimenter opened the soundproof room door and thanked the participant and asked them to return for the second session approximately two months later, 1 week prior to their exam period.

At the second session exactly the same procedure was followed and at the end the participant was thanked and debriefed.

The average time before the participants' next exam was 2 ½ days. Maximum time to next exam was 7 days. 4 participants were tested one day after their last exam, 4 participants were tested in the afternoon of the day that their last exam was scheduled for the morning, they were included in the study because it could have been the case that their residual state anxiety was still elevated.

Results

Self report data

Participants were already allocated to either a high or low trait anxiety group due to their responses at the screening stage of the study. Table 31 below shows summary descriptive data.

Table 31 Self report data from Experiment 4.

Category	Mean trait score	Mean state score at time 1	Mean state score at time 2	Mean change in state score	T-test to compare state scores at time 1 and 2
High Trait (n=24)	55.9 (6.4)	36.3 (8.4)	41.6 (9.6)	5.4 (6.8)	$t_{(23)} = 3.4$, $p<.01$
Low trait (n=19)	32.8 (3.7)	30.6 (4.9)	36.8 (8.4)	6.2 (6.7)	$t_{(19)} = 3.8$, $p<.01$

The proximity to exam manipulation did act to significantly elevate state anxiety by an average of 5.4 points in high trait participants and 6.2 points in low trait participants. The change scores of the high and low trait participants were compared using an independent t-test and it was found that the low trait participants did not show significantly larger elevations in state anxiety than the high trait participants ($t(42) = -.287$, $p > .05$).

Cognitive data

Stroop data

Mean and median data are shown in Appendix 10, analyses of these data showed the same patterns as analyses using ABIs.

There were three methods of presentation of the Stroop stimuli, blocked, mixed and masked. 4 valences of words were presented, neutral, positive, physical threat and social threat. The reaction times to these words were converted into the dependent variable Attentional Bias Index (ABI) according to the following formula:

Attentional Bias Index = RT to negatively valenced words - RT to neutral words

Summarised in Table 32 below are the mean ABIs to the different Stroop conditions for all participants who took part in the study.

Table 32 Mean ABIs for physically threatening Stroop words by presentation type (blocked, mixed or masked) and time (one or two) from Experiment 4.

		Blocked		Mixed		Masked	
	N	T 1	T 2	T 1	T 2	T 1	T 2
High trait Ss	24	2	-1	30	9	-16	10
		(92)	(64)	(63)	(50)	(81)	(97)
Low trait Ss	20	20	-11	6	19	17	-17
		(44)	(77)	(42)	(61)	(83)	(90)

Table 33 Mean ABIs for socially threatening Stroop words by presentation type (blocked, mixed or masked) and time (one or two) from Experiment 4.

		Blocked		Mixed		Masked	
	N	T 1	T 2	T 1	T 2	T 1	T 2
High trait Ss	24	11	-11	30	10	10	3
		(50)	(48)	(61)	(59)	(97)	(103)
Low trait Ss	20	0	-2	4	6	-17	16
		(63)	(39)	(56)	(77)	(90)	(107)

Tables 32 and 33 show that participants are not showing evidence of attentional bias. The bias should be most extreme during the high state condition and particularly for high trait participants. However, this is not the case, high trait participants at time two displayed an average attentional bias of 3.78ms over all conditions. A 2x2x2x3 mixed ANOVA was performed with a between subjects variable of trait anxiety group (high or low) and within subjects variables of time (one or two), valence (physical threat or social threat) and presentation (blocked, mixed or masked). No significant main or interaction effects were found, $Fs<1$.

However, not all participants showed an increase in state anxiety at time two, those participants' data have been removed from tables 34 and 35.

Table 34 Mean ABIs to physically threatening Stroop words for participants with elevated state anxiety levels at time 2 only from Experiment 4.

		Blocked		Mixed		Masked	
	N	T 1	T 2	T 1	T 2	T 1	T 2
High trait Ss	15	-3	-3	42	17	-13	16
		(112)	(68)	(75)	(43)	(91)	(74)
Low trait Ss	14	15	28	5	16	19	-21
		(47)	(78)	(22)	(43)	(87)	(98)

Table 35 Mean ABIs to socially threatening Stroop words for participants with elevated state anxiety levels at time 2 only from Experiment 4.

		Blocked		Mixed		Masked	
	N	T 1	T 2	T 1	T 2	T 1	T 2
High trait Ss	15	22 (56)	-5 (47)	41 (70)	9 (57)	18 (119)	33 (130)
Low trait Ss	14	-8 (59)	10 (31)	7 (38)	2 (51)	-5 (96)	-37 (94)

Again, these data do not show the extreme pattern of results that was expected. The group that should show the largest ABIs, high trait participants at time two, display an average ABI of 11.3ms when all presentation and threat type conditions are collapsed.

A 2x2x2x3 mixed ANOVA performed with a between subjects variable of trait anxiety group (high or low) and within subjects variables of time (one or two), valence (physical threat or social threat) and presentation (blocked, mixed or masked). There was no significant main effect of trait anxiety ($F(1,27) = 2.217$, $p>.05$) and there were no other significant main or interaction effects, $Fs<1$.

Dot probe data

Mean and median data are shown in Appendix 11, analyses of these data showed the same patterns as analyses using ABIs.

Attentional bias indices were calculated for the dot probe responses using the following formula.

Attentional Bias Index = RT to probe in neutral field - RT to probe in threat field

There were two conditions in the dot probe methodology, severely threatening and moderately threatening. The data for these are shown in Table 36 below.

Table 36 Mean ABIs to Dot Probe stimuli by trait group and stimulus severity from Experiment 4.

		Moderate threat		Severe threat	
	N	Time 1	Time 2	Time 1	Time 2
High trait	24	4 (40)	11 (39)	-9 (31)	-14 (38)
Low trait	20	7 (66)	8 (37)	-8 (56)	-15 (35)

Again, the expectation is that the more severe the stimuli the more extreme the attentional bias effect and this attentional bias should be in greatest evidence in the high trait participants at high state anxiety levels, i.e. at time two. However, the attentional bias index in this condition is –9ms which indicates that these participants are actually directing their attention away from threatening information.

A 2x2x2 mixed ANOVA with a between subjects variable of trait anxiety group (high or low) and within subjects variables of time (one or two) and severity (moderate or severe) was conducted. There was a main effect of severity, $F(1,42) = 10.53$, $p<.01$, but no other significant main or interaction effects, $Fs<1$. The negative ABI scores in Table 37 indicate that participants direct their attention away from severe threat pictures and towards the neutral stimuli when presented with a neutral/severe pair.

However, again, not all participants showed elevations in state anxiety as a result of impending examinations and so these participants' data were removed from the following table.

Table 37 Mean ABIs to Dot Probe stimuli for participants with elevated state anxiety levels at time 2 only from Experiment 4.

		Moderate threat		Severe threat	
	N	Time 1	Time 2	Time 1	Time 2
High trait	15	1 (41)	1 (31)	-10 (36)	-7 (39)
Low trait	14	12 (77)	5 (42)	-23 (46)	-15 (38)

Even though the table above only reports data for participants who showed elevations in state anxiety as a result of exam proximity, overall, the high trait participants still show attentional avoidance of severely threatening stimuli in a high state situation.

Another 2x2x2 mixed ANOVA with a between subjects variable of trait anxiety group (high or low) and within subjects variables of time (one or two) and severity (moderate or severe) was conducted. Again, a significant effect of severity was found, although it was only significant to the .05 level rather than the .01 level as previously found in the analysis of all participants' data ($F(1,27) = 6.867$, $p<.05$). There were no other significant main or interaction effects, $Fs<1$.

Physiological data

Like study 2, a variety of parameters were extracted from the EDA records prior to statistical analysis: (All amplitudes are in μS)

- Measure of habituation (number of trials until three null responses are obtained).
- Estimate of SCL, from an average of SCL at response onset.
- Frequency of n.s.-SCR (window set at 1-5 seconds).
- Mean amplitude of responses.
- Magnitude of first SCR.

It was expected that these responses would correspond to self reported levels of anxiety. Summary tables of descriptives at time one and time two are shown in tables 38 and 39 below.

Table 38 EDA data at time one from Experiment 4.

Trait group	Trials to habituation	Basal SCL	Freq. of n.s. SCRs	Mean amplitude	Magnitude of 1st SCR
High	4.7 (5.5)	8.64 (3.02)	25.33 (13.63)	.29 (.24)	.48 (.61)
Low	4.1 (5.2)	7.93 (3.64)	23.29 (16.19)	.36 (.28)	.69 (.75)

Table 39 EDA data at time two from Experiment 4.

Trait group	Trials to habituation	Basal SCL	Freq. of n.s. SCRs	Mean amplitude	Magnitude of 1st SCR
High	5.2 (5.1)	7.83 (3.54)	26.48 (17.62)	.31 (.22)	.54 (.55)
Low	4.8 (5.3)	8.29 (3.33)	24.24 (14.58)	.27 (.31)	.49 (.81)

As tables 38 and 39 show, there is very little difference between mean responses at time one and mean responses at time two, indicating little effect of state anxiety. More importantly there are no discernable differences between high and low trait participants. This observation was born out when the data were tested with five 2x2 mixed ANOVA with a between subjects factor of trait anxiety group (high or low) and a within subjects factor of time (one or two). For example, when comparing trials to habituation, there was no main effect of trait anxiety, $F<1$ no main effect of time (or state anxiety), $F(1,42) = 2.723$, ns, and no interaction effect, $F(1,42) =$

1.352, ns. The same pattern of non-significant results was found for each of the dependent physiological measures listed in tables 38 and 39 above.

Discussion

Following on from the lack of significant findings from studies 1 and 2, it was hoped that the proximity to exam manipulation would have elevated state anxiety sufficiently that the attentional bias effects would have emerged. The manipulation did result in a significant increase in state anxiety on both the high and low trait groups, high trait participants state anxiety scores were elevated by 5.4 points, low trait participants by 6.2. This degree of elevation is consistent with previous studies such as MacLeod et. al. (1992) who found that high trait participants' scores increased by 6.9 points and low trait participants by 7. It would seem counter intuitive that the low trait participants scores rose by more than the high trait participants. Pollens and Worden (1984) stated that high trait anxious participants experience state anxiety elevations "more frequently, and often with greater intensity than do people with lower trait anxiety." Yet in the present experiment, and in the other experiments reported in Table 29, page 103, low trait participants consistently showed greater elevations in state anxiety than high trait participants in response to proximity to an exam. There is no logical reason why this should occur but the independent measures t-test indicated that the elevations were not significantly different for the two groups of participants. This, combined with the fact that both groups showed significant elevations from baseline, was therefore not considered to be of importance.

Having established a significant elevation in state anxiety it would be expected that the attentional bias effects would have emerged. However, like studies 1 and 2, no significant effects of state or trait anxiety were found on Attentional Bias Indices.

This is additionally unexpected in light of the fact that extreme trait anxious participants were selected in order to facilitate the possibility of producing attentional bias effects.

The only significant effect found in this study was that of severity of dot probe stimuli. It was found that participants directed their attention away from severe threat pictures, irrespective of trait anxiety group or state anxiety situation. This main effect of stimulus severity was not found in studies 1 and 2. It implies that the severe pictures are so threatening that all participants are directing their attention away from

the stimuli, in other words that they are adopting the same strategy as the low trait participants from MacLeod and Mathews (1988) study when they were in the highly stressful situation. This hypothesis is in direct contrast to that of Yiend, Mathews, Bradley and Mogg (in press) who found that when using the same stimuli in colour rather than in black and white all participants attended to the threatening field irrespective of threat severity. They attributed this to the extremely threatening nature of the stimuli and so modified the pictures so that they were black and white only. This process implies that if a stimulus is very threatening all participants will allocate attention to it. This hypothesis is in direct contrast to the pattern of data reported in the present experiment which implies that the more threatening a stimulus the greater the degree of attentional avoidance. This pattern of response is consistent with that shown by repressors (see page 27 for a discussion of this participant group) but that explanation is superseded in the present experiment since any participants who scored highly on the Marlowe-Crowne Social Desirability scale in the screening phase were not invited to return for the main experiment.

Nevertheless, it is important to note that this issue has limited relevance for the aims of the present study since the main effect of severity did not interact significantly with either state or trait anxiety. Since there has been no significant effect of severity found previously in studies 1 and 2 the stimuli were not modified for Experiment 5.

The most plausible explanation for the lack of significant results is that the levels of state anxiety engendered by proximity to exam were not large enough to elevate attentional biases.

In order to test this hypothesis, Experiment 5 was designed so that state anxiety was elevated as much as possible using ethically acceptable methods.

Experiment 5

Introduction

This fifth and final study in the thesis used a similar design to that of the fourth. The aim was to investigate the effects of state and trait anxiety (measured using a self report scale) on cortisol and attentional biases and to examine correlations between the three types of measures: subjective, physiological and cognitive.
In order to dissociate the effects of state and trait anxiety the dependent variable must be measured at two time points, once when state anxiety is low and once when it is high. There are two available options for elevating stress, testing close to exams, a chronic stress situation, or using a lab stressor, an acute stress situation. A proximity to exam manipulation was used in Experiment 4 and although it did result in a significant increase in subjective reports of state anxiety, as measured by the Spielberger STAI, it did not result in an associated increase in attentional bias to threatening stimuli as indexed by the Stroop and dot probe tasks. Hence, a lab-based stressor was chosen as the preferred methodology for elevating state anxiety in this study.

An additional departure from the methodology used in Experiment 4 was that instead of using heart rate and skin conductance as physiological measures, salivary cortisol concentrations were recorded. This was done in order to extend the range of indicators of anxiety which were covered within the thesis as a whole, and also because there had been large amounts of heart rate and skin conductance data lost in the past due to frequent equipment failures.

It is common knowledge that the hypothalamic-pituitary-adrenocortical (HPA) axis responds sensitively to external stimulation, stressors lead to enhanced frequency and amplitude of cortisol pulses which can be measured by mean increases from baseline in response to stressors.

Most studies of physiological reactivity have used relatively brief exposures to single stressors such as reaction time tasks, Stroop tests and cold pressor tasks (a commonly used, standard procedure during which the participant is asked to place their hand in ice water for around one minute). These tasks, while being easy to

administer, tend to produce only small physiological responses and hence are not considered generalisable to stressors in daily life (Dimsdale, 1984).

Al'Absi et al. (1997) conducted the only study which directly compares one of the previously mentioned "traditional" laboratory stressors (mental arithmetic) with a social stress protocol. The study was conducted by a team of researchers who were affiliated to various medical institutions, the impetus behind the research being reports of correlations between reactions to lab stressors and medical conditions such as hypertension. They state that these apparent relationships require employment of lab stressors which are replicable, substantial in magnitude and relevant to daily life. To identify such stressors they recruited 52 healthy men and measured cortisol and cardiovascular responses to a social stressor test and a mental arithmetic test in a balanced repeated measures design.

It is easiest to understand the sequence of events in the experiment when they are displayed in a diagrammatic form, see Figure 10.

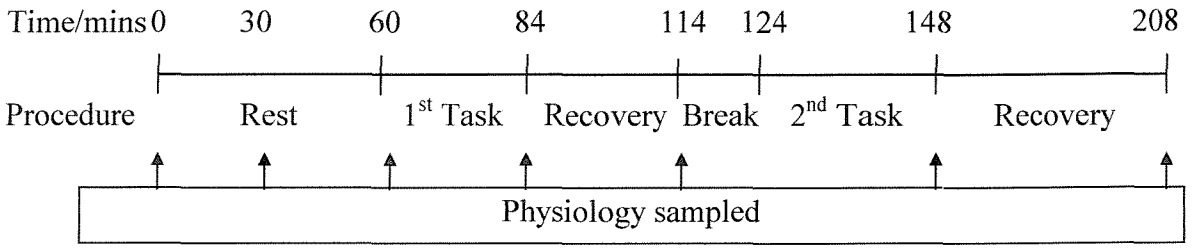


Figure 10 Timeline of procedural events in Al'Absi et al. (1997)

During the rest period participants read general interest magazines. The mental arithmetic task lasted 24 minutes in total, divided into three blocks of 8 minutes. At the start of each block the participants were given a three digit number and asked to add the digits together and then add the sum to the original number. When a mistake was made the experimenter used a microphone and loudspeaker to instruct the participant to go back to the previous correct answer. Participants were told in advance that they could earn a monetary bonus for speed and accuracy in each of the blocks, although in effect there was a flat fee paid irrespective of performance.

Like the mental arithmetic task, the social stress task lasted 24 minutes and was divided into three blocks of eight minutes. In each block participants were asked to construct and deliver a 4 minute speech after a 4 minute silent preparation period. Prior to commencing the first block the participants were told that they would be videotaped and their responses would be analysed by members of the laboratory.

During the preparation and delivery of the monologues two experimenters sat in front of the participant. Each block differed in the issues participants were asked to speak on, orders were counterbalanced. The three scenarios were 1) Participants were given an article on the causes of grey hair and asked to summarise it. 2) Participants were asked to argue for the inclusion of homosexual men in the army. 3) Participants were asked to imagine the experimenters were judges and that they were trying to defend themselves from a charge of shoplifting.

Both tasks, mental arithmetic and public speaking, significantly elevated cortisol and reported anxiety (measured by the McNair, et.al. (1992) Profile of mood scale (POMS)) from baseline levels. Changes in reported anxiety were correlated positively with changes in cortisol responses during the public speaking task ($r=.31$) but not during the mental arithmetic task. As expected, the social stress procedure elicited a significantly larger increase in cortisol than the mental arithmetic stressor, $F(1,44) > 4.6$, $p < .04$. Interestingly, greater responses to both tasks occurred when the mental arithmetic task was performed first. Because the participants were informed what each of the task requirements would be at the beginning of the experiment the authors conclude that the elevated responses are due to the effect of anticipating the speech task and that this effect acts over the course of the whole experiment. This study illustrates how potent social stressors are in comparison to cognitive stressors such as mental arithmetic.

Al'Absi et. al. (1997) comment that, "There have been few efforts to characterise HPA responses to social stress in humans." The main source of research on these stressors is from the team at Trier. Kirschbaum and Hellhammer (1989, 1994) have reviewed the literature on the measurement of salivary cortisol in psychobiological research. They report the common use of cognitive stressors such as mental arithmetic or proximity of examinations (e.g. Fibiger et.al., 1986; Hellhammer et.al., 1985;) and equally common, the use of stressful films (such as The Shining) to elicit emotional reactions (e.g. Hubert & de Jong-Meyer, 1989). However, the authors favour socially stressing techniques which elicit large elevations of cortisol from baseline and which can be administered to any population. Hence the authors have developed a socially stressing protocol which they have named the "Trier Social Stress Test" (TSST). The TSST consists of an anticipatory period of 10 minutes during which participants are asked to prepare a speech and a test period of ten minutes during which the participants have to deliver the speech to a panel of

experimenters. They then follow the speech with a mental arithmetic task which comprises of subtracting 3 repeatedly from a large number. Each time they subtract the number incorrectly they are told to return to the initial number and begin again. Kirschbaum, Pirke and Hellhammer (1993) report reliable increases of salivary cortisol of up to 4-fold elevations above baseline. The team of researchers at Trier have used the TSST repeatedly in their experiments (e.g. Kirschbaum, Prussner et.al., 1995) and have found that the technique reliably causes increases of salivary cortisol.

Outside of Trier it has not been used as widely as might be hoped but recently three studies have appeared in the literature which do employ the task. Jansen et.al. (1998), at the University of Utrecht, compared a group of 10 schizophrenic men and 10 normal controls in their cortisol reactions to the TSST. They found that the schizophrenic patients did not display elevations of cortisol in response to the stressor but that the normal controls did display significant elevations from baseline. A separate team of researchers at the University of Utrecht (Markus et.al., 1998) investigated the effects of diet on mood and performance after the TSST. Again, the stressor resulted in a significant increase in cortisol and self reported mood. The only other reported study which has used the TSST outside of Trier was conducted by Gerra et.al (1998) in Italy (the authors were affiliated to various institutions). They examined the relationship between different degrees of aggressiveness within the normal range (low, medium, high) and cortisol responses to the administration of the TSST in thirty male peripubertal junior school adolescents. Again, they found significant elevations from baseline in cortisol as a response to the TSST.

Al'Absi et. al (1997) suggest an explanation for the effectiveness of the TSST. They note that general social stressor tasks incorporate several challenging components: fear of evaluation, the necessity to maintain poise, and the emotional nature of the material being discussed. In the case of the TSST the participant is made acutely aware that his or her performance is subject to evaluation by the audience, the presence of the audience also necessitates the maintenance of poise. The actual content of the speech, which mimics a job interview, enables the evaluation of personal characteristics and hence could be considered emotional.

The TSST has an additional component which was not listed as one of those which contributes to the effectiveness of social stress tests by Al'Absi et. al., and that is the impact of anticipation. It may be that the 10 minute period for the preparation of the speech is the most significant source of stress. Al'Absi et. al. note from their

study, that it was when the more stressful task, i.e. the speech, was performed second following the mental arithmetic task that both tasks elicited higher elevations of cortisol, they attribute this to the lengthened anticipation period. The team at Trier do not seem to have investigated the possibility of performing the mental stressor test prior to the speech, but from the Al'Absi study it would appear that this may produce even larger elevations. However, in order to remain consistent with the established TSST methodology, the order of tasks was not changed in the present study.
The effect of anticipation is mirrored in the literature which examines attentional biases in anxiety. Three laboratory based procedures which have used stressors in order to dissociate the effects of state and trait anxiety on attentional biases are reported here.

Mogg et. al. (1990, exp. 1) told their participants that performance on anagrams correlated with exam performance. This procedure did not produce an elevation of state anxiety. In experiment 2 Mogg et. al. used the same procedure as experiment 1 but told participants they would have to repeat the anagram task at the end of the session. This did produce an elevation of state anxiety, a direct indication that anticipation was the mediating factor in state anxiety elevation.

Mogg et al. (1994) produced a significant elevation in state anxiety by giving participants a short IQ test under extreme time pressure and telling them they would have to do a longer one following the attention task.

Only one of these studies (Mogg et. al. 1990, exp. 1) did not produce a significant elevation in state anxiety, that which did not inform participants that the stressor would be reintroduced following the attention task.

(As an aside, in Mogg et. al. (1990) experiment 1, there was a significant interaction between stress and word content, $F(2,32) = 11.41$, $p<.01$, such that high stress participants were relatively slower in colour naming threat than non-threat words in comparison with low stress participants. In experiment 2, using a dot probe technique, high stress participants shifted their attention towards threat cues whereas low stress subjects showed no such bias. In Mogg et.al. (1994), using dot probe ABIs as the dependant measure, there was a significant interaction between trait anxiety, stress and exposure (masked/unmasked), $F(2,128) = 6.33$, $p<.01$.)

Thus the TSST was chosen as the stress induction method to be used in the present study because it incorporates a variety of aspects which seem to elicit high stress responses in under the umbrella of one protocol. Those aspects are, the potential

for evaluation, an anticipatory period and the need to maintain poise in front of an audience. In the present research it is impractical to employ an audience to be present for all the testing session. The removal of an audience reduces the awareness of the potential for evaluation. Instead the panel of three experimenters was replaced with one experimenter and a video camera and the participant was informed that their performance would be evaluated at a later date from the videotape. This procedure is similar to that which produced a significant elevation in Al'Absi's study and it is reasonable to assume that an audience of one experimenter instead of two should not have a significant effect.

The only way to investigate cortisol elevations as a result of stress induction is to record high and low state measures during one session. Ideally these two states would be counterbalanced but the literature on cortisol measurement clearly indicates that cortisol levels do not return to pre-stress baseline levels for approximately one hour following a psychosocial stressor. Kirschbaum, Wust and Hellhammer (1992) measured salivary cortisol responses to public speaking and mental arithmetic stressors in 42 males and 45 female participants. The results for studies 1 and 2 have been combined in Figure 11 to display the length of time it took for participants' cortisol levels to return to pre-test levels following the administration of the task at time 0.

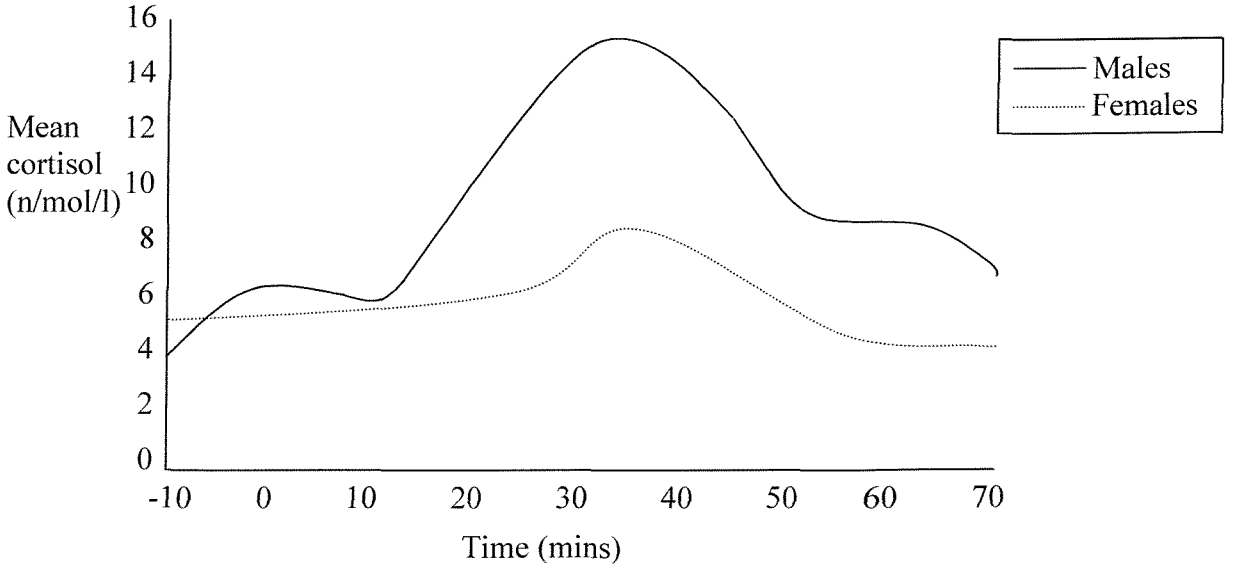


Figure 11 Mean salivary cortisol responses to a psychosocial stressor, adapted from experiment one and two Kirschbaum, Wust and Hellhammer (1992).

As Figure 11 shows, it would be impractical to perform the low stress phase following the high stress phase since the time allowed for the inter-task interval would have to exceed one hour in order to accurately record low stress cortisol levels, effectively doubling the time needed to run a participant through the protocol.

Two possible designs were therefore suggested. Firstly, to proceed with a within subjects design with two caveats - that practice and stress effects do not impact on the cognitive measures and that the self report measure of anxiety is sensitive to changes in state anxiety over such a relatively short period of time. The second option was to adopt a between subjects design in which participants were assigned to either high or low stress conditions.

Of these two options the first is the most desirable as it is more powerful than the between subjects design. In order to determine whether this design should be adopted the literature on the use of Dot Probe and Stroop task in repeated administrations was examined. In total, ten published studies have used a stress induction technique to dissociate the effect of state and trait anxiety on attentional bias in non-clinical participants, these are summarised in Table 40 below. As Table 40 shows, of those studies which have used a lab stressor, all but one has tested high and low stress reactions at two separate time points, only one measured the high and low state anxiety reactions during one session. Chen et. al. (1996) tested 23 spider fearful participants and 23 control participants on the emotional Stroop test once following a neutral condition and once following a stressful condition. During the neutral condition the participants stood and silently counted by sevens for two minutes. In the stressor condition participants watched an experimenter touch a tarantula with a cotton-wool bud and were told they would have to do the same following the Stroop task. The order of these two conditions was randomised and a ten minute filler task which consisted of filling in non-anxiety questionnaires was performed between them in order to allow state anxiety to return to baseline levels.

Critical to the design of the present study is whether Chen et. al. found a significant effect of order on the attentional bias data. They found no main effects or two three or four way interactions and so excluded this variable from further analysis and concluded that there were no practice effects. (Variables were: Group (spider fearful/ control); Condition (neutral/ stressful); Word Type (spider/ positive/ neutral) and order (stressful followed by neutral/ neutral followed by stressful))

Table 40 Summary of studies which have examined attentional biases in non-clinically anxious participants using stress induction procedures.

Authors & Date	Stress between/ within factor	Stressor	Measure
MacLeod & Mathews '88	Within	Exam proximity	Dot Probe
MacLeod & Rutherford '92	Within	Exam proximity	Stroop
Mogg, Bradley & Hallowell '94	Within	1) Exams proximity 2) Hard "IQ" test questions	Dot Probe
Mogg, Mathews, Bird & Macgregor-Morris '90 Exp 1	Between	Hard anagrams	Stroop
Mogg, Mathews, Bird & Macgregor-Morris '90 Exp 2	Between	Hard anagrams	Dot Probe
Mogg, Kentish & Bradley '93	Between	Hard IQ questions	Stroop
Richards et.al. '92	Between	Newspaper photographs	Stroop
vandenHout et.al. '92	Between	Parachute jump	Stroop
Green, Rogers & Hedderley '96	Between	Film about nuclear war	Stroop
Mathews & Sebastian '93	Between	Presence of a snake	Stroop
Chen, Lewin & Craske '96	Within	Presence of spider	Stroop

This finding is very encouraging for a within subjects design, recording all the data during one session.

The other issue which was critical to this design was whether the state scale of the Spielberger STAI is sensitive to change over the short periods of time associated with a stress manipulation. Chen, Lewin and Craske (1996) did not use the state scale of the STAI, they measured state anxiety throughout the stressor and neutral manipulations with a "Subjective Units of Distress Scale", which took the form of a nine point visual analogue scale. However, some of the studies summarised in Table 40 which used lab based manipulations recorded levels of state anxiety prior to the stressor and following the stressor. Mogg, Kentish and Bradley (1993) initially gave participants a series of 100 practice Stroop trials in which the stimulus words were digits spelt out (e.g. SEVEN). At this point participants filled in the state scale of the STAI for the first time. They were then allocated to either the stressful or relaxing mood induction procedure (MIP). The stressful procedure consisted of computer administered, hard IQ test questions with feedback and the promise of a longer test later in the session. In the relaxed mood induction procedure participants listened to a

tape of relaxation instructions for five minutes. Following this both groups completed the second of the STAI state scales. Participants were then asked to complete 320 colour naming Stroop trials. Some of these words were presented subliminally, i.e. followed by a mask of X's 14 ms after the presentation of the target word. Following the Stroop trials the participants took part in a presence/absence discrimination task to check for awareness of the masked words and following this test the participants filled in the third and final STAI state scale.

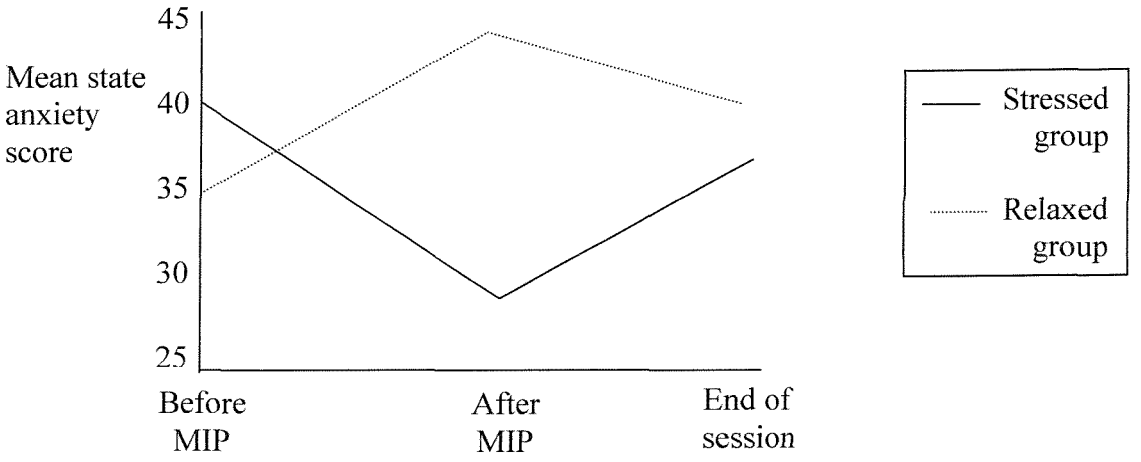


Figure 12 Mean state anxiety scores for each Mood Induction Procedure (MIP) group (taken from Mogg, Kentish & Bradley, 1993).

Figure 12 shows the mean state anxiety scores at the three time points for the participants in the stressed and relaxed groups. The stressed and relaxed group's state anxiety scores differed significantly at time 2, following the mood induction procedure, $F(1,36) = 18.15$, $p<.001$, but not at time 1 or time 3. Mogg et. al. concluded that the mood induction procedure successfully manipulated state anxiety scores within the test session. Additionally it can be concluded that the state scale of the STAI is sensitive to change in state anxiety over the short period of time which constitutes one testing session.

Hence the within subjects design, recording all data during one session, was adopted even though it does not allow for the counterbalancing of the stress and no stress procedures. This analysis of studies has satisfied those questions which were raised concerning practice effects and sensitivity of the STAI state scale and the design has considerable advantages in administration over the "between group" design.

The effects of smoking on cortisol responses are well documented. Nicotine stimulates the central nervous system and hence the HPA axis, and thus participants who smoke display increased cortisol concentrations (Kirschbaum, Wolf & Hellhammer, 1995). In order to circumnavigate this issue smokers were eliminated from the study.

This study attempted to examine the effects of anxiety on reactions to social stress as indicated by salivary cortisol increases. Cortisol does seem to be an accurate reflection of increases in state anxiety as a function of the TSST. However, Kirschbaum, Bartussek and Strasburger (1992) conducted 2 independent studies on a total of 87 men and found that there were no significant correlations between basal and TSST-induced cortisol and personality factors measured using questionnaires. The reason for this became clear when they examined variation in cortisol responses over five days (Kirschbaum, Wolf & Hellhammer, 1995). Essentially they found that the responses to the first day were unreliable. They concluded that "cortisol responses to a single exposure of a novel and psychosocially stressful situation contain both variance from rather stable characteristics (traits) and from acute orientation and adaptation to the novel situation (states)," (from Kirschbaum, Wolf & Hellhammer, 1995, p.39) and that only with repeated exposures does the effect of novelty decrease and the impact of psychological traits emerge. Unfortunately, in the present experiment, there will not be the opportunity to habituate the participants to the procedure over such an extended period and so a relationship between cortisol reactivity to the social stressor and trait anxiety is not anticipated.

However, a positive correlation is expected between subjective state anxiety increases and cortisol concentration elevations. Also, subjective state anxiety increases should, in theory, result in an increase in ABIs. Hence this implies that cortisol concentration elevations will correlate with increases in ABIs.

An additional measure was used in the design of this experiment which had not been used in the previous four. Behavioural-observer ratings were used as a dependent measure and also as an element of additional stress to the participant. Lamb (1978) attempted to delineate the specific behaviours which would distinguish participants who experience high state anxiety elevations during public speaking tasks and those who remain unaffected. He reviewed studies by Paul (1966), Meichenbaum et al. (1971) and Milac and Sherman (1974) who found that behavioural measures were good indicators. However, in Lamb's own study he found that, "There were no

consistent relationships found between behavioural measures and other measures of state anxiety obtained during a test speech." Since the motivation for using a behavioural measure in the present study is mainly as an additional stressor these mixed results from previous literature are not that disturbing. Lamb's study serves mainly as a useful source from which to extract appropriate measures. Of the 16 individual behaviours which Lamb recorded some showed the reverse pattern to that which would be expected, for example, frequency of lip moistening was higher in the low speech anxious group than the high speech anxious group (164 and 91 occurrences respectively). The measure which showed the largest difference between groups in the expected direction was "speech blocks", this occurred 294 times in the high speech anxious participant group and 247 times in the low speech anxious group thus this was selected for use as a dependent measure in the present study.

Additionally, rather than rate participants on the other 15 behaviours individually, a general, overall rating of anxiety was made using the behaviours listed in Lamb's study as indicators, such as "extraneous arm and hand movements", "breaths heavily" and "voice quivers".

Method

Design

This experiment took the form of a repeated measures design. Dot Probe, Stroop, self reported state anxiety and cortisol levels were recorded whilst the participants were in a low anxious state and again when they were made anxious through the use of a stress induction procedure within the same session. Participants' self reported trait anxiety was also recorded in order to allocate them to between subjects groups above and below the median.

Participants

A total of 40 participants took part in this study. 22 were undergraduate students who participated in the study in return for course credit, 18 were volunteers who were known personally by the experimenter. There were 7 males and 33 females, their ages ranged between 19 and 48 with a mean of 24.9 years (s.d. = 7.32). No participants classed themselves as smokers and no participants reported being on any medication other than the contraceptive pill.

Due to equipment failure Stroop data were not collected at time 1 for one participant.

Materials

Self report measures

Subjective measures of anxiety were recorded using the same questionnaires used in the previous experiments reported in this thesis, the Spielberger State Trait Anxiety Inventory (STAI) (Spielberger et. al., 1983) and the Marlowe-Crowne Social Desirability Scale (MC) (Crowne & Marlowe, 1960). See Experiment 1, page 53 for further details.

Cognitive measures

The Stroop and dot probe measures administered were the same as those used in Experiment 1, see page 53 for details.

Physiological measures

Unlike previous studies in the thesis, heart rate and skin conductance were not the chosen indicators of physiological activity, instead, salivary cortisol was sampled using a Sarstedt salivette which consists of four parts (see Figure 15 below). When each saliva sample was taken, participants were asked to take the cotton wool swab and to place it in their mouths and chew for between 30 seconds and 1 minute until it became sodden. When the participants indicated this had occurred they were given the main body of the salivette, with the suspended insert already placed inside the centrifuge vessel, into which they placed the swab, the experimenter then replaced the stopper.

Saliva samples were frozen within one hour of sampling and taken to the Endocrinology Laboratory at Southampton General Hospital where they were thawed and analysed for cortisol concentrations.

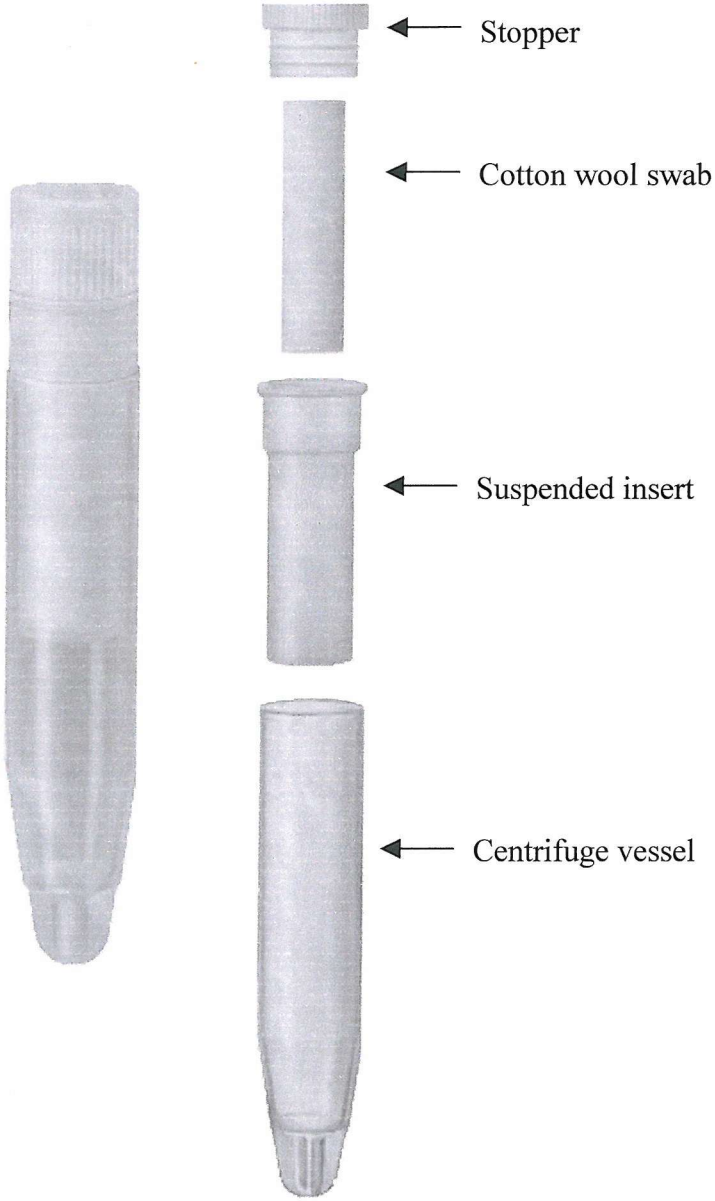


Figure 13 Sarstedt salivette for the collection of saliva (Illustration taken from Sarstedt "Patient instructions for the use of the Salivette" leaflet.)

Behavioural measures

Each participant was filmed, both as part of the stress induction procedure and in order to record behaviour that could be analysed at a later date. Participants were recorded from the point at which they were given the handout detailing the speech they had to prepare until the end of the second set of cognitive measures, approximately 30 minutes in total.

The experimenter made two behavioural ratings from the videotape. Firstly the numbers of "um" sounds or other vocal hesitations that the participants made during

the five-minute speech delivery period were counted. Secondly a general impression of anxiety level over the whole recording period was made on a scale of 1-5 where 1 indicated no evidence of anxiety at all and 5 indicated a high level of anxiety. This rating was made by identifying behaviours such as pen tapping, finger twitching, general body movements, sweating or flushing, nervous laughter etc.

Procedure

The laboratory was arranged as shown in Figure 14 below.

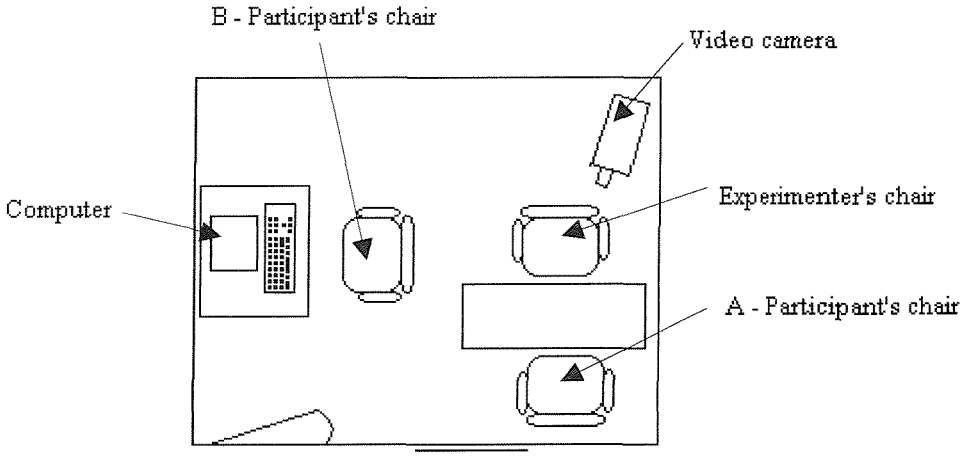


Figure 14 Arrangement of equipment in experiment 5.

Participants were welcomed into the room and asked to seat themselves in chair A. the experimenter sat in the chair opposite and briefed the participant on the general format and duration of the experiment. The participant was asked to fill in a state and trait scale of the Spielberger Anxiety Inventory and the Marlowe-Crowne Scale. While doing this they were asked to use the salivette to collect the first, baseline sample of saliva. Following completion of the questionnaires the participant was asked to move to chair B and complete the Stroop and Dot Probe trials. During this stage the experimenter left the room and the participant was asked to indicate when they had finished by opening the door. The experimenter then re-entered the room and asked the participant to reseat himself or herself in chair A while the experimenter sat opposite. At this point the participant was informed that the stress induction procedure would begin. The video camera was switched on and aimed at the participant's face and upper body. The participant was told that they now had ten

minutes in which to prepare a speech for a hypothetical situation and that the speech should last for five minutes. The participant was given pen and paper and the following written instructions:

> **Public speaking task**
>
> You should take the role of a job applicant for a job, which will involve contact with the public and some managerial duties.
> You have been invited to introduce yourself to the company's personnel manager.
> You have the opportunity to publicly speak for 5 minutes.
> You should try to convince the selector that you are the appropriate person for a job within this company that specialises in the retail of computer equipment.
>
> The experimenter you will deliver your speech to has been specifically trained to monitor non-verbal behaviour. Your performance will be analysed later from the video recording.
>
> You now have ten minutes in which to outline the speech you will make. Remember to give yourself enough to talk about for five minutes and to try to present yourself in the best possible way to get the job.

The experimenter then left the participant alone for ten minutes. When this period was over the experimenter returned to the room and sat opposite the participant and asked them to begin the speech, reminding them that the video camera was still recording. During the course of the five minutes speech the experimenter made bogus notes on a clipboard that could not be seen by the participant. If the participant ran out of things to say too soon the experimenter told them that they had not come to the end of five minutes and they had to continue.

When the five-minute speech period had finished the participant was told they now had to complete a mental arithmetic task. They were told to serially subtract 13

from 1022 and that if they made a mistake they would have to return to 1022 and start again. The experimenter informed the participant that they could stop after five minutes of this activity.

At this point the participant was asked to fill in another Spielberger state scale and to use a salivette to collect a second sample of saliva, thus this sample was collected 20 minutes after the onset of the stress induction procedure.

The participant was then asked to take a seat in front of the computer and the video camera was turned so that it continued recording over the participants' shoulder. The experimenter did not leave the room while the participants completed the Stroop and dot probe tasks for a second time.

Ten minutes after the second sample of saliva was taken the participant was asked to stop at the next break in the Stroop program and use a third salivette to sample saliva 30 minutes after stress onset. Finally, 40 minutes after stress onset, the last sample of saliva was taken. By this time the participant had also finished the Stroop and dot probe tasks and so was thanked and debriefed.

Results

Self report data

The 40 participants in this study displayed a normal distribution of trait and state anxiety in the low stress condition. The median trait anxiety score for all participants was 38, participants scoring above this were categorised as high trait anxious, those scoring below as low trait anxious. The two groups therefore differed significantly on trait anxiety ($t(38) = 8.638$, $p<.001$), and also on state anxiety at time one ($t(38) = 3.376$, $p<.005$) and at time two ($t(38) = 2.924$, $p<.01$).

Table 41 Self report data from Experiment 5.

Category	Mean trait score	Mean state score at time 1	Mean state score at time 2	Mean change in state score
High trait	47.2	34.3	49.2	14.8
(n=19)	(6.8)	(7.2)	(12.1)	(12.7)
Low trait	32.0	27.4	38.6	11.1
(n=21)	(4.0)	(5.8)	(10.8)	(9.4)
All Ss	39.3	30.7	43.6	12.9
(n= 40)	(9.4)	(7.3)	(12.5)	(11.1)

Table 41 above shows mean trait scores and mean state scores before and after the stress induction procedure (at time 1 and time 2), for high and low trait anxiety groups and all participants together.

Paired sample t-tests showed that there were significant increases in state anxiety as a result of the stress manipulation in the high trait group ($t_{(18)} = -5.1$, $p<.001$), the low trait group ($t_{(19)} = -5.5$, $p<.001$) and for all participants together ($t_{(39)} = -7.3$, $p<.001$)

The modified TSST raised state anxiety scores in the low trait group by 11.2 points on the state scale of the STAI, high trait participant's scores rose by 14.9 points.

These change scores for the high and low trait participants were compared using an independent t-test and it was found that the high trait participants did not show significantly larger elevations in state anxiety than the low trait participants ($t(38) = 1.039$, $p > .05$).

Cognitive data

Stroop data

Mean and median data are shown in Appendix 12, analyses of these data showed the same patterns as analyses using ABIs.

As in previous experiments, the Stroop stimuli, which were either neutral, positive, socially threatening or physically threatening words, were presented in three ways: blocked, mixed and masked. The reaction times (RT) to the neutral and emotional stimuli were converted into attentional bias indices (ABIs) using the following formula:

ABI = RT to emotional words – RT to neutral words

The following tables 42 and 43 show mean ABIs for each condition.

It was anticipated that high trait participants would show larger ABIs than low trait participants overall; tables 42 & 43 show that this is not the case in the physical threat or social threat conditions. At time 1 (low stress) the high trait participants actually responded quicker on average to physical threat words than neutral words, in direct opposition to the predicted pattern. The mean ABIs shown here are very small in comparison with other results found in previous literature.

Table 42 Mean ABIs for physically threatening Stroop words by presentation type (blocked, mixed or masked) and time (one or two) from Experiment 5.

		Blocked		Mixed		Masked	
	N	T 1	T 2	T 1	T 2	T 1	T 2
High trait Ss	19	-2	2	-8	-4	5	-8
		(47)	(35)	(74)	(44)	(77)	(45)
Low trait Ss	21	3	-27	-2	15	5	-3
		(42)	(67)	(37)	(49)	(50)	(44)
All Ss	40	0	-13	-5	10	5	-5
		(44)	(56)	(57)	(46)	(63)	(44)

Table 43 Mean ABIs (in ms per word) for socially threatening Stroop words by presentation type (blocked, mixed or masked) and time (one or two) from Experiment 5.

		Blocked		Mixed		Masked	
	N	T 1	T 2	T 1	T 2	T 1	T 2
High trait Ss	19	11	6	-5	3	-12	-21
		(49)	(58)	(62)	(74)	(47)	(48)
Low trait Ss	21	9	-11	-6	-4	4	-4
		(40)	(70)	(31)	(44)	(36)	(51)
All Ss	40	10	-2	-5	-1	-3	-12
		(45)	(65)	(47)	(59)	(42)	(50)

A 3x2x2x2 mixed ANOVA was performed with a between subjects variable of trait anxiety group (high or low) and within subjects variables of time (one or two), valence (physical or social threat) and presentation (blocked, mixed or masked). No main effects were found for trait anxiety, $F<1$, time, $F(1,38) = 1.618$, ns, presentation, $F<1$, or valence, $F<1$, no significant interaction effects were found.

In summary, none of the predicted results were shown. Trait and state anxiety had no effect on reaction times to threatening stimuli compared to neutral stimuli.

Dot probe data

Mean and median data are shown in Appendix 13, analyses of these data showed the same patterns as analyses using ABIs.

The dot probe trials consisted of two types, moderately threatening and severely threatening, it was expected that the results would show similar patterns, but that the effects would be more extreme for the severely threatening stimuli.

Again, as with the Stroop data, attentional bias indices (ABIs) were calculated using the following formula:

ABI = RT to probe in neutral field – RT to probe in threat field

Attentional bias indices for moderate and severely threatening stimuli are shown in Table 44 below, divided by trait group, at time one (low stress) and time two (high stress).

Table 44 Mean ABIs (in ms) for dot probe stimuli by trait group and stimulus severity from Experiment 5.

		Moderate threat		Severe threat	
	N	Time 1	Time 2	Time 1	Time 2
High trait	19	-4 (39)	-7 (32)	-6 (27)	.8 (34)
Low trait	21	-1 (38)	-9 (39)	4 (25)	0 (27)
All subjects	40	-2 (38)	-8 (36)	-1 (26)	0 (30)

Like the Stroop data, the table above shows smaller ABIs than previously found in the literature. The predicted interaction between state and trait anxiety was not displayed for either the moderate stimuli or the severely threatening stimuli, that is that as state anxiety increases vigilance for threat increases in high trait anxious participants and avoidance of threat increases in low trait anxious participants.

In the severe threat condition there *was* a slight tendency for the high trait participants to show elevated attentional bias towards threat as state anxiety levels increase. And in fact, the low trait participants do demonstrate increased attentional avoidance of threatening information as state anxiety increases. However, a 2 way repeated measures ANOVA with independent variables of time and trait anxiety group show that this relationship is not significant since there were no main or interaction effects, $Fs<1$.

In the moderate condition the low trait anxiety group did display increased avoidance of threat with increased state anxiety, the high trait group did not show increased vigilance. The results of a 2x2 repeated measures ANOVA with independent variables of time and trait anxiety group mirrored those of the severe threat condition in that there were no significant main or interaction effects, $Fs<1$.

Physiological data

Cortisol samples were taken in the expectation that they would rise as a result of stress induction and that that rise in concentration would have a significant relation to trait anxiety. In other words, that high trait anxious participants would show larger increases in cortisol concentrations as a result of stress induction than low trait participants.

Table 45 Mean cortisol concentrations (nmol/l) over time from Experiment 5. (Peak change is equal to cortisol concentrations at +30 minutes minus baseline cortisol levels at –15 minutes. Stressor was applied at time = 0 minutes).

	-15 mins	+20 mins	+30 mins	+40 mins	Peak change
High trait	9.8	7.5	7.5	7.9	-2.3
	(5.7)	(3.5)	(3.2)	(3.8)	(4.6)
Low trait	11.9	9.7	10.0	10.1	-1.9
	(7.0)	(5.6)	(6.7)	(6.0)	(5.5)
All Ss	10.9	8.6	8.8	9.0	-2.1
	(6.4)	(4.8)	(5.4)	(5.2)	(5.0)

Table 45 above shows mean cortisol concentrations 15 minutes prior to stress induction, and 20,30 and 40 minutes following the onset of stress induction. It was expected that cortisol concentrations would peak at 30 minutes after stress onset. As the table shows, there was actually a slight decrease in cortisol concentration from baseline (15 minutes prior to stress onset) to 30 minutes after stress onset.

The table also shows the gap between high and low trait participants' cortisol levels, which is opposite to the expected direction. It would be anticipated that high trait participants' cortisol concentrations would be higher than low trait participants', here the relationship is reversed. This difference was tested using a repeated measures AVOVA with sample point at the within group factor and trait anxiety group as the between group factor. Trait anxiety was shown to have no significant main, $F(1,38) = 2.013$, ns, or interaction effects, $F<1$. However, sample point was found to have a significant main effect, $F(3,36) = 5.86$, ns. A post hoc comparison was conducted using the Tukey a Honestly Significant Difference test, it was found that the

significant difference was between sample point 1 and all others. There were no other significant differences.

Behavioural data

Two measures of behavioural anxiety were noted; number of vocal hesitations during the speech, and a general rating of anxiety throughout the course of the stress induction procedure, these ratings are shown in Table 46 below.

Table 46 Mean behavioural ratings of anxiety for high and low trait anxious groups in Experiment 5.

	No. of speech hesitations	Behavioural anxiety
High trait	26.0 (13.7)	2.7 (1.0)
Low trait	31.6 (15.9)	2.1 (1.2)
All subjects	28.9 (14.9)	2.4 (1.2)

If speech hesitations are an indication of nervousness or anxiety it would be expected that high trait anxious participants would display this behaviour more frequently than low trait anxious participants, in fact this expected relationship was reversed. Low trait anxious participants had 31.6 speech hesitations on average during the course of the five minute speech, high trait anxious participants had an average of 26 vocal hesitations over the same time span. This difference was tested using an independent samples T-test and found to be non-significant, $t(38) = -1.182$, ns.
A comparison was made between the overall, subjective rating of anxiety made by the experimenter and the subjective rating of their own anxiety made by the participants using the STAI. If these two measures correlated it would indicate two things, firstly that the experimenter was a good judge of the levels of state anxiety that the participant's were experiencing, and this would in turn support the use of the STAI as a measure of state anxiety. These two measures were tested using Pearson's r and were found to be highly significantly correlated, $r=.445$, $p<.01$.

The overall rating of behavioural anxiety did show the predicted direction in relation to trait anxiety, high trait anxious participants were rated as more anxious than low trait anxious participants, however this difference was not significant, $t(38) = 1.665$, ns.

Correlations between measures

Peak elevation of cortisol (i.e. the difference between low state cortisol levels and high state levels) is an indicator of the impact of state anxiety on the participant. Change in dot probe attentional bias index is also an indicator of the impact of state anxiety and so these two measures should correlate positively.

A change in attentional bias was calculated by subtracting attentional bias at time one from attentional bias at time two. If attentional bias becomes more extreme with increasing state anxiety (as in the case of high trait participants) larger positive values will indicate a large effect of anxiety. If attentional bias is reversed, so that at high levels of state anxiety attention is directed away from threatening material (as in the case of low trait participants) large negative values will indicate a large effect of state anxiety.

Pearson's correlations were carried between moderate and severe threat dot probe data and cortisol peak concentrations, the results are shown in Table 47 below. As can be seen, there are no significant correlations between these two objective measures of state anxiety. This is not surprising since on their own the attentional bias data and the cortisol concentrations did not show the expected elevations in response to state anxiety.

Table 47 Correlations between cortisol change and dot probe ABI change by trait anxiety group in Experiment 5.

Trait anxiety group	Correlations between peak cortisol concentration and:	Pearson's r (significance indicated by *)
High trait	Moderate ABI change	.1
	Severe ABI change	.173
	All dot probe ABI change	.180
Low trait	Moderate ABI change	-.026
	Severe ABI change	.128
	All dot probe ABI change	.064
All participants	Moderate ABI change	.023
	Severe ABI change	.140
	All dot probe ABI change	.112

Data summary

To summarise, the stress induction procedure did result in a significant increase in state anxiety measured using the Spielberger STAI, but this subjective measurement of anxiety elevation was not mirrored in the objective measures. There were no significant effects of state or trait anxiety on cortisol concentrations or cognitive measures of attentional bias. The subjective measures made by the experimenter showed no relationship with trait anxiety.

Discussion

The state anxiety manipulation that was used in this study produced very large elevations in state anxiety. In study 4 low trait participants' state anxiety scores increased by 6.2 points and high trait participants' by 5.4, in the present study low trait participants' scores increased by 11.2 and high trait participants' by 14.9 And yet there were still no observable effects on attentional biases.
The lack of significant attentional bias results is mirrored by the cortisol concentrations. Salivary cortisol concentrations actually decreased over the period of testing.

The picture drawn by the four types of measures is not consistent. The self report measures indicate that participants feel themselves to be in a state of elevated anxiety following the stressor. The behavioural measures, while not measuring change in outward signs of anxiety, do support this as they correlate significantly with participant's reports of state anxiety. On the other hand, the cognitive measures do not show any indication of attentional bias, either at low state anxiety or high state anxiety situations. This finding is supported by the cortisol analyses which show that cortisol secretions dropped slightly over the course of the stressor and following it.

This study was an attempt to correlate anxiety indicators and it would seem that it has failed, not as a result of the anxiety manipulation but as a result of the measures themselves. The participant reported increased anxiety, the experimenter's reports concurred with that, yet the objective measures express that these reports are inaccurate and that the participant was not subject to stress. This issue will be discussed further in the general discussion (page 145).

Re-analysis of Marlowe-Crowne data

In studies 1 to 5 the Marlowe-Crowne Social Desirability Scale was administered at the same time as the Spielberger scale. This chapter is devoted to the analysis and evaluation of the impact of the data from participants who scored high on this measure of defensiveness.

Repressors can be defined operationally as those who score high on the Marlowe-Crowne Social Desirability Scale (Crowne & Marlowe, 1960) and low on the trait scale of the Spielberger State Trait Anxiety Inventory (Spielberger et. al., 1983). See appendix 1 and 2 respectively for copies of the questionnaires.

Hence groups can be divided into four cells on the basis of scoring high or low on the trait scale and the Marlowe-Crowne scale, see Figure 20 below.

Figure 15 The four possible groups resulting from high/low splits on the Marlowe-Crowne and trait STAI scales.

		Trait anxiety	
		High	Low
Marlowe-Crowne	High	Explicit repressors	Traditional repressors
	Low	True high trait anxious	True low trait anxious

These four groups were also identified by Dawkins and Furnham (1989) who noted that using a social desirability scale and an anxiety scale enables differentiation of four coping styles: repressors – high social desirability/low anxiety; low anxious – low social low/low anxiety; anxious – low social desirability/ high anxiety; and defensive high anxious – high social high/high anxiety. They used just the three groups they termed high anxious, low anxious and repressors in their analysis however since evidence suggested that defensive high anxious participants (labelled explicit repressors in Figure 20) are relatively rare in the population.

The true high trait anxious and true low trait anxious groups are familiar from the analyses performed on studies 1 to 5, these are participants who score below the median on the Marlowe-Crowne scale and either high or low on the trait scale respectively.

In the Stroop task both the neutral (colour) and the threatening (semantic meaning) elements of the stimuli are presented together in one word. Therefore, if the participant is avoidant to threat they will focus attention away from the word and hence take longer to perform the task requirement of colour naming. However, participants who allocate attention to threat will also take longer to perform the task requirement since their attention will be focussed on the semantic meaning of the stimulus. Therefore avoidant and vigilant responses are indistinguishable using the Stroop methodology. For this reason dot probe data was selected for this analysis rather than the emotional Stroop data since it can account for both attention effects and avoidance effects and, in theory, measures the same processes as the Stroop task. True high anxious participants would be expected to allocate attention to threatening information in favour of neutral and hence respond to probes in threat fields faster than probes in neutral fields.

True low anxious participants should theoretically show no preference for either type of stimuli and hence reaction times to probes in threat and probes in neutral fields should be comparable.

Those participants labelled traditional repressors in Figure 20 score above the median on the Marlowe-Crowne but respond to subjective measurements as if they are low trait anxious. In other words they show similar patterns of response as highly trait anxious but they employ a repressive coping style mechanism, one aspect of which is to deny their high levels of anxiety when asked to make a subjective report. Weinberger, Schwartz and Davidson (1979) identified this as a problem for anxiety research since the subjective report of anxiety will not match with other objective measures, such as attention allocation and physiological responses.

In terms of the dot probe task, because they are actually highly anxious but adopt a repressive coping style by directing their attention away from threatening information, it is expected that they will respond slower to probes in threat fields than probes in neutral fields.

The fourth group identified in Figure 20 is labelled explicit repressors, this group was identified by Andrew Mathews and Bundy Macintosh from the team at the MRC Cognition and Brain Sciences Unit in Cambridge, although they have yet to publish on the topic the conceptual ideas have been discussed in personal communications. Explicit repressors are conceptualised by Mathews and Macintosh as participants who are prepared to admit that they are high in anxiety but are also

consciously aware of it and hence explicitly employ strategies with which to control their experience of anxiety. A possible implication of the explicit repressors' awareness of their coping mechanism is that they would be even more effective about avoiding threatening information than other groups and hence would be expected to respond even slower to probes in threat than probes in neutral in comparison to traditional repressors.

So, to summarise, of the four groups, true high trait anxious participants are expected to show the most vigilance to threat; true low trait anxiety participants are not expected to display either vigilance to or avoidance of threat; repressors are expected to show avoidance to threat; finally, it is anticipated that explicit repressors will display the greatest degree of avoidance and hence will have slower reaction times to probes in threat fields compared to probes in neutral fields than any other group.

Data from studies 1,2 and 5 were subjected to this four-group analysis. Data were not taken from study 4 since participants were pre-selected and hence any repressors were identified and not asked to participate in the main study. Data were not used from study 3 because it was a comparison of card and computer presentation of emotional Stroop stimuli and hence the dot probe paradigm was not used.
In studies 1 and 2 each participant completed the dot probe task twice, with a test-retest interval of two weeks. In the case of study 1, the data from time one were selected. In the case of study 2, because equipment failure meant that dot probe data were lost from the first session, data from time 2 were analysed. In study 5 participants also completed the dot probe task twice but the separation interval was a matter of minutes since the aim of the experiment was to investigate the effect of a laboratory based state anxiety manipulation and so the whole experiment was completed within one session. Because the effect of elevated state anxiety may have had a differential effect on the responding of repressors, the data from time 1 study 5 were used in this meta-analysis. Thus, in total, 101 participants' dot probe ABI scores were subjected to the following analysis.

There are two possible methods of splitting the participants into two groups on the basis of their STAI trait scores, either by using a cut-off of 40 or the median score. In this case the median trait score for all 101 participants was 39 and so there was no appreciable difference. Thus all participants who scored 40 or above were assigned to

the high trait anxiety category and all participants scoring 39 and below were assigned to the low trait anxiety category.

In order to divide the participants into two groups on the basis of their Marlowe-Crowne score a median split could have also been chosen. However, this is a poor reflection of the actual incidence of repressive tendencies in the population since the phenomenon is relatively rare and yet this would result in half of the respondents being placed in the high scoring category. Instead the middle possible score of 17 was chosen, this is consistent with experiments 1 to 5.

These two cut-offs resulted in the following 'n's: 43 high trait anxious, 36 low trait anxious, 16 traditional repressors and 6 explicit repressors. As observed by Dawkins and Furnham (1989) the group of explicit repressors is under-represented in this sample of non-clinical participants. Table 48 shows the mean attentional bias indices in m.s. per stimulus for all studies combined, as in studies 1-5 reported previously, an attentional bias index is a measure of the degree to which attention is paid to threatening stimuli in favour of neutral stimuli and, in the case of dot probe data is calculated by subtracting the reaction times to probes in threat fields away from the reaction times to probes in neutral fields hence, negative values indicate avoidance of threat and positive values indicate attention to threat.

Table 48 Mean dot probe ABIs from time one study 1, time two study 2 and time one study 5, by Marlowe-Crowne and trait anxiety groups.

	N	Moderate ABI	Severe ABI
Explicit repressors High trait, high MC	6	.27 (35.9)	-9.3 (23.0)
Traditional repressors Low trait, high MC	16	10.9 (43.7)	-4.1 (46.9)
True low trait Low trait, low MC	36	-.8 (30.9)	2.0 (41.9)
True high trait High trait, low MC	43	-12.3 (68.3)	-5.4 (31.0)
All participants	101	-3.8 (52.1)	-2.8 (37.3)

The reaction times in Table 48 are organised by group in order of those predicated to be the most avoidant (explicit repressors) to those predicted to be most vigilant to threat (true high trait anxious). Therefore, it was predicted that values would progress from negative through to positive reading down the table. In the

moderate threat condition the reverse pattern is shown. In the severe threat condition the predicted pattern is shown apart from the true high trait anxious group who displayed avoidance of threat as opposed to vigilance.

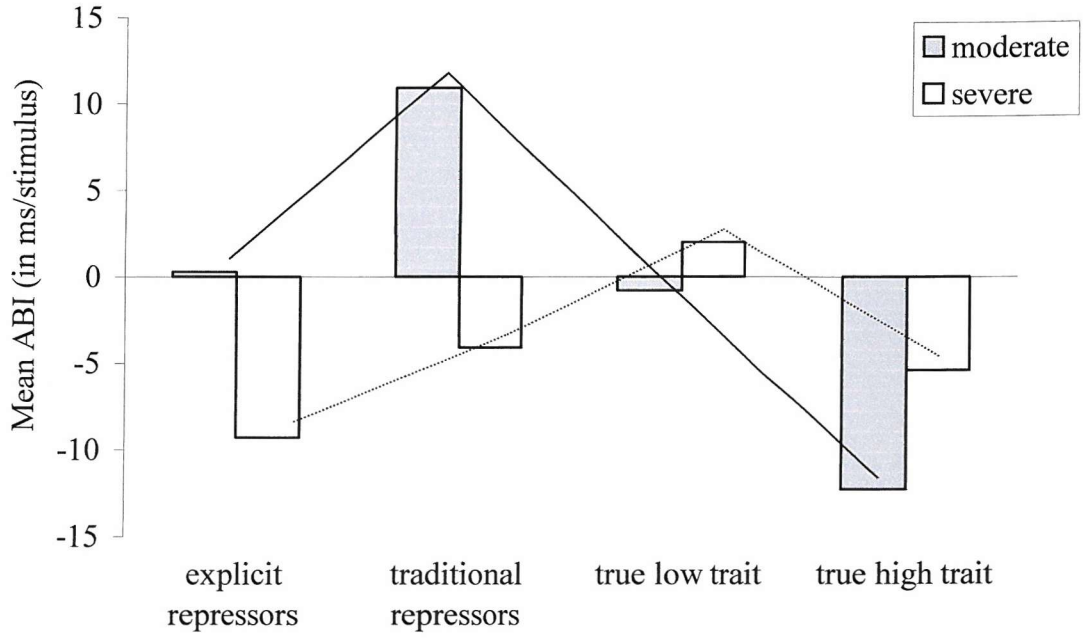


Figure 16 Mean severe and moderate dot probe ABIs by high and low STAI and Marlowe-Crowne groups.

For clarity these data are also shown in Figure 16, it would be predicted that for both moderate and severe threat conditions, the lines joining the tops of the bars would display positive gradients. It is clear however, that there is a positive gradient in the severe condition excluding the high trait group, but in the moderate condition the pattern is reversed to the extent that the traditional repressors and, to a lesser extent, the explicit repressors, are the only groups who displayed attention to threat instead of the predicted avoidance. The only group which was predicted to show attention to threat, high trait anxious, display avoidance to threat in both the moderate and severe conditions.

However, these unexpected patterns are derived from relatively small differences in ABIs, the data were therefore subjected to a 4x2 mixed ANOVA with a between subjects variable of group (explicit repressors, traditional repressors, true low trait and true high trait) and a within subjects variable of severity of stimuli (severe or moderate). This showed no main effect of severity, no main effect of group and no interaction, $Fs<1$.

This pattern of non-significant results is consistent with the previously reported studies. It is reasonable to assume therefore that the traditional and explicit repressor groups' responses did not have a significant impact on the data from the previous studies.

An additional factor that is worthy of examination is the mean reaction times, irrespective of whether the probe appeared in the neutral or threat field. These data are shown in Table 49 below and shows an immediately obvious pattern in both the severe and moderate condition.

Table 49 Dot probe reaction times from time one study 1, time two study 2 and time one study 5, by Marlowe-Crowne and trait anxiety groups.

	N	Moderate, probe in neutral	Moderate, probe in threat	Severe, probe in neutral	Severe, probe in threat
Explicit repressors					
High trait, high MC	6	447 (52)	447 (55)	457 (47)	466 (44)
Traditional repressors	16	465	454	469	473
Low trait, high MC		(75)	(71)	(74)	(90)
True low trait	36	469	469	475	476
Low trait, low MC		(67)	(64)	(70)	(69)
True high trait	43	466	479	484	490
High trait, low MC		(90)	(65)	(72)	(80)
All participants	101	466 (77)	470 (65)	477 (70)	480 (76)

These data show that, irrespective of whether the probe appeared in the neutral or threat field and whether the stimulus was severe or moderate threat, explicit repressors had the fastest reaction times, traditional repressors took slightly longer, true low trait participants slightly longer still and true high trait participants had the longest reaction times of all the groups. This can be seen more clearly if a mean reaction time is calculated for each group by collapsing the severity and probe position conditions. These data are shown in Figure 17 below.

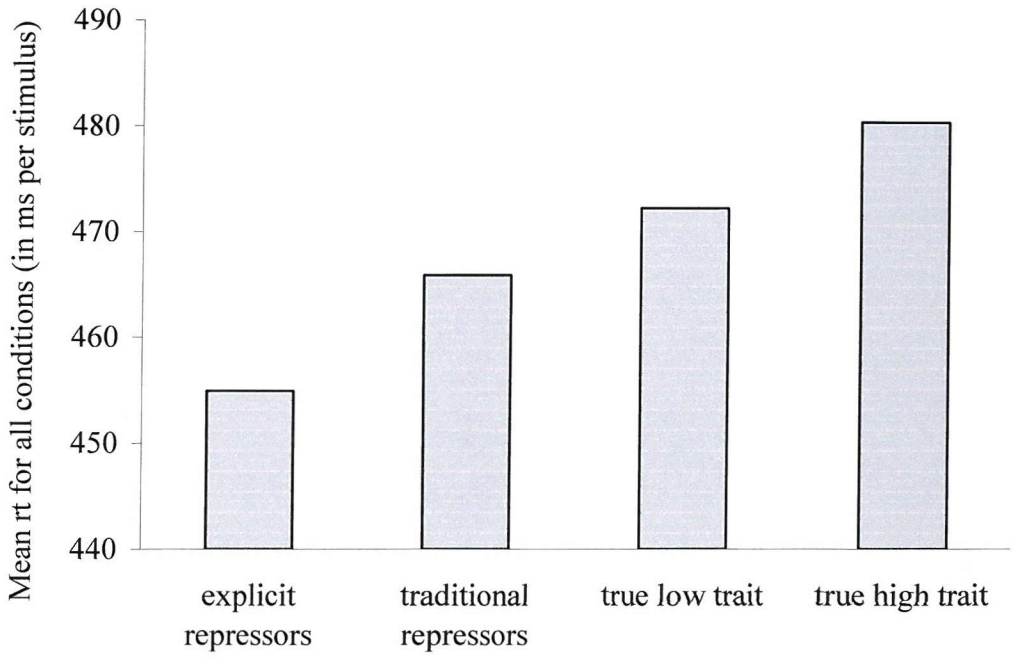


Figure 17 Mean reaction times, irrespective of probe position and severity of stimuli, by high and low STAI and Marlowe-Crowne groups.

The mean reaction time data were subjected to a 4x4 ANOVA with a between group variable of group (explicit repressor, traditional repressor, true low trait or true high trait) and a within participants variable of presentation (severe stimuli, probe in neutral; severe stimuli, probe in threat; moderate stimuli, probe in neutral; moderate stimuli, probe in threat). There was no significant effect of presentation, $F(3,97) = 2.37$, ns, no main effect of group and no interaction effect, $Fs<1$. Thus, even though the pattern of results seems clear the differences are not significant. This statistical test result is consistent with the fact that this was a post hoc hypothesis and there is no a priori reason why these differences should occur.

Finally, Marlowe-Crowne scores were analysed as a continuous variable rather than a between subjects dichotomous variable. A 2x2 repeated measures ANOVA was carried out on the ABIs with a between subjects variable of trait anxiety (high or low) and a within subjects variables of stimulus severity (moderate or severe), Marlowe-Crowne scores were entered as a covariate. There was no main effect of severity of stimuli, $F<1$, no main effect of trait anxiety group, $F(1,98) = 1.901$, ns, and no main effect of Marlowe-Crowne score, $F<1$. Also, there was no two-way interaction

between severity and Marlowe-Crowne score, or between severity and trait group, $Fs<1$.

In conclusion, it was important to include the Marlowe-Crowne scale in the designs of studies 1 to 5 in order to identify potential problems that could have resulted from repressor's data being erroneously added to the low trait anxiety group. However, after these scores were entered into analysis of these data it was shown that the traditional and explicit repressors did not respond any differently to the high and low trait anxiety groups.

Discussion

The overall aim of the experiments was to examine the relationship between different indicators. Attention allocation measures had never previously been used in conjunction with physiological measures. Researchers such as Kenardy et. al. (1993) had concluded that there was little convergence between the three aspects of anxiety, physiology, subjective experience and behaviour, including cognition. However, to date "cognition" had been viewed as equivalent to "thoughts", the use of an objective measure of cognitive processes may have shown that attentional biases are the mediating factor in anxiety, hence having a relationship with physiology, subjective and behavioural indicators. However, this question was unanswerable as a result of systematic failure of the chosen methodologies selected to indicate anxiety.

Each experiment was informed by the results of the previous study, a summary of each follows. The rationale for Experiment 1 was as a calibration exercise, to ensure that the cognitive methodologies showed test-retest reliability and were sensitive to inter-individual variations in anxiety. To do this, a test-retest design was used, 40 participants were tested on Stroop, dot probe and self report measures at time one and time two, two weeks later. These early findings from Experiment 1 were surprising in that there was no evidence of attentional bias and hence no test-retest reliabilities.

There were no obvious reasons why this result occurred and so the next study was designed with two aims, to retest the cognitive measures and to add the physiological measures. The results from this study replicated Experiment 1, once again no evidence of attentional bias was found. Additionally, the EDA measure did not show the expected relationships with the self-report measures.

The third study aimed to determine if the lack of positive cognitive results was due to a specific facet of the methodology employed in the first two studies. In order to investigate this further a comparison was made between the computerised version of the Stroop and an equivalent paper task. Also, the effect of participant population was examined, because the lack of positive results may have been due to a particular response bias displayed by psychology undergraduates. However, this study, on 30 non-student participants, using a computerised and equivalent paper version of the Stroop task, did not result in the demonstration of attentional biases.

At this point it appeared the next step was to manipulate state anxiety and record any associated changes in physiological or cognitive measures. It was hoped that the cognitive biases in particular would emerge at increased levels of state anxiety in line with the findings of MacLeod and Mathews (1988). A proximity to exam manipulation was used to test participants at two time points, when they were high and low in state anxiety. In order to further maximise the chances of positive findings the participants used in this study were pre-selected for extreme high or low scores on the trait scale of the Spielberger inventory. However, in line with studies one to three and in opposition to MacLeod and Mathews (1988) no significant results were found. In fact the direction of Stroop results and dot probe results were not even in the expected direction, for example, high trait participants showed avoidance of threatening dot probe stimuli. Again, no significant relationships were found between the self report measures and the indicators of electrodermal activity.

Experiment 5 was the last in the series of investigations, the design echoed Experiment 4 in that anxiety was again manipulated. However, instead of investigating the effects of chronic anxiety, acute anxiety was evoked through use of a relatively short, laboratory based stressor. The self report measures indicated that this was highly successful. Participants' state anxiety ratings increased by an average of 12.9 points in response to the stressor, in comparison with Experiment 4 in which participants displayed an increase of 5.8 points in response to exam proximity. Thus, all conditions were maximised for the observation of attentional biases. In this study a behavioural rating was added to the design, this was found to display a significant relationship with the state scores on the Spielberger STAI, indicating that the subjective perception of anxiety, be it by the participant or experimenter, showed agreement between measures. However, in common with the previous four studies, this subjective perception of anxiety did not match with the objective measures of cognitive and physiological anxiety (indicated using salivary cortisol concentrations).

To summarise, the cognitive and physiological measures employed did not show any evidence of the effects of either state or trait anxiety in any of the five studies, thus correlations between the different types of indicators of anxiety were not assessable.

Some aspects of the findings were more unanticipated than others. It is not that surprising that the physiological measures were not significant (e.g. Hart, 1974). Physiological measures are fairly unreliable, due to many reasons, one of which being

the complexity of the measurement apparatus. Another reason why there are numerous physiological studies which have failed to find significant effects is that the designs often use only one dependent variable a weakness noted by both Gale and Edwards (1986) and Cattel and Scheir (1961). One of the strong points of the design of studies 2 and 4 which used EDA as a dependent measure was that heart rate readings were also recorded. Unfortunately, due to errors at the programming level, these data were lost to the author and so a potential source of positive physiological data was lost.

This, combined with a literature review which indicated that positive effects were elusive, suggests that the failure to find significant effects is not that hard to appreciate.

Turning to the reaction times measurements, the traditional Stroop effect was found to be highly significant for all experiments. For example, in Experiment 4 for words which were congruent for content and colour (e.g. RED printed in red) mean reaction time was 646 ms., for incongruent words mean reaction time was 533 ms. A repeated measures t-test showed this to be highly significant, $t(39) = -3.98$, $p < .001$. This finding was replicated for all five experiments.

The more unexpected finding was that, without exception, the cognitive measures failed to show attentional bias effects associated with either state or trait anxiety.

It could be argued that studies one, two and three, since they did not examine attentional biases under elevated state anxiety, were not likely to find significant effects, even though other researchers (e.g. Richards et al., 1992) have observed the presence of bias in normal high trait participants under low state anxiety conditions. With this proviso, studies four and five, which did manipulate anxiety, were more likely to find the effects. They looked at both chronic and acute state anxiety and Experiment 4 maximised the likelihood of finding significant effects by only testing extreme high and low trait participants. However, again, these studies did not find significant effects on the cognitive measures, this occurred in spite of the fact that the levels of state and trait anxiety from these two studies are comparable with previous studies which have found significant effects. For example, Richards et. al. (1992) tested participants before and after a negative mood manipulation using unpleasant newspaper photographs, this is a laboratory based manipulation similar to that used in Experiment 5. The Spielberger data from these two studies are compared in Table 50.

It can be seen that the low trait groups in particular display similar STAI scores although the low trait participants in Experiment 5 showed greater elevations in state anxiety as a response to the public speaking and metal arithmetic task. This pattern is displayed to an even greater extent in the high trait participants from Experiment 5, their state anxiety levels increased by an average of 14.8 points, compared with the high trait participants from the Richards et. al. (1992) study who showed elevations of only 1.8 points on average, although Richards et.al. did find this to be significant.

Table 50 A comparison of Spielberger STAI scores from Experiment 5 and Richards et. al. (1992) (Data extracted from Table 3, page 487.)

Study	Trait group	N	Trait score	State T1	State T2	State change
Richards et. al.	High	10	43.7	38.3	40.1	1.8
	Low	11	32.6	29.1	36.2	7.1
Experiment 5	High	19	47.2	34.3	49.2	14.8
	Low	21	32.0	27.4	38.6	11.1

Richards et. al. calculated attentional bias indices from reaction times to the anxiety related Stroop words and the matched neutral words. Their participants were tested only once following the mood manipulation so Stroop ABIs are only available for the high state condition rather than the high and low conditions as in Experiment 5. Richards et. al. used mixed presentations and so this type of presentation from Experiment 5 has been compared with their data in Table 51 below.

Table 51 Mean ABIs (in ms per word) following state anxiety elevation from Experiment 5 and Richards et. al. (1992) (Data extracted from Table 4, page 488).

Study	N	High trait ABI	Low trait ABI
Richards et.al.	21	72	-24
		(86)	(52)
Experiment 5	40	-4	15
		(44)	(49)

From Table 51 it can be seen that the standard deviations in Experiment 5 are less than in the Richards study. However, where Richards et.al. found an ABI of 72ms

for high trait participants on anxiety related words following a negative mood manipulation the comparable Figure for Experiment 5 is –4.1ms. This is despite the fact that at the time of testing the high trait participants were scoring 9 points higher on the state scale than the high trait participants from the Richards' study.

In light of comparisons such as this it is difficult to understand why there was a systematic failure to find significant attentional bias effects.

The stimuli would be open to criticism as a possible source of the problem, were it not for the fact that they are directly taken from previous studies by the group of researchers working with Mathews who have found significant effects using the same stimuli and the same presentation techniques (Yiend, Mathews, Bradley & Mogg, in press; Mathews, Mogg, Kentish & Eysenck, 1995). Also, in studies one, two, four and five both the Stroop and dot probe tests were administered at the same time, if there was a problem due to one methodology the effects could still be observable using the other.

However, the use of pictures in the dot probe task is extremely rare, in fact the unpublished Yiend et al. study is the only one to have used this type of stimuli. Also, the use of only two colours in the Stroop methodology is rare, most studies have used four or five, see Table 23 for details. However, logically this should also interfere with the traditional Stroop effect and yet this was found to be highly significant in all five studies. Nevertheless it may be that the absence of positive results is an artefact of these two variations on common methodology.

The final source of a type II error was power. It may have been that the number of participants in each study was not sufficient. However, the section dealing with the question of repressors (page 27) answers the question of sufficient power since the combined results of 101 participants still resulted in no significant effects. A power calculation following Cohen (1988) and Hendrickx et. al. (1987) using a=.05, u=3, n=25 and f=.25 gave power= .53, which is considerably higher than the majority of published studies (see page 70). However, this analysis was performed on data from participants who were tested at normal levels of state anxiety and so, in order to maximise the likelihood of observation of significant effects, data from Experiment 4 and Experiment 5 where a stressor was applied was reanalysed as follows. Only participants who showed an elevation in state anxiety as a result of the proximity to exam (Experiment 4) or the laboratory stressor (Experiment 5) were selected, this

resulted in 10 participants rejected from Experiment 4 and 6 from Experiment 5, leaving a total of 68 from both studies combined.

These 68 participants were allocated to high and low trait anxiety groups. Rather than use a median split, as in Experiments 1 to 5, the top 40% and bottom 50% of trait scores were selected and the middle 20% discarded. This was done in order to maximise the strength of the independent variable. Mean reaction times were then calculated for each group and are shown in Table 52 below, for simplicity the Stroop presentation conditions of blocked, mixed and masked, and the stimulus conditions of social and physical threat were collapsed, as were the severe and moderate stimulus severity conditions for the dot probe task (unpacking the conditions had no effect on the pattern of data).

Table 52 shows that even with 27 participants in each trait group the mean ABIs do not deviate from 0 by more than 13ms, thus there is no evidence of attentional bias or avoidance.

Table 52 Collapsed ABIs for all participants from Experiment 4 and 5 who showed an elevation in state anxiety

	N	Trait score	Stroop ABI	Dot probe ABI
High trait	27	55	8	0
		(61)	(61)	(28)
Low trait	27	31	-14	-10
		(3)	(50)	(25)

The original intention of this research was to attempt to understand anxiety further by adopting a multi-faceted measurement approach. However, there was no way to do this without using reliable measures that are sensitive to individual differences. Studies one and two quickly showed that the results were not showing the expected pattern, studies three, four and five were essentially all attempts to explain why the effects were not occurring and to try to elicit the cognitive effects in particular.

The strategies used to try and produce effects included the following: different modes of presentation were tested (Experiment 3); the population the participants were sampled from was varied (Experiment 3); only extreme scorers were used (Experiment 4); and state anxiety was elevated using two different types of procedure

(Experiments 4 and 5). Throughout these studies, the state and trait scores of participants were comparable with those previously published. Hence, in the search to explain the failure to find effects the focus shifted from the studies themselves and returned to the literature to ask if it was an accurate representation of all the research into anxiety and attentional biases.

In the mid 1980s there was an explosion of research into the topic of cognition and emotion, and publications in the field have continued at a more or less steady rate ever since. Hunter et. al. (1982) suggested that "in many areas of research the need today is not additional empirical data but some means of making sense of the vast amounts of data that have accumulated." This observation is particularly true of the field of cognition and emotion nearly twenty years after that comment was made.

To date, in the field of cognition and emotion, the narrative review has been the tool of choice to produce a synthesis of numerous studies. For example, Williams, Mathews and MacLeod (1996) provide an excellent narrative review of research, which used the Emotional Stroop task. In the same vein, the literature review and introductions to studies 1-5 that are reported in this thesis have taken a narrative approach in an attempt to distil the essence of findings in the field. However, as Wood (1995) notes, "Even the best literature reviews...are not above criticism...Inevitably the interpretation of findings, the insights derived, the manner in which conclusions are drawn, are all dependent on the judgements of a single individual..or small group (of individuals)..In other words such opinions fall squarely into the category of subjective judgements."

The experiments in this thesis were based on the assumption gleaned from the existing literature that there was a robust effect of state and trait anxiety on attentional bias. There have been suggestions that even at low levels of state anxiety high trait anxious normal participants will display attentional bias towards threat and low trait anxious participants will not but these biases are even more exaggerated in high stress situations.

However, out of the five studies that used 186 participants in total, no evidence of this effect was found. Up to this point possible sources of error deriving from the experimental designs have been discussed, assuming that there has been a failure to find a robust effect, however there is a possibility that this effect was never robust in the first place.

The narrative reviews that resulted in the conclusion that there was a robust effect to be found do not appear to be biased. The published studies in the field do indicate that when conducting studies of this sort it is reasonable to anticipate a positive finding. For example, Logan and Goetsch (1993) in an early example of a narrative review of Stroop studies state that "non-clinical (anxious) subjects show bias towards general threat." The suggestion is that the published studies are unrepresentative of findings in this field as a result of the so called "file drawer problem" which refers to the non-publication of non-significant results.

Before continuing with an analysis of whether there is evidence of a publication bias in the field it is worthwhile highlighting the point that if this bias were to exist in the field of cognition and emotion it would not be an isolated example. There is a long-standing assumption that there are more positive results published than negative. This is supported anecdotally and by analyses of patterns of published studies. There follows an extract from a copy of a letter submitted in confidence to the editor of American Statistician which was sent to a researcher who submitted his article to a major environmental journal, it sums up perfectly the way in which editorial policy contributes to this problem:

"Unfortunately, we are not able to publish this manuscript. The manuscript is very well written and the study was well documented. Unfortunately the negative results translate into a minimal contribution to the field. We encourage you to continue your work in this area and we will be glad to consider additional manuscripts that you may prepare in the future." (Cited in Sterling, Rosenbaum & Weinkam, 1995)

Editorial policy is not the only source of this problem; researchers may also hold a "prejudice against the null hypothesis". Cooper et al. (1997) asked 33 psychology researchers to describe what had happened to 159 studies that were approved by their departmental ethics committees. Two thirds of completed studies were not submitted for publication, of those that were, significant findings were more likely to be submitted than non-significant findings. Rotton et. al. (1995) surveyed 468 authors of empirical psychological articles that had been published in refereed journals, they found that authors had decided against publishing approximately 15% of their manuscripts. The most frequently cited reason for not publishing was "non-significant results."

What does this bias against publishing non-significant results actually mean for the range of studies published? Sterling et. al. (1995) examined 597 articles published in 8 major psychological journals. The proportion of articles that rejected the major null hypothesis was 95.56%. Sterling et. al. calculate that the average proportion of studies that should be unable to reject the H_0 should be at least 20%, and this is a highly conservative estimate. The extreme view would be that journals are filled with the 5% of studies which show Type I errors and file drawers are filled with 95% of studies which show non-significant results (Rosenthal & Rubin, 1986).

The best way to interpret the impact of the file drawer problem is to calculate the number of studies with null results which must be stored unpublished before the overall probability of a Type I error can be brought to .05 (Rosenthal, 1995). If the overall level of significance of all studies combined is brought down to the just significant level (.05) by the addition of just a few studies then the finding is not resistant to the file drawer problem.

The hypothesis in question is that high anxious and low anxious participants show differential bias to threat under high state anxiety conditions, in order to assess the net effect of the file drawer problem, the following calculation was performed according to the method developed by Rosenthal (1991).

There are ten published studies which have looked at the effect of state anxiety on processing bias, these are represented in Table 53 below. These studies have used either dot probe or Stroop methodologies, but since the two methodologies are both indices of attentional bias it is reasonable to combine them. In some papers additional effects such as masking were investigated, in order that the results be comparable with the other papers only unmasked results are analysed here.

The unit of analysis is the Z value for the interaction between trait (high/low) and state (high/low) on attentional bias indices. Unfortunately, not all values are available, some papers did not use attentional bias indices as the dependent variable. For example they may found an interaction between state anxiety and stimulus valence in the high trait condition and not in the low trait condition but concluded that this indicates a differential response to state anxiety in high and low trait participants. Where the exact p value is not recorded Rosenthal recommends using a conservative estimate and setting $Z = 1.645$ for any result significant at $p<.05$ and $Z= 0$ for any non-significant results.

Table 53 Studies which have examined attentional biases in non-clinically anxious participants using stress induction procedures.

Authors & Date	P	Actual or estimated	Z
MacLeod & Mathews '88	.05	Actual	1.645
MacLeod & Rutherford '92	.02	Actual	2.05
Mogg, Bradley & Hallowell '94	.05	Actual	1.645
Mogg, Mathews, Bird & Macgregor-Morris '90 Exp 1	1.81	Actual	0
Mogg, Mathews, Bird & Macgregor-Morris '90 Exp 2	ns	Estimated	0
Mogg, Kentish & Bradley '93	ns	Estimated	0
Richards et.al. '92	.05	Estimated	1.645
vandenHout et.al. '92	ns	Estimated	0
Green, Rogers & Hedderley '96	ns	Estimated	0
Mathews & Sebastian '93	.19	Actual	.86
Chen, Lewin & Craske '96	.05	Estimated	1.645

To find the number (X) of new, filed or unretrieved studies averaging null results required to bring the new overall p to just significant the following equation is used:

$$1.645 = \frac{K\overline{Z}}{\sqrt{K+X}}$$

Where K is the number of studies combined and Z is the mean Z obtained for K studies.

Rearrangement shows that:

$$X = \frac{K[K\overline{Z}^2 - 2.706]}{2.706}$$

So, for studies which have examined the interaction effect of state and trait anxiety on attentional bias indices:

$$X = \frac{11\ [\ 11\ (.8627)^2 - 2.706] = 22}{2.706}$$

So, there would have to be 22 studies with null findings stored unpublished in order to conclude, "the overall results were due to sampling bias in the studies summarised by the reviewer" (Rosenthal, 1991). The question then stands, is 22

unpublished studies a likely figure? Aside from the fact that this thesis contains two just such unpublished null results, Rosenthal suggests that this figure should be estimated based on the amount of published studies. The suggested formula assumes that as the number of published studies increases so too does the number unpublished. Rosenthal assumes that it is unlikely that file drawers contain more than five times the number of published studies but he also sets a minimum level of unpublished studies at 10 (when there is one published). Hence if X is larger than 5K + 10, the combined results can be considered robust to the file drawer problem.

In this case:

$$5K + 10 = 65 > X = 22$$

Rosenthal is probably the most prolific author of articles dealing with meta-analyses and related issues, including the file drawer problem. Using his formulae it has been calculated that this field would need just 22 unpublished studies to bring the overall probability down to just significant. Based on the number of published studies an estimated 65 studies are unpublished.

This estimate has important implications for this thesis. It implies that the attentional bias results reported in studies 4 and 5 are not necessarily anomalous, but may be representative of the general field of both published and unpublished studies. The fact that there was a failure to replicate is consistent with the observation of Glass, McGraw and Smith (1981) who found the average experimental effect from studies published in journals to be larger than the corresponding effect estimated from theses and dissertations.

The original aim of this thesis was to examine the correlation between different indicators of anxiety in an attempt to further understand the nature of the construct. This aim was thwarted by a failure to find the significant physiological or cognitive results and hence there was no way to investigate the correlations between the different indicators of anxiety.

This was a novel approach to studying anxiety. There have been studies which have made forays into a multi-method approach, but generally the attentional bias component of anxiety has been neglected. The paper by Calvo and Cano-Vindel (1997) is typical of a multi-method style of research which appears to be becoming more popular. Researchers adopt this type of methodology when they wish to understand complex constructs such as anxiety in more depth. In their abstract Calvo and Cano-Vindel report that they have investigated the nature of anxiety "using self-

report and objective measures of biological, behavioural, and cognitive characteristics." Their index of "cognitive characteristics" however, was the Cognitive and Somatic Anxiety Scale (Calvo, Alamo & Ramos, 1990). "Cognitive" in this case was taken to mean the thoughts that accompany anxiety.

Kenardy et.al. (1993) gave another example of this approach. They measured cognition, physiology and subjective reports of anxiety in a group of phobic patients exposed to phobic relevant situations. For example, agoraphobic patients were taken to a busy shopping precinct. During exposure they wore an ambulatory heart rate monitor and were asked to give continuous reports of their subjective anxiety and the general content of their thoughts (i.e. their cognitions). Again, Kenardy et.al. conceptualise cognition as equivalent to the focus of worries.

Borkovec and Inz (1990) define worry as a cognitive process which involves repetitive thoughts concerning traumatic events and their potentially disastrous outcomes. A highly anxious person is more likely to engage in these kinds of thoughts (Eysenck, 1985). In other words, highly anxious people focus on potential sources of negative outcomes for themselves. To do this they must remain constantly vigilant to their physiological and psychological well-being in order to detect and deflect any source of trauma. Eysenck (1997) saw this as an internal application of attentional bias for threat. A high anxious person has a bias for threatening and potentially upsetting stimuli in the environment, but there is no reason why this bias should not operate internally as well. Thus anxious people are overly vigilant to internal signals of distress. This explains why a highly anxious person may give a subjective report of their anxiety which is exaggerated above and beyond the objective observations.

Calvo and Cano-Vindel (1997) use this argument to explain why they found that high trait anxiety was associated with reports of extreme somatic and cognitive anxiety and yet there were no physiological manifestations of this.

This argument, when applied to the findings from studies one to five, implies that there is one further explanation of the pattern of results. Up to this point the lack of attentional bias effects has been interpreted as a result of misleading literature, stemming from a publication bias, which suggested the effect was more robust than it really is. The lack of physiological results has been interpreted as due to the notorious difficulty associated with the methodologies and hence consistent with previous findings. However, it may be that studies one to five are relevant to the original aim of the thesis and they show that anxiety is not a unitary phenomenon but that the

subjective report of anxiety is separate from cognitive or physiological manifestations. In other words, anxiety has two facets which are not correlated, objective anxiety and subjective anxiety.

Calvo and Cano-Vindel found that participants reported high levels of anxiety but that objective measures didn't support their subjective evaluation. These findings are mirrored in studies one to five. In all five studies participants indicated that they were feeling more highly anxious than the objective measures implied.

The final interpretation is that the indicators *did* record the different manifestations of anxiety accurately, and that anxiety can be viewed as having at least two separable facets. On the one hand there is anxiety of the type which manifests objectively, and on the other there is anxiety which is experienced subjectively, characterised by worry.

Calvo and Cano-Vindel in fact conclude that their findings are "mainly consistent with a cognitive, rather than a biological, notion of trait anxiety." They neglect to observe that their cognitive measures which showed a significant relationship to trait anxiety were all subjective and that their biological measures were all objective. Thus an equally valid conclusion would have been that their findings were consistent with a subjective vs. objective, notion of trait anxiety. The only way to test this is to use an objective cognitive measure, which was the design adopted in studies one to five.

However, there is an obvious theoretical argument against this two faceted conception of objective and subjective anxiety. If, as set out above, worry is a product of the high trait anxious persons' attentional bias towards internal signals of threat, then there is no obvious reason why that bias should not apply to external sources of threat also.

There is no real basis to suggest that subjective and objective anxiety are separable constructs. Low methodological reliabilities associated with objective measures, which are not associated to the same degree with subjective measures, are the most likely cause of this apparent difference.

This harks back to the analogy made by Gray (1994, see page 23) about the man looking for his watch in the pool of the streetlight rather than where he dropped it. Perhaps the metaphorical light of objective measures is not yet bright enough to be sure that the nature of anxiety will be shown if one looks for it there. And hence one should be cautious of what is found when groping in the dark.

Appendix 1- SELF-EVALUATION QUESTIONNAIRE

Name: .....
Session: ..... **Subject number:** .....

*A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to indicate how you feel **right now**, that is, **at this moment**. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.*

	Not at all	Some-what	Moder-ately so	Very much so
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I am tense	1	2	3	4
4. I feel strained	1	2	3	4
5. I feel at ease	1	2	3	4
6. I feel upset	1	2	3	4
7. I am presently worried over possible misfortunes	1	2	3	4
8. I feel satisfied	1	2	3	4
9. I feel frightened	1	2	3	4
10. I feel comfortable	1	2	3	4
11. I feel self confident	1	2	3	4
12. I feel nervous	1	2	3	4
13. I am jittery	1	2	3	4
14. I feel indecisive	1	2	3	4
15. I am relaxed	1	2	3	4
16. I feel content	1	2	3	4
17. I am worried	1	2	3	4
18. I feel confused	1	2	3	4
19. I feel steady	1	2	3	4
20. I feel pleasant	1	2	3	4

SELF-EVALUATION QUESTIONNAIRE

Name: .....
Session: ..... **Subject number:** .....

*A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to indicate how you **generally** feel. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.*

	Almost never	Some-times	Often	Almost Always
21. I feel pleasant	1	2	3	4
22. I feel nervous and restless	1	2	3	4
23. I feel satisfied with myself	1	2	3	4
24. I wish I could be as happy as others seem to be	1	2	3	4
25. I feel like a failure	1	2	3	4
26. I feel rested	1	2	3	4
27. I am "calm, cool and collected"	1	2	3	4
28. I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
29. I worry too much over something that really doesn't matter	1	2	3	4
30. I am happy	1	2	3	4
31. I have disturbing thoughts	1	2	3	4
32. I lack self-confidence	1	2	3	4
33.I feel secure	1	2	3	4
34. I make decisions easily	1	2	3	4
35. I feel inadequate	1	2	3	4
36. I am content	1	2	3	4
37. Some unimportant thoughts run through my mind and bother me	1	2	3	4
38. I take disappointments so keenly I can't put them out of my mind	1	2	3	4
39. I am a steady person	1	2	3	4
40. I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4

Appendix 2- MARLOWE-CROWNE SCALE

Name: .....
Session: ..... **Subject Number:** .....

*Listed below are a number of statements concerning personal attitudes and traits. Read each item and decide whether the statement is **true** or **false** as it pertains to you personally.*

	True	False
1. Before voting I thoroughly investigate the qualifications of all the candidates.	☐	☐
2. I never hesitate to go out of my way to help someone in trouble.	☐	☐
3. It is sometimes hard for me to go on with my work if I am not encouraged.	☐	☐
4. I have never intensely disliked someone.	☐	☐
5. On occasion I have had doubts about my ability to succeed in life.	☐	☐
6. I sometimes feel resentful when I don't get my own way.	☐	☐
7. I am always careful about my manner of dress.	☐	☐
8. My table manners at home are as good as when I eat out at a restaurant.	☐	☐
9. If I could get into a movie without paying and be sure I was not seen I would probably do it.	☐	☐
10. On a few occasions, I have given up doing something because I thought too little of my ability.	☐	☐
11. I like to gossip at times .	☐	☐
12. There have been times when I felt like rebelling against people in authority even though I knew they were right.	☐	☐
13. No matter who I'm talking to I'm always a good listener.	☐	☐
14. I can remember playing "sick" to get out of something.	☐	☐
15. There have been occasions when I took advantage of someone.	☐	☐
16. I am always willing to admit when I've made a mistake.	☐	☐

Name: .....
Session: ..... **Subject Number:** .....

	True	False
17. I always try to practise what I preach.	☐	☐
18. I don't find it particularly difficult to get along with loud-mouthed, obnoxious people.	☐	☐
19. I sometimes try to get even rather than forgive and forget.	☐	☐
20. When I don't know something I don't at all mind admitting to it.	☐	☐
21. I am always courteous, even to people who are disagreeable.	☐	☐
22. At times I have really insisted on having things my own way.	☐	☐
23. There have been occasions when I have felt like smashing things.	☐	☐
24. I would never think of letting someone else be punished for my wrongdoing.	☐	☐
25. I never resent being asked to return a favour.	☐	☐
26. I have never been irked when people expressed ideas very different from my own.	☐	☐
27. I never make a long trip without checking the safety of my car.	☐	☐
28. There have been times when I was quite jealous of the good fortune of others.	☐	☐
29. I have almost never felt the urge to tell someone off.	☐	☐
30. I am sometimes irritated by people who ask favours of me.	☐	☐
31. I have never felt that I was punished without cause.	☐	☐
32. I sometimes think when people have a misfortune they only get what they deserve.	☐	☐
33. I have never deliberately said something that hurt someone's feelings.	☐	☐

Appendix 3- Stroop word stimuli

Neutral Stroop word stimuli

bleach	cabinet
furnished	curtain
groceries	drain
lamp	linoleum
ornament	mattress
shower	polished
staircase	refrigerator
switch	sweep
towel	varnish
wardrobe	washing
broom	antique
chimney	basement
cushion	carpet
domestic	cutlery
lounge	decorate
mantelpiece	garage
shampoo	pillow
shelves	radiator
upstairs	sofa

Positive Stroop word stimuli

achievement	cheerful
celebration	courageous
comfort	darling
delight	elated
enthusiasm	enchanting
generous	fortunate
merry	lively
praise	passion
sensual	relief
superb	smiling
applause	beloved
charm	bliss
confident	clever
devoted	frolic
excellent	marvellous
helpful	pleasure
miracle	satisfaction
romance	splendid
serene	triumphant
terrific	welcome

Physical threat Stroop word stimuli

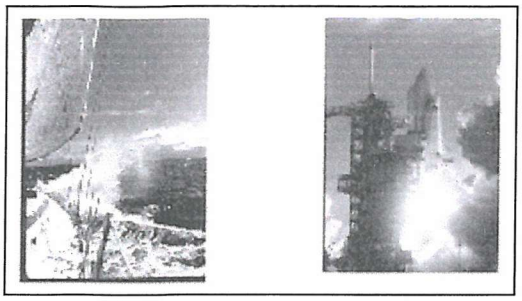
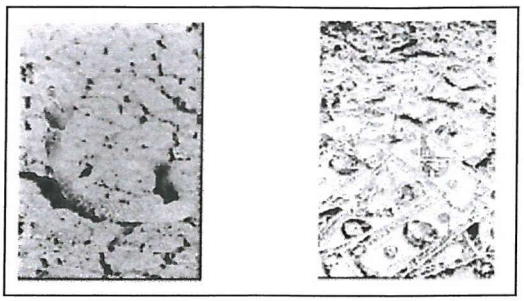
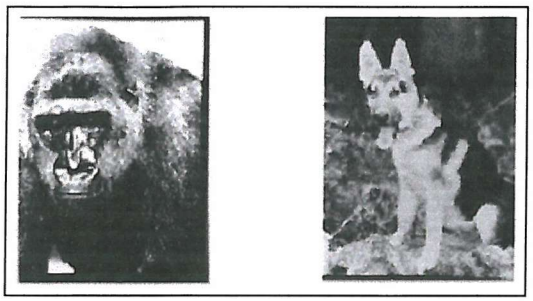
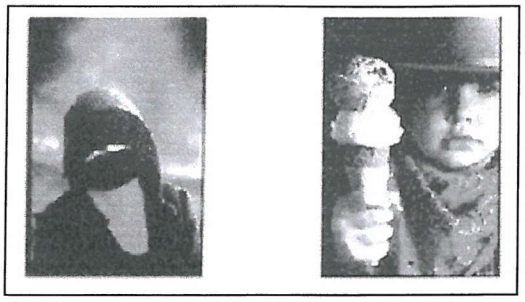
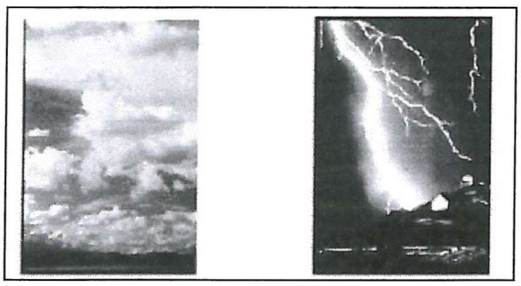
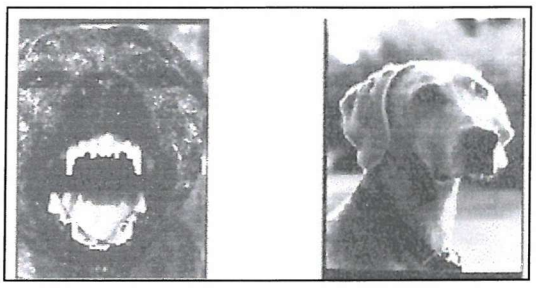
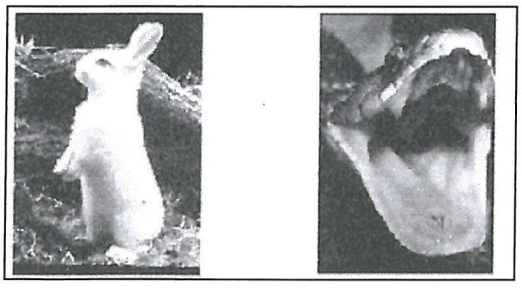
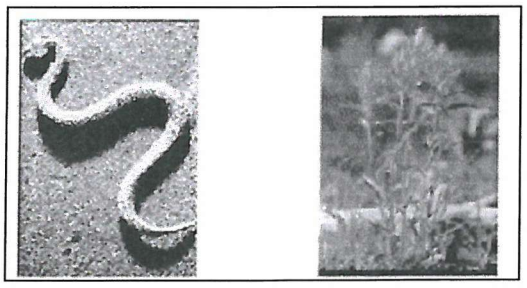
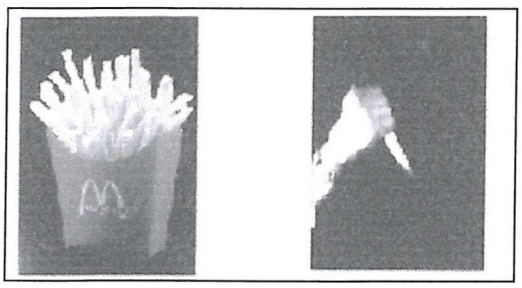
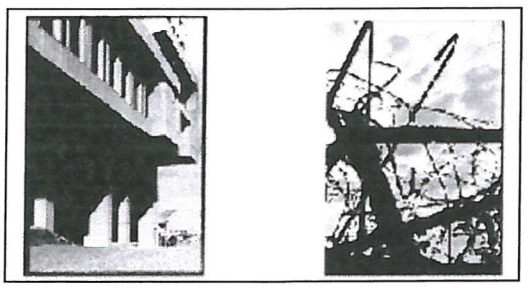
accident	attack
burial	casualty
cancer	coronary
cemetery	inquest
collapse	lethal
emergency	mutilated
fatal	trapped
hazard	unwell
murder	victim
paralysis	violence
ambulance	assault
choking	breakdown
coffin	brutal
disease	cruelty
fracture	harm
funeral	killer
injury	operation
pain	strangled
suffocated	suicide
surgery	tumour

Social threat Stroop word stimuli

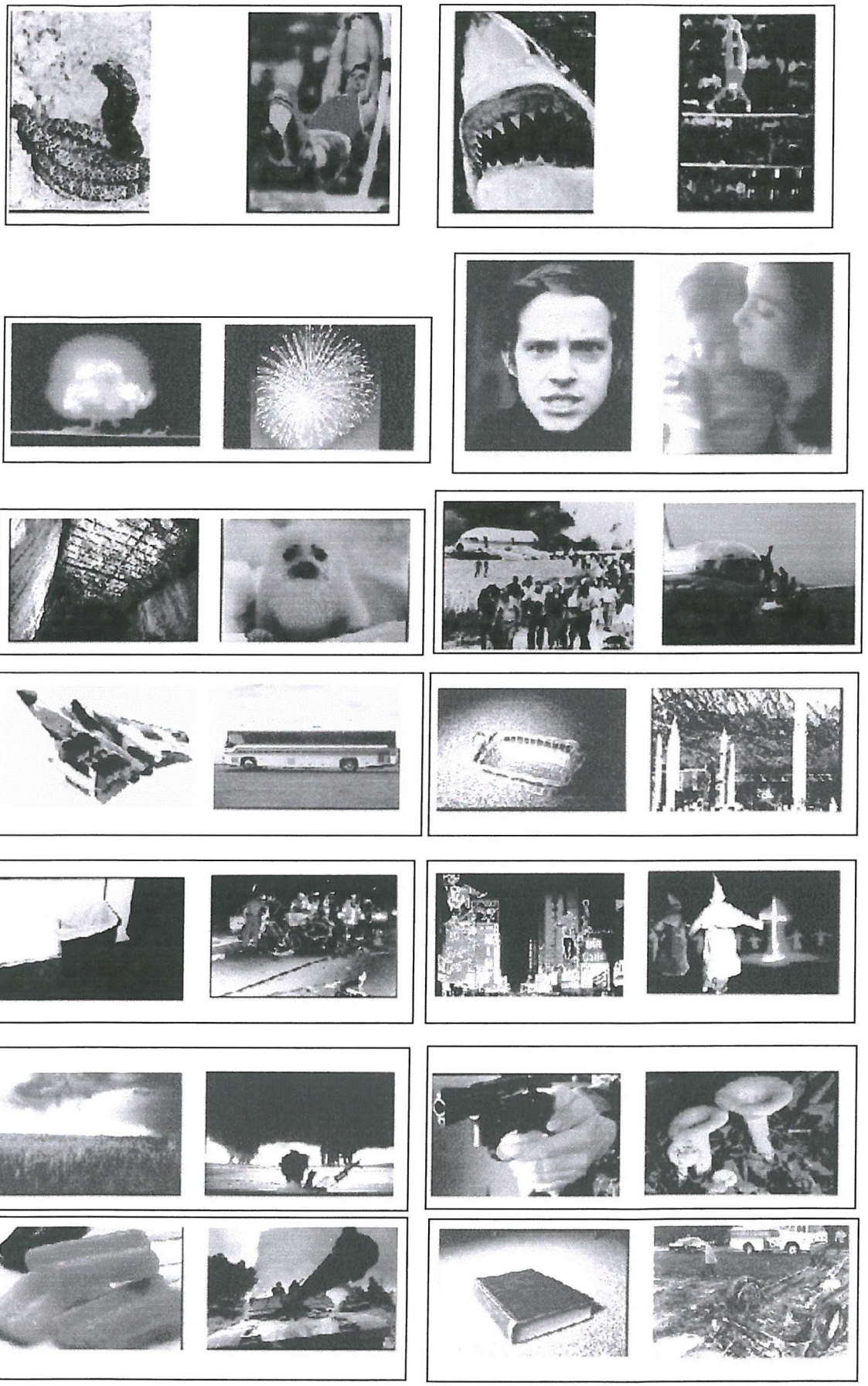
foolish	boring
hated	embarrassed
hostile	fail
inferior	ignorant
neglected	inadequate
persecuted	insult
ridicule	mistake
sneer	pathetic
unsuccessful	resentment
worthless	unloved
hopeless	ashamed
humiliated	blame
indecisive	criticism
inept	despised
lonely	immature
offended	intimidated
snub	rejected
stupid	scorn
unfriendly	spite
useless	unpopular

Appendix 4 - Dot probe pictures

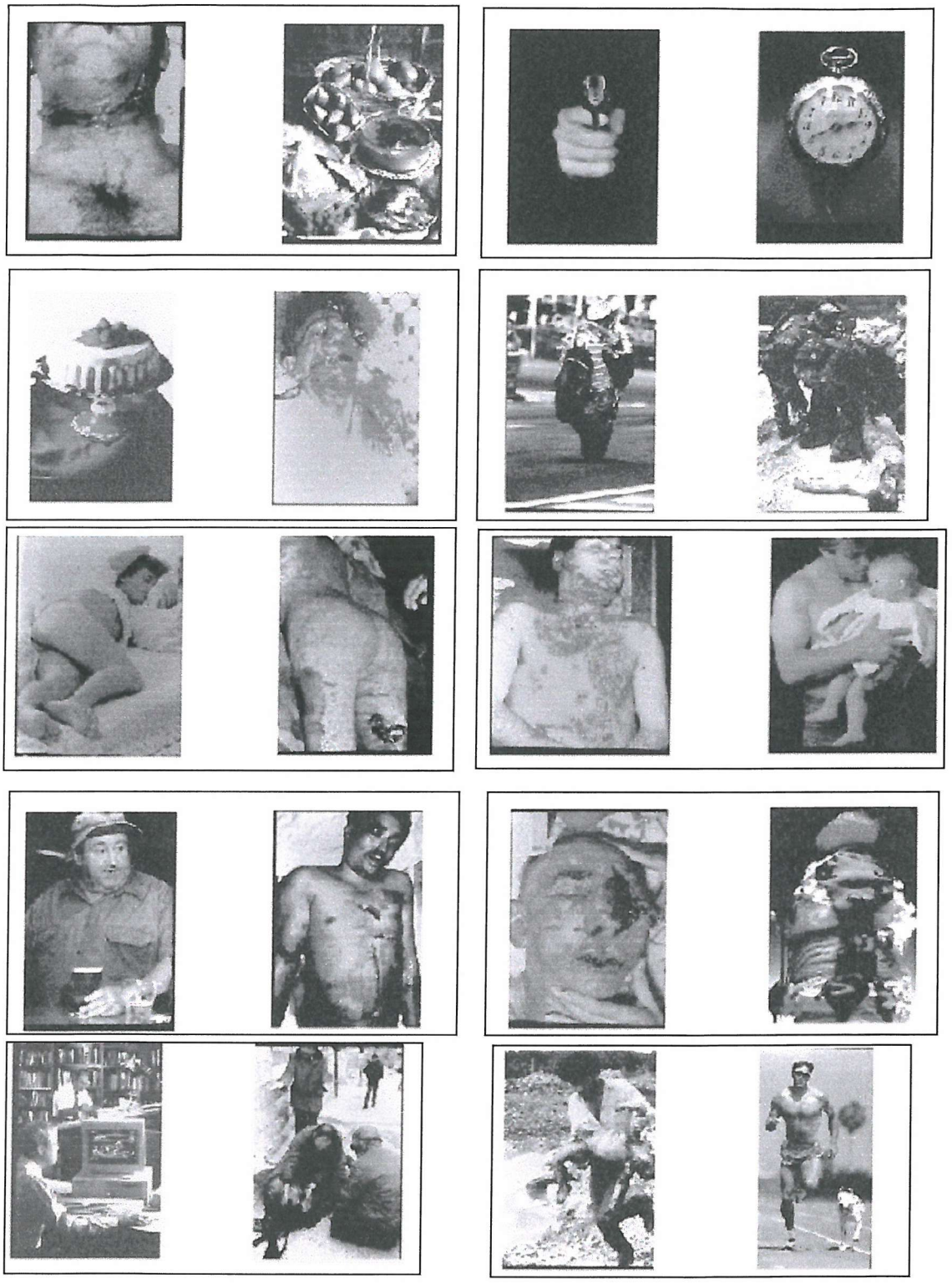
Moderate picture pairs

Moderate picture pairs (cont.)



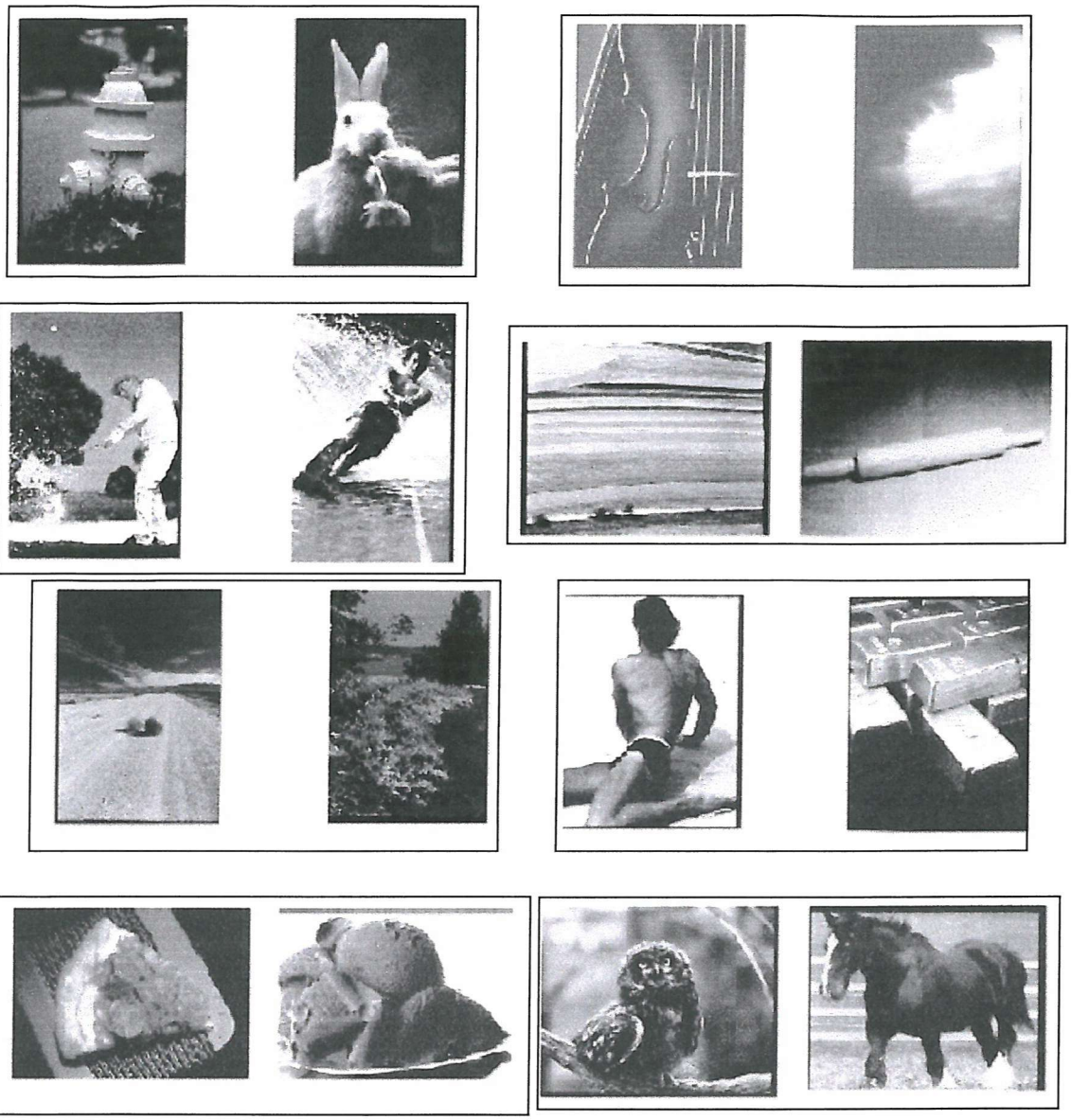
Severe picture pairs



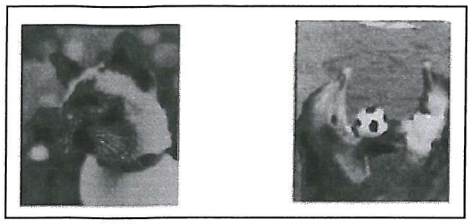
Severe picture pairs (cont.)

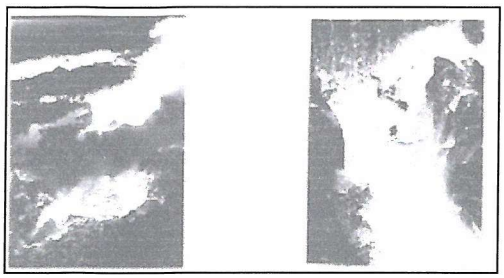
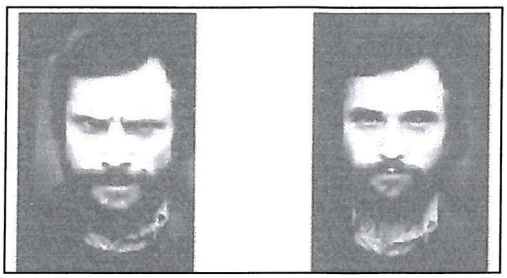
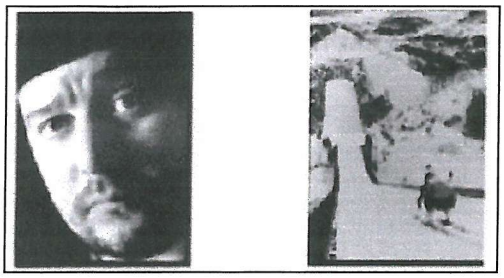
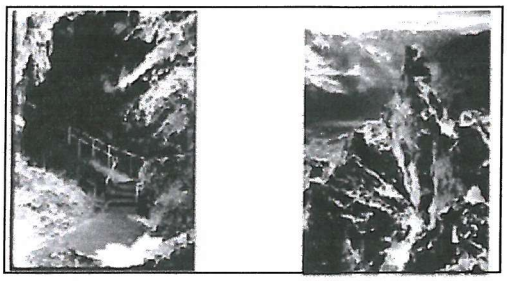
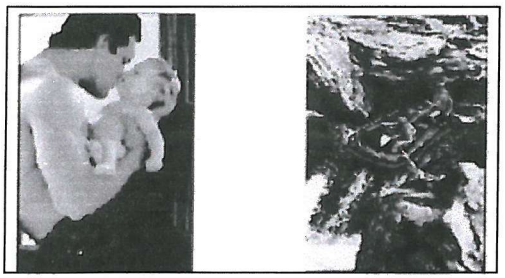
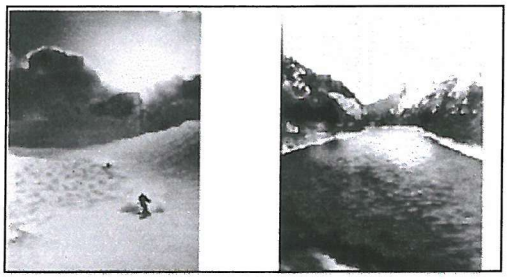
Novel picture pairs

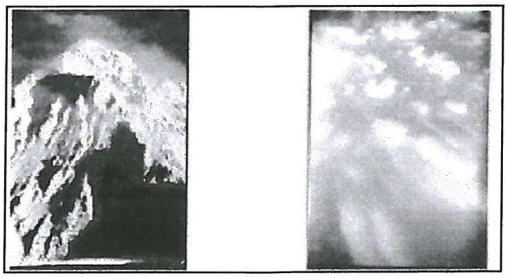
Novel picture pairs (cont.)

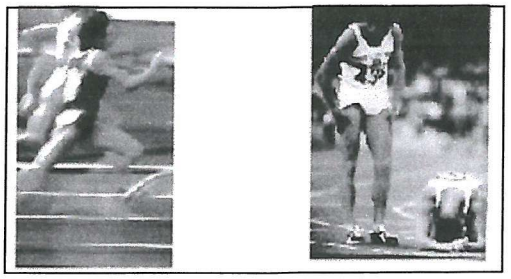


Practice picture pairs

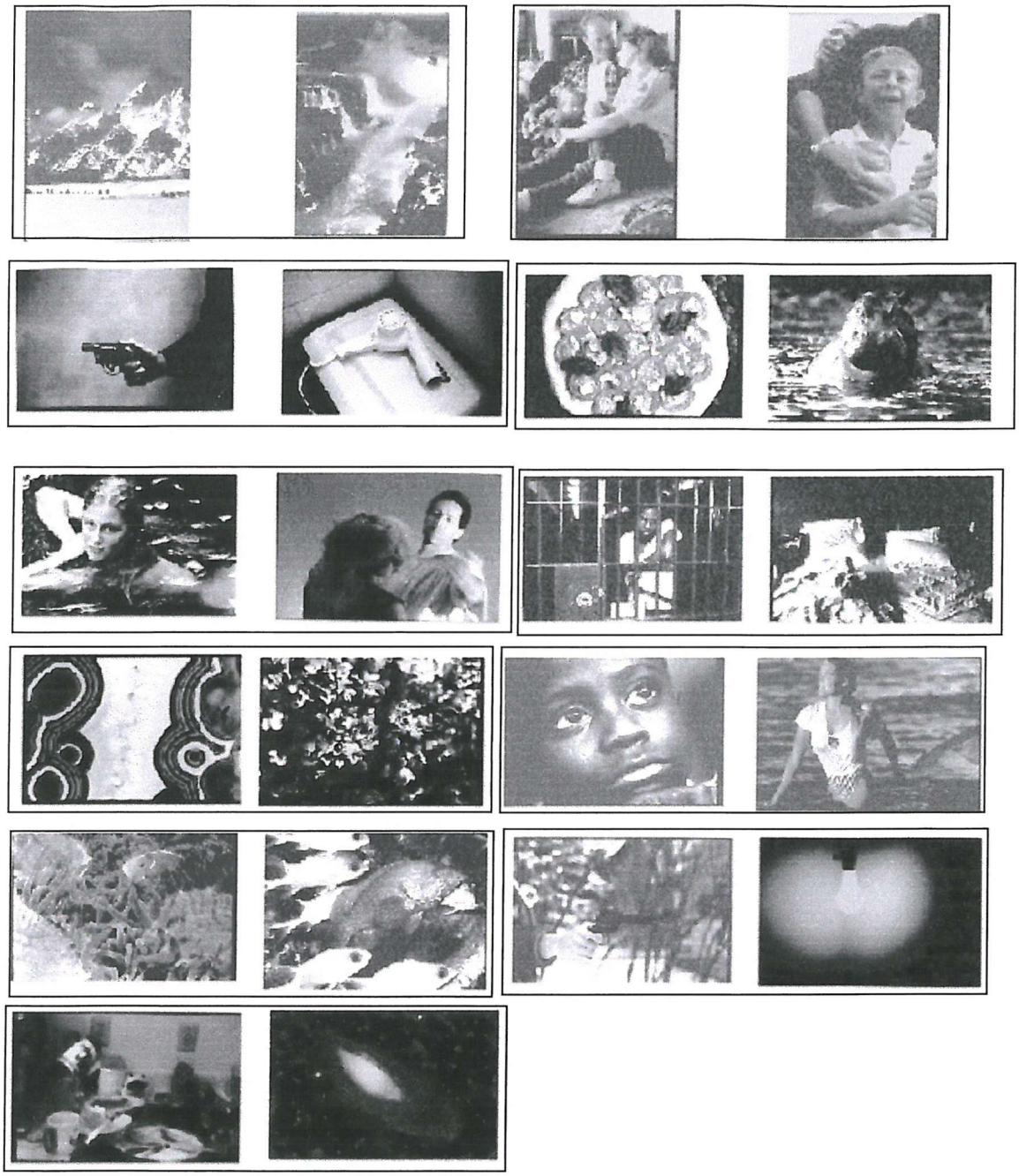






Practice pictures)cont.)



Appendix 5 - Stroop reaction times for Experiment 1

Table 54 Mean and median reaction times at time 1 to block presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	520	510	509	498	520	515	519	511
Low trait Ps	519	512	523	506	533	515	534	517

Table 55 Mean and median reaction times at time 2 to block presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	501	498	497	487	504	503	501	498
Low trait Ps	497	478	517	490	516	505	518	502

Table 56 Mean and median reaction times at time 1 to mixed presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	539	527	531	527	528	517	545	537
Low trait Ps	542	539	532	528	532	533	536	527

Table 57 Mean and median reaction times at time 2 to mixed presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	502	514	518	508	532	523	522	516
Low trait Ps	510	494	509	491	517	491	519	506

Table 58 Mean and median reaction times at time 1 to masked presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	540	505	538	533	547	543	529	528
Low trait Ps	557	547	531	529	536	545	540	532

Table 59 Mean and median reaction times at time 2 to masked presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	519	504	525	510	521	518	537	537
Low trait Ps	525	504	511	500	517	504	519	504

Appendix 6 – Dot probe reaction times for Experiment 1

Table 60 Mean and median reaction times at time 1 to dot probe stimuli by trait anxiety group

	Moderate picture, probe in neutral field		Moderate picture, probe in threat field		Severe picture, probe in neutral field		Severe picture, probe in threat field	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	484	484	482	477	488	491	484	481
Low trait Ps	493	489	498	499	514	496	509	494

Table 61Mean and median reaction times at time 2 to dot probe stimuli by trait anxiety group

	Moderate picture, probe in neutral field		Moderate picture, probe in threat field		Severe picture, probe in neutral field		Severe picture, probe in threat field	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	471	465	474	454	486	474	484	475
Low trait Ps	494	484	493	492	496	496	490	496

Appendix 7 - Stroop reaction times for Experiment 2

Table 62 Mean and median reaction times at time 1 to block presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	542	517	526	495	551	541	540	543
Low trait Ps	505	508	516	504	521	507	498	500

Table 63 Mean and median reaction times at time 2 to block presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	539	491	528	510	536	509	533	506
Low trait Ps	497	498	511	495	495	486	516	511

Table 64 Mean and median reaction times at time 1 to mixed presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	564	548	562	579	555	533	537	529
Low trait Ps	527	504	513	510	528	514	531	525

Table 65 Mean and median reaction times at time 2 to mixed presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	521	503	516	504	537	544	534	503
Low trait Ps	498	497	511	506	513	513	513	509

Table 66 Mean and median reaction times at time 1 to masked presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	581	603	557	574	586	582	552	567
Low trait Ps	535	540	537	532	548	548	521	519

Table 67 Mean and median reaction times at time 2 to masked presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	516	478	534	500	533	518	544	523
Low trait Ps	517	528	516	514	516	520	520	525

Appendix 8 – Dot probe reaction times for Experiment 2

Table 68 Mean and median reaction times at time 1 to dot probe stimuli by trait anxiety group

	Moderate picture, probe in neutral field		Moderate picture, probe in threat field		Severe picture, probe in neutral field		Severe picture, probe in threat field	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	534	519	521	498	543	517	561	544
Low trait Ps	496	492	492	494	495	511	539	543

Table 69Mean and median reaction times at time 2 to dot probe stimuli by trait anxiety group

	Moderate picture, probe in neutral field		Moderate picture, probe in threat field		Severe picture, probe in neutral field		Severe picture, probe in threat field	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	473	498	523	518	539	547	564	546
Low trait Ps	494	483	478	474	475	482	494	506

Appendix 9 - Stroop reaction times for Experiment 3

Table 70 Mean and median reaction times to computerised, block presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	517	517	515	501	521	517	527	514
Low trait Ps	508	497	536	528	540	539	522	519

Table 71 Mean and median reaction times to computer presented mixed presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	523	519	503	501	514	504	528	528
Low trait Ps	516	513	515	506	536	528	531	500

Table 72 Mean and median reaction times to paper presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	492	479	477	459	480	487	480	466
Low trait Ps	460	470	462	446	461	465	450	444

Appendix 10 - Stroop reaction times for Experiment 4

Table 73 Mean and median reaction times at time 1 to block presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	476	448	476	446	476	454	484	428
Low trait Ps	418	382	433	416	438	415	418	390

Table 74 Mean and median reaction times at time 2 to block presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	443	426	413	398	442	433	431	418
Low trait Ps	433	419	451	403	421	408	430	398

Table 75 Mean and median reaction times at time 1 to mixed presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	471	427	477	429	502	444	502	452
Low trait Ps	429	411	428	406	435	412	433	407

Table 76 Mean and median reaction times at time 2 to mixed presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	434	409	431	407	444	427	445	439
Low trait Ps	432	423	441	393	452	421	438	399

Table 77 Mean and median reaction times at time 1 to masked presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	478	433	454	417	462	421	482	409
Low trait Ps	454	451	429	423	471	448	471	428

Table 78 Mean and median reaction times at time 2 to masked presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	439	414	422	409	450	409	450	422
Low trait Ps	428	419	408	387	410	385	403	401

Appendix 11 - Dot probe reaction times for Experiment 4

Table 79 Mean and median reaction times at time 1 to dot probe stimuli by trait anxiety group

	Moderate picture, probe in neutral field		Moderate picture, probe in threat field		Severe picture, probe in neutral field		Severe picture, probe in threat field	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	452	443	448	439	442	432	451	441
Low trait Ps	441	419	433	418	437	440	446	433

Table 80Mean and median reaction times at time 2 to dot probe stimuli by trait anxiety group

	Moderate picture, probe in neutral field		Moderate picture, probe in threat field		Severe picture, probe in neutral field		Severe picture, probe in threat field	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	444	439	432	436	436	438	451	442
Low trait Ps	426	429	417	422	414	414	430	430

Appendix 12 - Stroop reaction times for Experiment 5

Table 81 Mean and median reaction times at time 1 to block presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	399	372	399	360	397	389	411	407
Low trait Ps	377	358	399	390	381	362	387	368

Table 82 Mean and median reaction times at time 2 to block presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	384	374	400	406	386	386	391	370
Low trait Ps	390	355	379	358	363	350	379	351

Table 83 Mean and median reaction times at time 1 to mixed presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	429	395	421	407	421	410	424	411
Low trait Ps	415	382	419	409	412	401	408	397

Table 84 Mean and median reaction times at time 2 to mixed presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	407	414	410	416	403	399	410	389
Low trait Ps	400	399	377	363	384	351	395	388

Table 85 Mean and median reaction times at time 1 to masked presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	423	407	431	408	429	383	411	397
Low trait Ps	415	380	423	420	420	404	419	398

Table 86 Mean and median reaction times at time 2 to masked presented emotional Stroop words by trait anxiety group

	Valence							
	Neutral		Positive		Physical threat		Social threat	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	412	397	399	389	404	396	390	388
Low trait Ps	391	387	384	379	388	361	387	386

Appendix 13 - Dot probe reaction times for Experiment 5

Table 87 Mean and median reaction times at time 1 to dot probe stimuli by trait anxiety group

	Moderate picture, probe in neutral field		Moderate picture, probe in threat field		Severe picture, probe in neutral field		Severe picture, probe in threat field	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	444	447	448	444	451	459	457	458
Low trait Ps	422	418	423	416	430	422	426	418

Table 88 Mean and median reaction times at time 2 to dot probe stimuli by trait anxiety group

	Moderate picture, probe in neutral field		Moderate picture, probe in threat field		Severe picture, probe in neutral field		Severe picture, probe in threat field	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
High trait Ps	413	412	420	418	405	398	404	411
Low trait Ps	400	392	409	396	398	391	398	403

References

Akiskal, H., Maser, J., Wolfe, B., & Solomon, S. (1997) *Anxiety Disorders*. NIMH Publication No. 97-3879.

Al'Absi, M., Bongard, S., Buchanan, T., Pincomb, G.A., Lincinio, J. & Lovallo, W.R. (1997) Cardiovascular and neuroendocrine adjustment to public speaking and mental arithmetic stressors. *Psychophysiology, 34*, 266-275.

Allport, F.H. (1932) *Personality in our changing society.* Chicago: Chicago Press.

Angleitner, A., Ostendorf, F., John, O.P. (1990) Towards a taxonomy of personality descriptors in German: A psycho-lexical study. *European Journal of Personality, 4*(2), 89-118.

Arena, J.G. & Hobbs, S.H. (1995) Temporal stability of psychophysiological stress profiles: A re-analysis using intraclass correlation coefficients. *Psychological Reports, 76*(1), 171-175 .

Asendorpf, J.B., Wallbott, H.G. & Scherer, K.R. (1983) The confounded repressor: An empirically based proposal for two-dimensional operationalisation of repression-sensitization. *Zeitschrift fuer Differentielle und Diagnostische Psychologie. 4*(2), 111-126.

Ashcroft, , K.R., Guimaraes, F.S., Wang, M. & Deakin, J.F. (1991) Evaluation of a psychophysiological model of classical fear conditioning in anxious patients. *Psychopharmacology, 104*(2), 215-219.

Auden, W.H. & Mendelson, E. (Ed.) (1977) *The English Auden.* London: Faber and Faber.

Ax, A.F. (1953) The physiological differentiation between fear and anger in humans. *Psychosomatic Medicine, 15*, 433-442.

Beidel, D.C., Turner, S.M. & Dancu, C.V. (1985) Physiological, cognitive and behavioral aspects of social anxiety. *Behaviour Research and Therapy, 23*(2), 109-117.

Block, J. (1977) The Eysencks and Psychoticism. *Journal of Abnormal Psychology, 86*(6), 653-654.

Borkovek, T.D. & Inz, J. (1990) The nature of worry in generalised anxiety disorder: A predominance of thought activity. *Behaviour Research and Therapy, 28,* 69-73.

Boucsein, W. (1992) *Electrodermal Activity*. New York: Plenum Press

Bower, G.H. (1981) Mood and memory. *American Psychologist, 36*(2), 129-148.

Bower, G.H. (1987) Commentary on mood and memory. *Behaviour Research and Therapy, 25*(6), 443-455.

Bower, G.H. & Cohen, P.R. (1982) Emotional influences on memory and thinking: Data and theory. In S. Fiske & M. Clarke (Eds.) *Affect and Cognition.* Hillsdale, N.J.: Lawrence Earlbaum.

Bremner, J. D., Randall, P., Vermetten, E., Staib, L. (1997) Magnetic resonance imaging-based measurement of hippocampal volume in posttraumatic stress disorder related to childhood physical and sexual abuse: A preliminary report. *Biological Psychiatry, 41*(1), 23-32.

Briggs, S.R. (1989) The optimal level of measurement for personality constructs. In D.M. Buss & N. Cantor (Eds.) *Personality psychology: Recent trends and emerging directions*. New York: Springer-Verlag.

Calvo, M.G., Alamo, L. & Ramos, P.M. (1990) Test anxiety, motor performance and learning: Attentional and somatic interference. *Personality and Individual Differences, 11,* 29-38.

Calvo, M.G. & Cano-Vindel, A. (1997) the nature of trait anxiety: Cognitive and biological vulnerability. *European Psychologist, 2*(4), 301-312.

Cannon, W.B. (1927) The James-Lange theory of emotions: a critical examination and an alternative theory. *American Journal of Psychology, 39*, 106-124.

Cannon, W.B. (1934) The significance of the emotional level. *Scientific Monthly, 38*, 101-110.

Cassidy, K. L., McNally, R.J., & Zeitlin, S.B. (1992) Cognitive processing of trauma cues in rape victims with post-traumatic stress disorder. *Cognitive Therapy and Research, 16,* 283-295.

Cattell, R.B. (1965) *The Scientific Study of Personality*. Harmondsworth: Penguin.

Cattell, R.B. & Scheier, I.H. (1961) *The meaning and measurement of neuroticism and anxiety*. New York: Ronald.

Catell, R.B. & Scheier, I.H. (1966) Personality measurement in applied psychology as illustrated by the 16 personality factor test. *Revista de Psicologia Normal e Patologica, 11*, 42-58.

Chattopadhyay, P.K., Bond, A.J. & Lader, M.H. (1975) Characteristics of galvanic skin response in anxiety states. *Journal of Psychiatric Research, 12*(4), 265-270.

Chen, E., Lewin, M.R. & Craske, M.G. (1996) Effects of state anxiety on selective processing of threatening information. *Cognition and Emotion, 10,* 3, 225-240.

Clark, D.M. & Teasdale, J.D.(1982) Diurnal variation in clinical depression and accessibility of memories of positive and negative experiences. *Journal of Abnormal Psychology, 91*(2), 87-95.

Clark, L.A., Watson, D. & Mineka, S. (1994) Temperament, personality, and the mood and anxiety disorders. *Journal of Abnormal Psychology, 103*(1), 103-116.

Cohen, J. (1988) *Statistical Power Analysis for the Social Sciences.* Hillsdale, N.J.: Earlbaum.

Cohen, J.D., Dunbar, K. & McClelland J.L. (1990) On the control of automatic processes: A parallel distributed processing account of the Stroop effect. *Psychological Review, 27,* 259-260.

Connor, A., Franzen, M.D. & Sharp, B. (1988) Effects of practice and differential instructions on Stroop performance. *International Journal of Clinical Neuropsychology, 10*(1) 1-4.

Cook, M. (1993) *Levels of Personality*. London: Cassell.

Cook, N.J., Harris, B., Walker, R.F. & Hailwood, R.(1986) Clinical utility of the dexamethasone suppression test assessed by plasma and salivary cortisol determinations. *Psychiatry Research, 18,* 143-150.

Cooper, H., DeNeve, K. & Charlton, K. (1997) Finding the missing science: the fate of studies submitted for review by a human subjects committee. *Psychological Methods, 2*(4) 447-452.

Costa, P.T. & McCrae, R.R. (1988) From catalogue to classification: Murray's needs and the five-factor model. *Journal of Personality and Social Psychology, 55*(2), 258-265.

Crowne, D.P. & Marlowe, D. (1960) A new scale of social desirability independent of psychopathology. *Journal of Consulting Psychology, 42,* 349-354.

Davison, G.C. & Neale, J.M. (1994) *Abnormal Psychology.* New York: Wiley.

Dawkins, K. & Furnham, A. (1989) The colour naming of emotional words. *British Journal of Psychology. 80*(3), 383-389.

de-Ruiter, C. & Brosschot, J.F. (1994) The Emotional Stroop interference in anxiety: Attentional bias or cognitive avoidance? *Behaviour and Research Therapy. 32*(3) 315-319.

Dimberg, U., Fredrikson & M., Lundqvist, O. (1986) Autonomic reactions to social and neutral stimuli in subjects high and low in public speaking fear. *Biological Psychology, 23*, 223-233.

Dimsdale, J. (1984) Generalising from laboratory studies to field studies of human stress physiology. *Psychosomatic Medicine, 46,* 463-469.

Duchek, J.M. & Neely, J.H. (1989) A dissociative word frequency by levels of processing interaction in episodic recognition and lexical decision tasks. *Memory and Cognition, 17,* 148-162.

Edelmann, R.J.(1992) *Anxiety: Theory, research and intervention in clinical and health psychology.* Chichester, England UK: John Wiley and Sons.

Ehlers, A., Margraf, J., Davies, S., & Roth, W.T. (1988) Selective processing of threat cues in participants with panic attack. *Cognition and Emotion, 2*, 201-219.

Endler, N.S., Edwards, J.M., Vitelli, R. & Parker, J.D. (1989) Assessment of state and trait anxiety: Endler Multidimensional Anxiety Scales. *Anxiety Research, 2*(1), 1-14.

Ekman, P. & Davidson, R.J. (Eds.) (1994) *The nature of emotion: Fundamental questions.* New York: Oxford University Press.

Ekman, P. & Friesen, W.V. (1971) Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology, 17*(2), 124-129.

Ekman, P., Friesen, W.V. & Ellsworth, P. (1972) *Emotion in the human face: Guidelines for research and an integration of findings.* New York: Pergamon Press.

Ekman, P., Sorenson, E. R. & Friesen, W.V. (1969) Pan-cultural elements in facial displays of emotion. *Science, 164*(3875), 86-88.

Epstein, L. (1982) Adapting to the patient's therapeutic need in the psychoanalytic situation. *Contemporary Psychoanalysis, 18*(2), 190-217.

Eysenck, H.J. (1967) *The Biological Basis of Behaviour.* Springfield, IL: C.C. Thomas.

Eysenck, H.J. (1991) Dimensions of personality: 16, 5 or 3? Criteria for a taxonomic paradigm. *Personality and Individual Differences, 12*(8), 773-790.

Eysenck, M.W. (1985) Anxiety and the worry process. *Bulletin of the Psychonomic Society, 22,* 545-548.

Eysenck, M.W. (1992) *Anxiety: The cognitive perspective.* Hove: Lawrence Erlbaum.

Fahrenberg, J. (1996) Concurrent assessment of blood pressure, physical activity, and emotional state in natural settings. In Fahrenberg, J. & Myrtek, M. (Eds.) et.al. *Ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies.* Goettingen, Germany: Hogrefe & Huber.

Fahrenberg, J., Foerster, F.,Schneider, H.J. & Mueller, W. (1986) Predictability of individual differences in activation processes in a field setting based on laboratory measures. *Psychophysiology, 23*(3) 323-333.

Fahrenberg, J. & Myrtek, M. A (1966) Critical contribution to the investigation of psychophysiological personality factors. *Zeitschrift fuer Experimentelle und Angewandte Psychologie, 13*(2), 222-247.

Fibiger, W., Evans, O. & Singer, G. (1989) Hormonal responses to a graded mental workload. *European Journal of Applied Physiology, 55*, 339-343.

Foa, E.B., Feske, U., Murdock, T.B., Kozak, M.J., & McCarthy, P.R. (1991) Processing of threat related information in rape victims. *Journal of Abnormal Psychology, 100*, 156-162.

Foa, E.B., Ilai, D., McCarthy, P.R., Shoyer, B., & Murdock, T. (1993) Information processing in obsessive-compulsive disorder. *Cognitive Therapy and Research, 17*, 173-189.

Fowles, D.C. (1980) The three arousal model: Implications of Gray's two-factor learning theory for heart rate, electrodermal activity, and psychopathy. *Psychophysiology, 17*(2), 87-104.

Fowles, D.C. (1987) Application of a behavioral theory of motivation to the concepts of anxiety and impulsivity. *Journal of Research in Personality, 21*(4), 417-435.

Fowles, D.C. (1983) Motivational effects on heart rate and electrodermal activity: Implications for research on personality and psychopathology. *Journal of Research in Personality, 17*(1), 48-71.

Fox, E. (1993a) Allocation of visual attention and anxiety. *Cognition and Emotion, 7*(2), 207-215.

Fox, E. (1993b) Attentional bias in anxiety: Selective or not? *Behaviour Research and Therapy, 31*(5), 487-493.

Franzen, M.D., Tishelman, A.C., Sharp, B.H. & Friedman, A.G. (1987) An investigation of the test-retest reliability of the Stroop Color-Word Test across two intervals. *Archives of Clinical Neuropsychology, 2* (3) 265-272.

Fredrikson, M. & Ohman, A. (1979) Cardiovascular and electrodermal responses conditioned to fear relevant stimuli. *Psychophysiology, 16*(1), 1-7.

Fridhandler, B.M. (1986) Conceptual note on state, trait, and the state-trait distinction. *Journal of Personality and Social Psychology, 50*(1), 169-174.

Gale, A. (1973) Individual differences: Studies of extraversion and the EEG. In Kline, P. (Ed) *New Approaches in Psychological Measurement*. New York: Wiley.

Gale, A. & Edwards, J.A. (1986) Individual differences. In Coles, M.G.H., Donchin, E. & Porges, S.W. (Eds.) *Psychophysiology: Systems, processes, and applications.* Amsterdam: Elsevier.

Gerra,G., Zaimovic,A., Giucastro,G., Folli,F., Maestri,D., Tessoni,A., Avanzini,P., Caccavari,R., Bernasconi,S. & Brambilla,F. (1998) Neurotransmitter-hormonal responses to psychological stress in peripubertal subjects: Relationship to aggressive behavior. *Life Sciences, 62*(7) 617-625.

Glass, G.V., McGraw, B., & Smith, M.L. (1981) *Meta Analysis in social research.* Beverly Hills, CA: Sage.

Golombok, S., Satvrou, A., Bonn, J., Mogg, K., Critchlow, F., & Rust, J. (1991) The effects of diazepam on anxiety related cognition. *Cognitive Therapy and Research, 15,* 459-467.

Gotlib, I.H., McLachlan, A.L. & Katz, A.N. (1988) Biases in visual attention in depressed and nondepressed individuals. *Cognition and Emotion, 2*(3), 185-200.

Gray, J.A. (1971) *The psychology of fear and stress*. New York: Mcgraw-Hill.

Gray, J.A. (1983) A theory of anxiety: The role of the limbic system. *Encephale, 9*(4), 161-166.

Gray, J.A. (1987) Perspectives on anxiety and impulsivity: A commentary. *Journal of Research in Personality, 21*(4), 493-509.

Gray, J.A. (1994) Framework for a taxonomy of psychiatric disorder. In van Goozen, S. H. M. & Van de Poll, N. E. (Eds.) *Emotions: Essays on emotion theory.* Hillsdale, NJ: Lawrence Erlbaum.

Green, M.W., Rogers, P.J. & Hedderley, D. (1996) The time course of mood induced decrements in colour naming of threat related words. *Current Psychology, 14*(4) 350-358.

Gross, R.D. (1992) *Psychology: Science of Mind and Behaviour. (2nd Ed.)* London: Hodder and Stoughton.

Gudjonsson, G. (1981) Self-reported emotional disturbance and its relation to electrodermal reactivity, defensiveness and trait anxiety. *Personality and Individual Differences, 2*(1) 47-52.

Hallam, R.S. (1985) *Anxiety: Psychological perspectives on panic and agoraphobia.* London: Academic Press. (Cited in Hallam, 1994)

Hallam, R.S. (1994) Some constructionist observations on "anxiety" and its history. In Sarbin, T.R. & Kitsuse, J.I. (Eds.) et.al. *Constructing the social. Inquiries in social construction series*. London: Sage.

Hamilton, M. (1960) A rating scale for depression. *Journal of Neurology, Neurosurgery and Psychiatry, 23*, 56-61.

Harris, L.M. & Menzies, R.G. (1997) Changing attentional bias: Can it effect self reported anxiety? *Anxiety, Stress and Coping, 11,* 167-179

Hellhammer, D.H., Heib, C. & Hubert, W., et. al. (1985) Relationships between salivary cortisol and behavioural coping under exam stress. *IRCS Medical Science, 1330*, 1179-1180.

Hendrickx, H., de Houwer, J., Baeyens, F., Eelen, P. & Van Avermaet, E. (1997) Hidden covariation detection might be very hidden indeed. *Journal of Experimental Psychology: learning Memory and Cognition, 23,* (1) 201-220.

Hocevar, D. & El-Zahhar, N.E.(1988) Arousability, trait anxiety and the worry and emotionality components of test anxiety. *Anxiety Research, 1*(2), 99-113.

Hodges, W.F. (1976) The psychophysiology of anxiety. In Zuckerman, M. & Spielberger, C.D. Eds. *Emotions and Anxiety: New Concepts Methods and Applications.* New York: LEA.

Hofstee, W.K., de-Raad, B. & Goldberg, L.R. (1992) Integration of the Big Five and circumplex approaches to trait structure. *Journal of Personality and Social Psychology, 63*(1), 146-163.

Hohmann, G.W. (1966) Some effects of spinal cord lesions on experienced emotional feelings .*Psychophysiology, 3*(2), 143-156.

Hope, D.A., Rapee, R.M., Heimberg, R.G., & Dombeck, M.J. (1990) Representations of the self in social phobia: Vulnerability to social threat. *Cognitive Therapy and Research, 14*, 477-485.

Hubert, W., de Jong-Meyer, R. (1989) Emotional Stress and saliva cortisol response. *Journal of Clinical and Chemical Biochemistry, 27*, 221-222.

Hunter, J.E., Schmidt, F.L., & Jackson, G.B. (1982) *Meta-analysis: Cumulating research findings across studies.* Beverly Hills: Sage.

Izard, C.E. (1971) *The face of emotion.* New York: Appleton Century Crofts.

Izard, C.E. & Bartlett, E.S. (1972) *Patterns of emotions: A new analysis of anxiety and depression.* New York: Academic Press.

James, W. (1890) *The Principles of Psychology*. New York: Holt. (Cited in Powers and Dalgleish, 1997.)

Jansen,L.M.C., GispendeWied,C.C., Gademan,P.J., DeJonge,R.C.J., vanderLinden,J.A. & Kahn,R.S. (1998) Blunted cortisol response to a psychosocial stressor in schizophrenia. *Schizophrenia Research, 33,* 1-2, 87-94

Jensen, A.R. (1965) Scoring the Stroop Test. *Acta Psychologica,.24*, 398-408. (Cited in MacLeod, 1991)

John, O. P. (1990) The Big Five factor taxonomy: Dimensions of personality in the natural language and questionnaires. In Pervin, L.A. (Ed) *Handbook of Personality: Theory and Research.* New York: Gulford.

John, O.P., Angleitner, A. & Ostendorf, F, (1988) The lexical approach to personality: A historical review of trait taxonomic research. *European Journal of Personality, 2*(3), 171-203.

Johnson-Laird, P.N. & Oatley, K. (1989) The language of emotions: An analysis of a semantic field. *Cognition and Emotion, 3*(2), 81-123.

Kaspi, S.P., McNally, R.J, & Amir, N. (1995) Cognitive processing of emotional information in posttraumatic stress disorder. *Cognitive Therapy and Research, 19*, 319-330.

Kenardy, J., Oei, T.P.S., Weir, D. & Evans, L. (1993) Phobic anxiety in panic disorder: Cognition, Heart rate and subjective anxiety. *Journal of Anxiety Disorders, 7,* 359-371.

Kindt, M., Bierman, D., & Brosschot, J.F. (1996) Stroop versus Stroop: Comparison of a card format and a single trial format of the standard colour-word Stroop test and the emotional Stroop task. *Personality and Individual Differences, 21,* 653-661.

Kirschbaum, C. Bartussek, D., & Strasburger, C.J. (1992) Cortisol responses to psychological stress and correlations with personality traits. *Personality and Individual Differences, 13*, 1353-1357.

Kirschbaum, C. & Hellhammer, D.H. (1989) Salivary Cortisol in Psychobiological Research: An overview. *Neuropsychobiology, 22*, 150-169.

Kirschbaum, C. & Hellhammer, D.H. (1994) Salivary cortisol in psychoneuroendocrine research: Recent developments and applications. *Psychoneuroendocrinology, 19,* 4, 313-333.

Kirschbaum, C., Pirke, K.M. & Hellhammer, D.H. (1993) The Trier Social Stress Test - A tool for investigating Psychobiological stress responses in a laboratory setting. *Neuropsychobiology, 28*, 76-81.

Kirschbaum, C., Prussner, J., Gaab, J., Schommer, N., Lindtz,D., Sone, A.A. & Hellhammer, D.(1995) Persistent high cortisol responses to repeated psychological stress in a subpopulation of healthy men. *Psychosomatic Medicine, 57*, 468-474.

Kirschbaum, C., Wolf, O. & Hellhammer, D. (1995) Adrenocortical responsiveness to psychosocial stress in humans: Sources of interindividual differences. In D.S. Krantz and A. Baum (Eds.) *Technology and Methods in Behavioral Medicine*, Lawrence Earlbaum: New Jersey.

Kirschbaum, C., Wust, S. & Hellhammer, D. (1992) Consistent sex differences in cortisol responses to psychological stress. *Psychosomatic Medicine, 54,* 648-657.

Kreitler, S. & Kreitler, H. (1990) Repression and the anxiety defensiveness factor: Psychological correlates and manifestations. *Personality and Individual differences. 11*(6) 559-570.

Lacey, J.I. & Lacey, B.C. (1958) The relationship of resting autonomic activity to motor impulsivity; Research Publications, Association for research in nervous and mental disease, 36, 144-209. Cited in Crider, A. (1979) The electrodermal response: biofeedback and individual difference studies. *International Review of Applied Psychology, 28*(1) 37-48.

Lader, M.H.(1983) The psychophysiology of anxiety. *Encephale, 9*(4) 205-210.

Lader, M.H. & Wing,,L.(1964) Habituation of the psycho-galvanic reflex in patients with anxiety states and in normal subjects. *Journal of Neurology, Neurosurgery and Psychiatry, 27*(3), 210-218.

Lamb, D. (1978) Use of behavioural measures in anxiety research. *Psychological Reports, 43,* 1079-1085.

Lang, P.J., Bradley, M. & Cuthbert, B.N. (1995) *International Affective Picture System (IAPS)*. NIMH Centre for the Study of Emotion and Attention, University of Florida.

Lang, P.J. & Cuthbert, B.N. (1984) Affective information processing and the assessment of anxiety. *Journal of Behavioral Assessment,* 6, (4), 369-395.

Lang, P.J., Levin, D.N., Miller, G.A. & Kozak, M.J. (1983) Fear behaviour, fear imagery, and the psychophysiology of emotion: the problem of affective response integration. *Journal of Abnormal Psychology, 92,* (3), 276-306.

Lavy, E.H., Hout, M. van den, & Arntz, A. (1993) Attentional bias and spider phobia: Conceptual and clinical issues. *Behaviour Research and Therapy, 31*, 17-24.

Lavy, E.H., Oppen, P. van, & Hout, M. van den. (1994) Selective processing of emotional information in obsessive-compulsive disorder. *Behaviour Research and Therapy, 32,* 243-246.

Lazarus, R.S. (1982) Thoughts on the relations between emotion and cognition. *American Psychologist, 37*(9), 1019-1024.

Lazarus, R.S. (1984) On the primacy of cognition. *American Psychologist, 39*(2), 124-129.

Levenson, R.W. (1992) Autonomic nervous system differences among emotions. *Psychological Science, 3*(1) 23-27.

Levenson, R.W., Ekman, P. & Friesen, W.V. (1990) Voluntary facial action generates emotion-specific autonomic nervous system activity. *Psychophysiology, 27*(4), 363-384.

Levenson, R.W., Ekman, P, Heider, K. & Friesen, W.V. (1992) Emotion and autonomic nervous system activity in the Minangkabau of West Sumatra. *Journal of Personality and Social Psychology, 62*(6), 972-988.

Logan, A.C. & Goetsch, V.L. (1993) Attention to external threat cues in anxiety states. *Clinical Psychology Review, 13,* 541-559.

MacLeod, C. (1991) Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin, 109*(2), 163-203.

MacLeod, C. (1995) Training selective attention: a cognitive-experimental technique for reducing anxiety vulnerability? *World Congress of Behavioural and Cognitive Therapies Abstracts.* p.118. (Cited in Harris & Menzies, 1998)

MacLeod, C. (1998) Selective Information processing and emotional vulnerability. Taken from *British Psychological Society Cognitive Psychology Section XV Annual Conference Abstracts*, 2-4th September 1998.

MacLeod, C., Ebsworthy, G. & Rutherford, E.M. (In press) Selective attention and emotional vulnerability: Assessing the causal basis of their association through the experimental induction of attentional bias.

MacLeod, C. & Rutherford, E.M. (1992) Anxiety and the selective processing of emotional information: Mediating roles of awareness, trait and state variables and personal relevance of stimulus materials. *Behaviour Research and Therapy, 30(*5) 479-491.

MacLeod, C. & Mathews, A. (1988) Anxiety and the allocation of attention to threat. *Quarterly Journal of Experimental Psychology, 40*(4) 653-670.

MacLeod, C. & Mathews, A. (1991) Cognitive-experimental approaches to the emotional disorders. In Martin, P.R. (Ed) *Handbook of behavior therapy and psychological science: An integrative approach.* New York: Pergamon Press. Page 21 of lit review.

MacLeod, C., Mathews, A. & Tata, P. (1986) Attentional bias in emotional disorders *Journal of Abnormal Psychology, 95*(1), 15-20.

Manuck, S.B., Kasprowicz, A.L., Monroe, S.M., Larkin, K.T. & Kaplan, J.R. (1989) Psychophysiological reactivity as a dimension of individual differences. In Schneiderman, N. & Weiss, S.M. (Eds.)et.al. *Handbook of research methods in cardiovascular behavioral medicine.* New York: Plenum Press.

Markus,C.R., Panhuysen,G., Tuiten,A., Koppeshaar,H., FekkesD. & Peters,M.L. (1998) Does carbohydrate-rich, protein-poor food prevent a deterioration of mood and cognitive performance of stress-prone subjects when subjected to a stressful task? *Appetite,31*, 1, 49-65.

Marlowe, D. & Crowne, D.P. (1961) Social desirability and response to perceived situational demands. *Journal of Consulting Psychology, 25*, 109-115.

Marshall, G.D. & Zimbardo, P.G. (1979) Affective consequences of inadequately explained physiological arousal. *Journal of Personality and Social Psychology, 37*(6), 970-988.

Martin, M., Horder, P. Jones, G. (1992) Integral bias in the naming of phobia related words. *Cognition and Emotion, 6*(6) 479-486.

Martin, M., Williams, R.M. & Clark, D.M. (1991) Does anxiety lead to selective processing of threat related information? *Behaviour Research and Therapy, 29*, 147-160.

Mathews, A. (1997) Information-processing biases in emotional disorders. In Clark, D. M. & Fairburn, C. G. (Eds.) et.al. *Science and practice of cognitive behaviour therapy.* Oxford: Oxford University Press.

Mathews, A. & Klug, F. (1993) Emotionality and interference with colour naming in anxiety. *Behaviour research and therapy, 31*(1) 57-62.

Mathews, A., Mackintosh, B. & Fulcher, E.P. (1997) Cognitive biases in anxiety and attention to threat. *Trends in Cognitive Science, 1* (9), 340-345.

Mathews, A. & MacLeod, C. (1985) Selective processing of threat cues in anxiety states. *Behaviour Research and Therapy, 23*(5),563-569.

Mathews, A. & MacLeod, C. (1986) Discrimination of threat cues without awareness in anxiety states. *Journal of Abnormal Psychology, 95*(2), 131-138.

Mathews, A. & MacLeod, C. (1987) An information-processing approach to anxiety. *Journal of Cognitive Psychotherapy, 1*(2), 105-115.

Mathews, A. & MacLeod, C. (1994) Cognitive approaches to emotion and emotional disorders. *Annual Review of Psychology, 45*, 25-50.

Mathews, A. Mogg, K., Kentish, J. & Eysenck, M. (1995) Effect of psychological treatment on cognitive biases in GAD. *Behaviour Research and Therapy, 33*, 293-303.

Mathews, A.M, & Sebastian, S. (1993) Suppression of emotional Stroop effects by fear arousal. *Cognition and Emotion, 7*, 517-530.

McCrae, R.R. & Costa, P.T. (1987) Validation of the five-factor model of personality across instruments and observers. *Journal of Personality and Social Psychology, 52*(1), 81-90.

McNair, D.M., Lorr, M. & Droppleman, L.F. (1992) *POMS manual - Profile of mood questionnaire*. San Diego: Edits.

McNally, R.J., Amir, N., Louro, C.E., Lukach, B.M., Reimann, B.C., & Calamari, J.E. (1994) Cognitive processing of idiographic emotional information in panic disorder. *Behaviour Research and Therapy, 32,* 119-122.

McNally, R.J., English, G.E. & Lipke, H.J. (1993) Assessment of intrusive cognition in PTSD: Use of the modified Stroop paradigm. *Journal of Traumatic Stress, 6*(1), 33-41.

McNally, R.J., Kaspi, S.P., Reimann, B.C., & Zeitlin, S.B. (1990a) Selective processing of threat cues in post-traumatic stress disorder. *Journal of Abnormal Psychology, 99*(4), 398-402.

McNally, R.J., Reimann, B.C., & Kim, E. (1990b) Selective processing of threat cues in panic disorder. *Behaviour Research and Therapy, 28*(5), 407-412.

McNally, R.J., Reimann, B.C., Louro, C.E., Lukach, B.M., & Kim, E. (1992) Cognitive processing of emotional information in panic disorder. *Behaviour Research and Therapy, 30,* 143-149.

Meichenbaum, D., Gilmore, J. ?& Fedoravicus, A. (1971) Group insight vs. group desensitisation in treating speech anxiety. *Journal of Consulting and Clinical Psychology, 36,* 410-421.

Milac, A. & Sherman, A. (1974) Behavioural assessment of speech anxiety. *Quarterly Journal of Speech, 60,* 134-143.

Mineka, S., Sutton, S.K. (1992) Cognitive biases and the emotional disorders. *Psychological Science, 3*(1), 65-69.

Miyawaki, E., Salzman, C. (1991) Autonomic nervous system tests in psychiatry: Implications and potential uses of heart rate variability. *Integrative Psychiatry, 7*(1), 21-28.

Mogg, K., Bradley, B.P., de Bono, J., & Painter, M. (1997) Time course of attentional bias for threat information in non-clinical anxiety. *Behaviour, Research and Therapy, 35,* (4) 297-303.

Mogg, K., Bradley, B.P., & Hallowell, N. (1994) Attentional bias to threat: Roles of trait anxiety, stressful events and awareness. *Quarterly Journal of Experimental Psychology, 47,* 841-864.

Mogg, K., Bradley, B.P., Williams, R., & Mathews, A.M. (1993) Subliminal processing of emotional information in anxiety and depression. *Journal of Abnormal Psychology, 102,* 304-311.

Mogg, K., Kentish, J., & Bradley, B.P. (1993) Effects of anxiety and awareness of colour-identification latencies for emotional words. *Behaviour Research and Therapy, 31*(6), 559-567.

Mogg, K. & Marden, B. (1990) Processing of emotional information in anxious subjects. *British Journal of Clinical Psychology, 29*(2), 227-229.

Mogg, K., Mathews, A., Bird, C. & Macgregor-Morris, R. (1990) Effects of stress and anxiety on the processing of threat stimuli. *Journal of Personality and Social Psychology, 59*, 1230-1237.

Mogg, K., Mathews, A. & Weinman, J. (1987) Memory bias in clinical anxiety. *Journal of Abnormal Psychology, 96*(2), 94-98.

Mogg, K., Mathews, A. & Weinman, J. (1989) Selective processing of threat cues in anxiety states: A replication. *Behaviour Research and Therapy. 27,* 317-323

Myers, L.B. (1996) The attributional style of repressive individuals. *Journal of Social Psychology, 136*(1), 127-128.

Myers, L.B. & McKenna, F.P. (1996) The colour naming of socially threatening words. *Personality and Individual Differences, 20*(6), 801-803.

Oatley, K. (1992). *Best laid schemes: The psychology of emotions*. New York: Cambridge University Press.

Oatley, K. & Johnson-Laird, P.N. (1987) Towards a cognitive theory of emotions. *Cognition and Emotion, 1*(1), 29-50.

Odbert, H.S. (1936) Trends in the study of personality (as revealed in the 1936 meeting of the American Psychological Association). *Character and Personality; A Quarterly for Psychodiagnostic and Allied-Studies, 5*, 149-154.

Panksepp, J. (1993) Neurochemical control of moods and emotions: Amino acids to neuropeptides. In M. Lewis & J. Haviland (Eds.) *The handbook of emotions.* New York: Gulford.

Paul, G. (1966) *Insight vs. Desensitisation in psychotherapy.* Stanford: Stanford university Press. (Cited in Lamb, 1978)

Power, M. & Dalgleish, T. (1997) *Cognition and Emotion: From Order to Disorder.* Hove: Psychology Press.

Pruneti, C.A., Vogele, C. & Steptoe, A. (1991) Stress and cardiovascular disorders: Methodological problems in the use of techniques of mental stress (Mental Stress Test). *Medicina Psicosomatica, 36*(4), 343-356.

Rachman, S. (1998) *Anxiety* Hove, East Sussex: Psychology Press

Rachman, S. & Hodgson, R.I. (1974) Synochrony and desynchrony in fear and avoidance. B*ehavior Research and Therapy, 12,* 311-318.

Rawlins, J. N., Feldon, J. & Gray, J. (1980) Discrimination of response-contingent and response-independent shock by rats: Effects of chlordiazepoxide HCl and sodium amylobarbitone. *Quarterly Journal of Experimental Psychology, 32*(2), 215-232.

Richards, A. & French, C.C. (1990) Central versus peripheral presentation of stimuli in an emotional Stroop task. *Anxiety Research, 3*(1), 41-49.

Richards, A., French, C.C., Johnson, W, Naparstek, J, & Williams, J. (1992) Effects of mood manipulation and anxiety on performance of an emotional Stroop task *British Journal of Psychology, 83*, 479-491.

Richards, A. & Millwood, B. (1989) Colour-identification of differentially valenced words in anxiety. *Cognition and Emotion, 3,* 171-176.

Richards, A., Whittaker, T.M. (1990) Effects of anxiety and mood manipulation in autobiographical memory. *British Journal of Clinical Psychology, 29*(2), 145-153.

Rosenthal, R. (1991) *Meta analytic procedures for social research.* Newbury Park, CA: Sage.

Rosenthal, R. & Rubin, D.B (1986) Meta analytic procedures for combining studies with multiple effect sizes. *Psychological Bulletin, 99*(3), 400-406.

Rotton, J., Foos, P.W., VanMeek, L. & Levitt, M. (1995) Publication practices and the file drawer problem – A survey of published authors. *Journal of Social Behaviour and Personality, 10*(1) 1-13.

Sarason, I.G. & Spielberger, C.D. (1975) *Stress and anxiety: II.* Washington, DC: Hemisphere.

Sarbin, T.R. (1964) Anxiety: Reification of a metaphor. *Archives of General Psychology, 10*, 630-638. (Cited in Hallam, 1994)

Sarbin, T.R. (1968) Ontology recapitulates philology; the mythic nature of anxiety. *American Psychologist, 23*, 411-418. (Cited in Hallam, 1994)

Schachter, S. & Singer, J. (1962) Cognitive, social, and physiological determinants of emotional state. *Psychological Review, 69*(5), 379-399.

Smith, C.A. & Lazarus, R.S. (1993) Appraisal components, core relational themes, and the emotions *Cognition and Emotion, 7*(3-4), 233-269.

Spielberger, C.D. (1966) *Anxiety and behavior.* New York: Academic Press.

Spielberger, C.D. (1970) *Current topics in clinical and community psychology: II.* New York: Academic Press.

Spielberger, C.D. (1972) *Anxiety. Current trends in theory and research. Vol 1.* New York: Academic Press.

Spielberger, C.D., Gorsuch, R.L., Lushene, P.R., Vagg, P.R. & Jacobs, G.A. (1983) *Manual for the State-trait Anxiety Inventory.* Palo Alto, California: Consulting Psychologists Press.

Steptoe, A. & Johnston, D. (1991) Clinical applications of cardiovascular assessment. *Psychological Assessment, 3*(3), 337-349.

Sterling, T.D, Rosenbaum, W.L., & Weinkam, J.J. (1995) Publication decisions revisited: The effect of the outcome of statistical tests on the decision to publish and vice versa. *The American Statistician, 49*, 1, 108- 112.

Stokvis, B & Bolten, M.P. (1963) Statistical data on personality alterations in chronic illness. *Psychological Reports, 13*(3), 829.

Strongman, K.T. (1996) *The psychology of emotion: Theories of emotion in perspective (4th ed.)*. Chichester: Wiley

Stroop, J.R. (1935) Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18,* 643-662.

Taylor, J.A.(1953) A personality scale of manifest anxiety. *Journal of Abnormal and Social Psychology, 48*, 285-290.

Uechi, Y. (1972) Cognitive interference and intelligence. Re-examination of the measures of SCWT. *Japanese Journal of Educational Psychology, 20*(2), 92-100.

vandenHout, M., Arntz, A., Janssen, S., deJong, P. & Pool, K. (1992) No threat-related processing bias in low trait anxious high state anxious novice parachuters. *Cognitive Therapy and Research, 22,*(2), 125-135.

Vining, R.F., McGinley, R.A. & Maksvytis, J.J. (1983) Salivary cortisol, a better measure of adrenal cortical function than serum cortisol. *Annals of Clinical Biochemistry, 20,* 329-335.

Walker, R.F., Joyce, B.G. & Dyas, J. (1984) Salivary cortisol: I Monitoring changes in normal adrenal activity. In Read, G.F., Riad-Falmy, D. & Wlaker, R.F. (Eds.) *Immunoassays of Steroids in Saliva.* Cardiff: Alpha Omega.

Watts, F.N., McKenna, F.P. Sharrock, R., & Trezise, L. (1986) Colour naming of phobia-related words. *British Journal of Psychology, 77,* 97-108.

Weinberger, D.A., Schwartz, G.E. & Davidson, R.J. (1979) Low-anxious, high-anxious, and repressive coping styles: Psychometric patterns and behavioral and physiological responses to stress. *Journal of Abnormal Psychology, 88*(4), 369-380.

Wilder, J. (1957) The law of initial value in neurology and psychiatry. *Journal of Nervous and Mental Disease, 125*, 73-86.

Williams, J.M.G., Mathews, A. & MacLeod, C. (1996) The emotional Stroop task and psychopathology. *Psychological Bulletin, 120*(1), 3-24.

Williams, J.M.G., Watts, F.N., MacLeod, C. & Mathews, A. (1988) *Cognitive psychology and emotional disorders*. Chichester, UK: Wiley.

Wood, P. (1995) Meta-analysis. In Breakwell, G.M., Hammond, S. & Fife-Shaw, C. (Eds.) *Research methods in psychology*. Beverly Hills, CA: Sage.

Woodfield, E., Jones, G.V. & Martin, M. (1995) Selective processing of stress-related words in colour naming. *Personality and Individual Differences, 19*(3), 385-387.

Yiend, J., Mathews, A., Bradley, B. & Mogg, K. (Unpublished) Anxiety and attention to threatening pictures.

Zajonc, R.B. (1980) Feeling and thinking: Preferences need no inferences. *American Psychologist, 35*(2), 151-175.

Zajonc, R.B. (1984) On the primacy of affect. *American Psychologist, 39*(2), 117-123.

Zigmond, A.S. & Snaith, R.P. (1983) The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavia, 67*(6), 361-370.