Perceptual and Attentional Biases in Spider Fear: An Exploration using the Inattentional Blindness Paradigm

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Abstract

This thesis investigates the allocation of visual processing resources to stimuli perceived as being threatening by individuals with an increased fear of spiders. The literature in the broad field of cognitive psychopathology suggests that, throughout a number of subtypes of anxiety, there is a visual processing bias that causes anxious individuals to rapidly notice threatening objects in their environment. It is further suggested that individuals with low or normal levels of anxiety do not display the same pattern of attentional allocation. The thesis reviews the range of theories and the experimental paradigms that have informed them and suggests that in the majority of cases methodological limitations lead to different interpretations of the results. Additionally, alternative interpretations of the findings, namely that of the delayed disengagement hypothesis, which suggests that anxious individuals are not faster at detecting images than low anxious control participants, but rather they display a bias where they are unable to rapidly disengage their attention from threatening stimuli when they have been noticed, are explored. The thesis then investigates the use of a method from the perception and attention literature, called inattentional blindness. It is proposed that the inattentional blindness experiment is able to overcome the methodological difficulties associated with current methods in cognitive psychopathology. A series of experiments are detailed investigating the allocation of attention to neutral and spider images in individuals with increased fear of spiders. The first series of experiments suggests that, relative to control participants with low levels of spider fear, individuals with an increased fear of spiders do rapidly allocate attention to spiders appearing in their left visual field. The thesis also examines whether heightened anxiety causes a general hypervigilance of the attentional system. However, the results do not confirm this prediction. Two additional experiments were conducted. Firstly, one investigating whether individuals with a fear of spiders display difficulties disengaging their attention from spider stimuli. The results from this experiment do not confirm the delayed disengagement hypothesis. Secondly, an experiment using the dynamic inattentional blindness paradigm was developed to investigate attentional allocation to spider stimuli in individuals with high and low spider fear. The results provide partial support for the hypothesis that the high, but not the low, fear group, notice moving spiders when they are presented against expectation. The implications of these results are discussed.

Authors Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of the University of Gloucestershire and is original except where indicated by specific reference in the text. No part of this thesis has been submitted as part of any other academic award. The thesis has not been presented at any other education institution in the United Kingdom or overseas.

Any views expressed in this thesis are those of the author and in no way represent those of the University.

Signed………………………………………………………………………………… Date………………………

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Chapter 1. Introduction

1.1 Introduction to anxiety and rationale for choice of spider phobia

In the fields of Psychology and Psychiatry, anxiety is used as an umbrella term to refer to a constellation of emotional sub-disorders that are characterised by feelings of fear, apprehension and worry. The sub-disorders that comprise anxiety differ, primarily, on the object or situation that is feared. For example, simple phobias, such as spider phobia, create anxiety when a phobic individual is presented with a spider or the subject of spiders is discussed in their presence. While exposure to the feared stimulus causes feelings of fear, these feelings are typically suppressed or not present at all when the object is not present (DSM-IV, 1994; Sue, Sue & Sue, 2003).

Other anxiety disorders, however, are situation, rather than object, dependent. For example, a common form of obsessive-compulsive disorder is characterised by the patient being apprehensive about carrying contagious germs on their hands. This obsession, driven by a fear of harming another individual, results in compulsive behaviour, such as frequently repeated hand washing. The important distinction between the two disorders discussed so far are that spider phobia is typically stimulus driven; that is to say, it is elevated by the presence of the stimulus, whereas the example of obsessive compulsive disorder is not specifically stimulus dependent, but rather is characterised by an anticipated situation or effect (DSM-IV, 1994; Sue et al. 2003).

A further range of anxiety disorders is less dependent on specific stimuli or specific situations. For example, Generalised Anxiety Disorder (GAD) represents a particularly constant worry that spans a range of situations. For example, one's health, one's occupational or scholarly performance or one's social abilities. While it is common, therefore, to characterise anxiety disorders together on the basis of the feelings and emotions broadly associated with the disorder, the specific sub-categories differ to a large extent on a range of different variables (DSM-IV-TR, APA, 2000).

Additionally to the clinical disorders described above, two types of more general anxiety are present within the general population. These are known as state and trait anxiety. State anxiety reflects a level of fear an individual has at a given moment that is often situation dependent. For example, a student facing an examination, will be apprehensive about what questions may be given and their performance. State anxiety, therefore, is largely situation-heightened anxiety, which will typically decrease when the situation ceases. Trait anxiety on the other hand, represents a more general level of anticipation that may be situation independent. For example, an individual with increased levels of trait anxiety will see possible danger in an array of situations. In trait anxiety, this interpretation of situations remains more stable over time (Eysenck, 1997; Spielberger, Gorsuch,, Lushene, Vagg & Jaccobs, 1983).

Rationale for choosing spider phobia

The thesis presented here is primarily concerned with spider phobia, which is a specific type of simple phobia characterised by heightened fear of spiders. This heightened fear, it is suggested, causes patterns of perception, cognition and behaviour that leads the spider phobic individual to rapidly detect spiders in their visual environment, have increased worries about the harm a spider will cause to them, and behaviourally avoid situations where spiders are present (Williams, Watts, MacLeod & Matthews, 1988; 1997).

Due to the focus on spider phobia and because of the wide range of anxiety disorders and related traits in the literature, and the relevant experiments on attentional bias in each of these, the current thesis will concentrate on the literature from the following anxiety states: Spider Phobia, Social Phobia (clinical and trait), Snake Phobia, State and Trait Anxiety and Generalised Anxiety disorder. Disorders such as Obsessive-Compulsive Disorder, Panic Disorder and Anxiety Sensitivity will not be considered unless particularly relevant to the thesis.

While this separation is somewhat arbitrary, disorders such as spider phobia, social phobia and snake phobia cause biases towards images that have a possible evolutionary basis: spiders, faces and snakes, respectively (LeDoux 1996; Öhman 1996). Generalised anxiety disorder and state and trait anxiety have been included in the literature search because models of anxiety disorders, such as Eysenck (1997), suggest that anxiety causes a general hypervigilance for new and novel items in a persons visual field. These predictions, therefore, can be tested with the spider stimuli and neutral objects contained in the experiments presented here.

Specifically conducting the research on spider phobia was influenced by theoretical and practical reasons. In the literature on cognitive psychopathology, spider phobia has received less attention than, for example, social phobia, which has its own specific theories and literature base that will not be included in this thesis. Therefore, spider phobia is understood in terms of the general models presented in the literature (e.g., Mogg & Bradley, 1998). It is interesting to speculate as to why spider phobia has received relatively less attention. It is likely that, due to spider phobia not being a disorder that severely inhibits general daily lives in terms of occupational or social activities, research councils have not extensively funded research in the area.

The above factors directly influenced the choice of studying spider phobia. Additionally, the inattentional blindness paradigm requires the participant to have no knowledge that a spider will appear, and thus participants had to be recruited from the general population and not from patients receiving assessment or treatment. This meant a sub-type of anxiety disorder was needed that was reasonably well represented in the general population. Sue et al. (2003) suggest that specific phobias, of which spider phobia is the most common, have a prevalence rate 7% to 13%, which is considerably higher that other types of anxiety.

Additionally, particularly in the case of stimulus driven anxiety disorders such as spider phobia, perceptual and attentional responses may serve to establish and maintain a pervasive human condition. Therefore, understanding the precise mechanisms involved in attention and anxiety can be considered an important task. Furthermore, because of the methods used to understand how / if fearful stimuli are selected for preferential processing by the attentional system, remaining questions about the mechanisms involved in attention can be addressed. For example, the findings of such experiments will contribute to the early-late bottleneck debate of attention. As such, the above factors contributed to the decision to investigate spider phobia.

The current thesis examines, through a number of experiments, the broad hypothesis that spider phobic individuals will rapidly detect spiders in their visual environment, and this pattern of perceptual analysis and attentional allocation is specific only to individuals with increased fear of spiders. However, because models of cognitive psychopathology predict that increased levels of general anxiety will elicit similar biases for new stimuli in an anxious persons visual environment, this will also be investigated.

1.2 Overview of thesis

As suggested above, broadly, anxiety is classified as an emotional disorder. While earlier work investigating emotion's effect on cognition had focussed on how, for example, anxiety affects attention and memory in a uniform manner (e.g., Zajonc, 1984), the field of cognitive psychopathology emerged from the information processing approach to cognition. The information processing approach suggests that there are a series of distinct neural mechanisms that allow us to perceive, attend to, remember and manipulate sensory information from our environment. It is further suggested that, due to the theoretical separation of these components, emotion's effect might be specific to different cognitive domains. Broadly, working from an evolutionary perspective, which suggests that anxiety is an evolutionarily adaptive function designed to allow us to detect and respond to threat in the environment, it was hypothesised that anxiety has a specific effect on the perceptual and attentional cognitive systems. Findings from three dominant visual paradigms – the Emotional Stroop, the probe-detection task and the visual search task – have suggested that anxiety is characterised by patterns of hypervigilance, both for threat and new stimuli in the environment (Eysenck, 1997; Williams et al., 1988, 1997).

While positive biases towards threat have been found in a range of anxiety disorders, this thesis contends that these biases are largely a methodological artefact. Criticisms regarding the emotional Stroop task are wide and varied and outlined within the contents of this thesis. Additionally, working from the suggestions presented by Fox, Russo, Bowles and Dutton (2001), difficulties associated with the emotional probe-detection task make conclusions about the findings open to different interpretations. These are also addressed in the forthcoming chapters. Similarly, a number of new criticisms are made about the visual search task. With such methodological discrepancies, it is possible to suggest the current understanding of perceptual and attentional biases in anxiety is limited. This has a number of important implications both for cognitive psychopathology and our understanding of perception and attention in general and these are addressed throughout the thesis.

The primary objective of this thesis, therefore, is to test and refine a new experiment to examine perceptual and attentional response to threatening stimuli in people with increased anxiety, in order to assess the hypothesis that anxiety leads to the rapid detection of threat in the visual environment. Additionally, an attempt will be made to establish a new experiment that examines the attentional response of phobic individuals to dynamic, moving images. A further objective of this thesis is to examine a relatively new prediction, suggested by Fox et al., that anxiety causes difficulties with the disengage component of visual attention, rather than, as prior theories suggest, the engage component as outlined by Posner and Peterson (1990).

The issues outlined above are addressed in the forthcoming chapters. However, before the experimental results are presented, this introduction will provide a brief account of the perceptual system of the human species. Moving on, the human attentional system is described from both neurological and cognitive psychological perspectives. These two sections are provided in order to allow the reader to understand the models of cognitive psychopathology discussed later in the thesis. Next, a description and analysis of the literature on inattentional blindness will be provided. The aim here is to assess the current state of knowledge on inattentional blindness and to provide a detailed description of the methods used to study the phenomenon.

The thesis will then turn to the field of cognitive psychopathology. Firstly, early theories are described in order to provide the reader with a background on the field. Moving on, contemporary models of attentional bias in anxiety are described. Next, the experimental evidence that has informed these models is described. The analysis provided for these experimental methods concentrate not only on the discrepant findings between studies (where this is the case), but also on the methodological difficulties that affect the conclusions drawn from methods. Finally, an analysis is presented that assesses the possible utility of the inattentional blindness paradigm for assessing attentional response in anxiety disorders.

After the introduction, the pilot study is presented. The pilot study was conducted to establish the stimuli to be used in the static experiments that follow. After the pilot study, a series of seven experiments investigating what factors affect inattentional blindness. This chapter begins with a general method section, describing the equipment and experiments used. Particular ethical considerations are also addressed here. The seven experiments are then presented in the traditional scientific format. After this chapter, the next chapter presents the dynamic inattentional blindness experiment. Finally, the findings from the thesis are interpreted together in the general discussion section.

1.3 Perception and attention: the background to inattentional blindness and cognitive psychopathology

Any attempts at understanding inattentional blindness or the processes that mediate perceptual and attentional biases in anxiety disorders require an understanding of the basic human visual system. The two primary areas for concern, therefore, are visual perception and visual attention. These will now be considered in terms of their basic neurophysiology and the psychological theories accounting for their processing structures.

1.3.1 Overview of the neurophysiology of the visual system

The human visual system has developed to allow us to perceive, interpret and respond to our environment. Beginning with the eye, the cells that comprise the human visual system stretch through the diencephalon brain region to the occipital area of the cerebral cortex. Visual attention broadly refers to the ability to select certain visual information for more detailed processing, while excluding other information received by the eyes. The following chapter outlines neurological and psychological theories and evidence of how the visual system receives, responds and processes information in the human visual system (Banich, 2004).

Following the visual process from the projection of the stimulus on to the retina of the eye to either object recognition in the ventral stream, or the detection of objects in motion in the dorsal stream begins with the stimulus passing through the lens of the eye and being projected onto the retina. The retina receives an inverted two-dimensional representation of a stimulus, and is comprised of rod and cone cells, which are specialised for particular types of vision. Rod cells are sensitive and become active in conditions with limited light, whereas cone cells are specialised cells that provide high-acuity vision. Within the retina there is a specialised area for high-acuity vision – the fovea. Situated below the fovea is the blind spot, caused by the exiting of retinal cells to form the optic nerve, objects that fall on this area go unperceived (Banich, 2004; Pinel, 2000).

After the optic chiasm, the optic nerve becomes the optic tract, which connects the eyes with sub-cortical and cortical areas of the brain. In the case of sub-cortical areas, visual information goes to the superior colliculus, which is a structure in the mid brain. The superior colliculus has a specialised function, which is to process visual stimuli in a rapid but vague manner. This is important in parafoveal vision. However, it does not discriminate between objects but serves to control eye movements (and attention, which will be considered later) so large objects can be centred in the fovea for further, higher acuity visual processing (Banich, 2004). Furthermore, at this early stage of visual processing (i.e., before the primary visual cortex) it is noted, Gazzaniga (2000), that information detected by the left visual field is projected to structures in the right cerebral hemisphere, whereas information received by the right visual field is processed by structures in the left cerebral hemisphere.

In the case of cortical processing, firstly visual information passes through optic chasm. Here the information received from the left and right visual fields of each eye crosses over. Information from the left field is passed on to the left geniculate nucleus of the thalamus and information from the right visual field of each eye is passed on to the thalamus, where it is reorganised so that information from each eye is sent to the contra-lateral hemisphere of the primary visual cortex. Information received by the primary visual cortex is processed by two systems: the dorsal stream and the ventral stream. The dorsal stream, beginning at V1, goes laterally through V2, V3, V4 and V5 to the dorsal prelunate and medially to the medial superior temporal area. Electrophysiological evidence from macaque monkeys shows that cells in the dorsal stream are not sensitive to the colour or form of an object. Rather, they detect motion and movement, with specialist cells operating for different directions (Motter & Mountcastle, 1981). The dorsal stream, therefore, allows for the perception of movement independently from knowledge of object identification.

The ventral stream begins at V1, goes through V2, V3, V4, V5, the Posterior Inferotemporal cortex (PIT) and ends in the Anterior Inferotemporal cortex (AIT). Its primary function is object recognition. The receptive fields of the cells in the ventral stream widen as information passes from one area to the next (e.g. from V1 to V2 and V3). As such, cells in the primary visual cortex respond to only a small area of the visual field, where as in the latter stages, cells respond to larger areas, which allows for correct identification of whole objects, with cells in the PIT and AIT being specialised for detailed information received by the fovea (Banich, 2004). Finally, the hemispheric specialisation found for the different visual fields at a subcortical level become more specialised as the visual system progresses past V1. The right cerebral hemisphere, it is suggested takes the role of global vigilance across both visual fields. However, there are specific specialisations for the hemispheres beyond V1 in terms of object recognition. However, the suggestion that the right hemisphere, at an early stage is dominant in visual processing and vigilance has important implications for the study of vigilance and anxiety, and will be discussed further in section 1.8.

Object recognition has certain hemispheric specialisations, with the left and right hemispheres being dedicated to processing different aspects of an object. The right hemisphere is specialised for processing the global aspects of an object, for example, the complete recognition of a spider image. The left hemisphere is relatively more specialised for processing constituent parts of that object individually, for example the body and legs of a spider separately. Evidence suggests that global processing takes precedence over local processing, so that, in the first instance, the interconnected parts of the object are perceived more rapidly than its constituent parts (Banich, 2004). Supporting these suggestions, Koivisto and Revonsuo (2004) found, from visual field experiments, that objects presented in the left visual field (that is, to the right cerebral hemisphere) were processed faster when they were familiar in comparison to objects that were unfamiliar. When the same familiar objects were distorted to make the components familiar but the overall shape configuration unfamiliar, participant's accuracy for identifying the objects increased when the objects were presented in the right visual field (i.e., to the left cerebral hemisphere).

Furthermore, using data from brain-injured patients and neuroimaging techniques in neurologically intact controls, Damasio, Grabowski, Tranel, Hichwa & Damasio (1996) found that different areas of the left temporal lobe are associated with different categories of object. Following the ventral stream from V1, the posterolateral inferotemporal cortex (PIT) is associated with naming tools; naming pictures of animals was associated with the inferotemporal region and retrieval of names for faces was associated with the left temporal lobe. Therefore, it appears that object recognition occurs in parallel, with the right cerebral hemisphere reacting and identifying objects rapidly and matching them to representations stored in memory (Koivisto & Revonsuo, 2004), whereas the left cerebral hemisphere processes objects more fully and categorise them if it is not possible to readily match them to a memory trace (Damasio et al., 1996).

1.3.2 Overview of psychological theories of perception

Psychological theories of visual object perception broadly attempt to account for two phenomena. Firstly, due to the retina receiving only a two-dimensional representation of the three-dimensional structure, how the visual system is able to convert them back into three-dimensional objects, and how we can recognise a single object across a number of different viewing angles. For example, how we can recognise a table from both canonical and non-canonical viewing angles. The second class of theory places greater emphasis on how we categorise objects and match them with stored internal representations. For example, how we know that a particular type of object with four cylindrical geons attached to a rectangular geon represents a desk and not a table. This categorisation of type of theory is also linked with the bottom-up and top-down visual processing debate. Bottom-up processing refers to the dismantlement of objects into their constituent parts and forming a representation that is then matched to stored representations in the memory system. Top-down processing, on the other hand, refers to how objects are rapidly recognised by matching the object with one stored in memory and bypassing the more fine grained perceptual analysis (Eysenck & Keane, 2001).

Relating to the bottom-up processing theories of perception, it is suggested (Marr, 1982; Marr & Nishihara 1978) that perception works in a series of stages. Firstly, basic visual properties such as colour, brightness and outline are encoded. This is known as the primal sketch. Secondly, a 2 ½ -D sketch is created when the components, which are separated by naturally occurring junctures, become synthesised. In this stage depth is also incorporated into the percept, but the object is still only in a transient form where it does not become stable over different viewing angles (e.g., canonical and non-canonical). In the final 3D sketch, the object has become stable and the visual properties can be converted from, for example, a canonical viewing angle to an inverted viewing angle. In this classification of there subsequent matching to objects stored in memory occur and semantic activation informs us of what the object is, if our knowledge base allows for this.

Top-down processing, on the other hand, refers to when an observer bypasses a fine-grained perceptual analysis in order to understand what the object is, but rather, matches the constituent parts more rapidly with objects stored the memory system. Farah and McClelland (1991) suggest that objects perceived by the visual system are mapped in two ways. Firstly, the object is mapped on to objects that are perceptually similar. For example, an object comprising of two linked circular components with eight (or 16 if the joints of the legs constitute natural junctures) cylindrical geons protruding from the circular components will be matched onto an internal representation of a spider.

It is clear that both systems could operate in parallel. In the case of bottom-up processing, if an item is new and cannot be matched on to a stored memory item, a full perceptual representation of that item and it's constituent parts would facilitate a new and accurate memory of that object. On the other hand, however, a top-down processing style would also be important. For example, it would be evolutionarily adaptive for the rapid and accurate and detection of dangerous objects, in order to react to them appropriately. Hershler and Hochstein (2009) found that when participants were experts on a subject (birds or cars) they were quicker to detect objects that they were experts in (thus, more familiar with) than other items in a visual search task. They were also quicker to identify faces than other non-familiar objects. These authors suggest that there is a clear advantage for top-down processing in the human visual system. However, it is also important to note that while top-down processing would be faster, it is also possible that it is less accurate. For example, it might be the case, given the previous example, that a spider would be matched on to another object if the perceptual registration was not detailed enough to specify it as a spider. However, when threat is considered, it would be evolutionarily adaptive again to react in a false-positive way (i.e., to escape from something that is not dangerous) than it would be to react slowly to something that is potentially dangerous.

The description presented so far suggests that there are two visual processing pathways that operate in parallel and are equally advantageous depending upon a range of different factors. As highlighted above, the distinction between the two processes is an important consideration when studying attentional bias to threat in anxiety disorders. For example, the findings from Hershler and Hochstein (2009) would suggest that if spider phobic individuals rapidly detect and attend to spiders, they might have a top-down bias towards objects, which might be mediated by familiarity. Such questions are addressed in the current thesis. However, firstly, the above description of perceptual processes has not considered the role of attention. While it is now well established that object recognition and semantic activation can occur in the absence of conscious awareness (Holender, 1986; Mack & Rock, 1998; Williams et al. 1988, 1997) it is also understood that attention is required for objects to be consciously perceived (Mack & Rock, 1998; Simons & Chabris, 1999; Wayland & Levin, 2005).

1.3.3 Overview of the neurophysiology of attention

Due to the array of different types of attentional processes, for example rapidly allocated attention and sustained spatial or object based attention, a number of different neural areas are involved. Firstly, regarding basic subcortical structures and the lower level neural structures associated with the rapid allocation of attention, regions of the brain stem, including the reticular activating system (RAS), the superior colliculus and the thalamus are associated, at varying levels, with attention and attentional control. Additionally, as will be demonstrated later, the amygdala also influences attentional control (e.g. LeDoux, 1996). At the most primitive level, the RAS, while not having a specific role in attentional allocation, controls cortical arousal (e.g. sleep-wake cycles). Therefore, it is suggested that the RAS is crucial for speed of vigilance and reaction times (Pinel, 2000).

As the brain stem progresses upwards its involvement in attention becomes more specialised. Returning to the neurophysiology of the visual system, the optic nerve/tract can be separated into two pathways. The higher-level pathway passes through the lateral geniculate nucleus of the thalamus on its way to V1, where higher level visual processing occurs. The lower level pathway also enters the thalamus. However, this terminates at the superior colliculus. Evidence suggests (Banich, 2004) that the superior colliculus is responsible for the immediate allocation or reallocation of attention and directing eye movements so that items in parafoveal vision are brought to the fovea for more detailed analysis. Two types of eye movement are controlled by the superior colliculus. The first, an express saccade, is typically an involuntary reaction to the presence of a novel stimulus entering parafoveal vision and occurs within 120ms. This is particularly the case for sudden onset and / or flashing stimuli. Voluntary eye movements, termed regular saccades, are under voluntary control and operate in 200 – 300ms (Banich, 2004).

Additionally, the thalamus has been implemented in a number of complex attentional and visual tasks. As suggested earlier, the thalamus acts as a relay centre for sensory information and the pulvinar is particularly specialised to do this. The consequential role of the pulvinar in attention is two fold. Firstly, evidence from brain-injured patients suggests that individuals with thalamic damage have difficulty in allocating their attention to particular areas in visual space. Secondly, through neuroimaging studies, it has been found that the thalamus shows increased activity in visual search tasks, which suggests that it is active in gating certain visual information. As such, it is suggested that the thalamus may have an important role to play in task performance, what types of stimuli draw attention and when they do so (Banich, 2004).

The neural areas discussed above have been linked with the more rapid allocation of attentional resources to new or novel stimuli, which is important for both the study of inattentional blindness and cognitive psychopathology. For example, the recognition of the critical stimulus in the inattentional blindness paradigm (see section 1.4) could be related to these subcortical areas. Similarly, if anxiety causes the rapid allocation of attention to threatening objects, the same areas will be activated.

The inattentional blindness experiment, however, also requires focussed spatial or object based attention for participants to perform the explicit element of the task (the line judgement task, see section 1.4). Brain regions associated with volitional focussed attention are located in the frontal and parietal lobes. For example, using fMRI technology, Thakral and Slotnick (2009) found that sustained attentional tasks caused activation in the middle frontal gyrus and the right intraparietal suclus, respectively (this is discussed further in relation to psychological theories of attention. See section 1.3.4). Therefore, it can be demonstrated that attention involves both subcortical and cortical brain regions. In reference to the current study, therefore, it is important that the dual attentional processes in operation are accounted for as the inattentional blindness task utilises both rapid attentional orienteering and sustained volitional attention. Nevertheless, while neurophysiological evidence highlights the brain regions involved in attentional processes, psychological theories of attention require discussion as these describe the functional processes involved in attention.

1.3.4 Psychological theories of attention

Theories of attention arose from the observation that the human information processing system has a limited capacity. For example, we cannot process all the information received by the visual system. Therefore, we must select what stimuli are important and process these, with the cost of not processing others. Early experiments and theories of attention attempted to establish how and why certain information is selected and what happens to the non-selected information. This section will, therefore, firstly examine bottleneck models of attention (Broadbent, 1958; Deutsch & Deutsch, 1963; Triesman, 1960), which were largely based on data obtained from experiments in the auditory modality. Moving on to visual attention, theories of focussed attention and the components that comprise the attentional system (e.g. Posner, 1980) will be considered.

The first major attempt at modelling attention was provided by Broadbent (1958), who suggested that our attentional system could be viewed as a bottleneck. Initially, sensory information is processed superficially and in parallel. The next stage is a selective filter. At this stage, stimuli selected on the basis of their level of importance (e.g., task relevant stimuli) begin to pass through in a serial manner for further in-depth processing. The less important stimuli are disregarded at the superficial level of processing. The suggestion that initially all stimuli receive only superficial processing and that less important stimuli are disregarded at this level became known as early bottleneck theory (Styles, 1997).

The early bottleneck theory could not accommodate all of the experimental findings. For example the commonly used experimental tool, the dichotic listening paradigm, involves presenting different auditory information to both ears and participants are asked to attend to, and shadow (repeat aloud), the message presented to one ear. This experiment revealed that breakthrough of the unattended message can occur (Treisman, 1960). Using this paradigm, Corteen and Wood (1973) found that words presented to the unattended ear received deeper processing. Initially, participants were conditioned to expect an electric shock when they heard certain words. Using Galvanic Skin Response (GSR), they found that, when the conditioned words were presented to the unattended ear, participants GSR increased significantly. However, the participants reported that they did not consciously hear these words. Findings such as these suggest that, contrary to early bottleneck theory, even though stimuli are not consciously perceived they do receive more in-depth levels of processing.

The first theory attempting to account for the more thorough processing of unattended information was Treisman's (1964) attenuator theory. According to this theory, when information passes through the limited capacity system, depending upon the attentional demands placed by the primary task, information goes through a variable level of semantic analysis. Thus, if primary task demand is high a low level of analysis is provided (e.g. basic visual features), whereas if task demand is low a more thorough analysis (e.g. the semantic meaning of the stimulus) will be provided. Treisman's theory accounted for some of the findings the original early selection theory could not (Eysenck & Keane, 2001). However, Corteen and Wood's (1973) finding that, even if a stimulus does not reach conscious awareness its meaning is accessed, is better accounted for by the late bottleneck theory proposed by Deutsch and Deutsch (1963). This suggests that all stimuli are fully processed before they reach consciousness and, indeed without the need for them to reach conscious awareness.

Lavie (1995) provides a similar account to that of Triesman (1964), which suggests that the closing of the attentional bottleneck varies depending upon demands placed upon the perceptual system. For example, when task demands are low, irrelevant items are processed to a greater level. However, when task demands are high, less irrelevant information passes through the bottleneck for further processing. Furthermore, it is suggested that this occurs in both the visual and auditory modalities. This theory will be further explored in relation to inattentional blindness in section 1.4

While many of the models described above relate to the filtering of information by the attentional system, other work has focussed on the orienting of visual attention to different stimuli. In relation specifically to focussed visual attention, Posner (1980) found that, when participants were instructed by a central visual cue representing an arrow that a target item was soon to appear in an area of a visual display, they were faster to detect and respond to the probe when there was no cue. Such findings suggest that participants were narrowing their attentional spotlight to a particular area in visual space. Additional to the central cue, participants were also given a parafoveal cue. The parafoveal cue involved briefly highlighting the area of the screen where the target is due to appear, again this enhanced detection of the target. However, when the accuracy of the cues was manipulated so that on the majority of trials they indicated the wrong location, participants could freely orient their attention away from the central cue, but they could not do the same for the parafoveal cue. This led to the distinction between two types of visual attention: endogenous and exogenous. Endogenous attention refers to processes where we consciously direct our attention (for example, it refers to attention that is task oriented). Exogenous attention refers to involuntary, or reflexive, attention that is not under strong volitional control. This finding relates to the voluntary and involuntary saccades described by Banich (2004).

While the above theories suggest that attention is a unitary construct, Posner and Petersen (1990) suggest that the attention system is comprised of a series of stages relating to the pattern of attentional allocation. They suggest that the attentional system is comprised of the engage, disengage and shift components. The engage component refers to the process where an object is initially selected by the attentional system. The disengage component removes attention from a currently attended area. Finally, the shift component reflects the reallocation of attention to new areas in visual space. Additionally, Posner and Petersen (1990) provide suggestions for the neurological loci of each component. Citing research from patients who have sustained brain damage and animal studies using monkeys, they suggest that the disengage component is under cortical control and, as suggested in section 1.3.3, is located in the parietal lobe. The shift and engage components of visual attention, however, are controlled by subcortical structures. They suggest that the shift component has been disrupted by patients suffering damage to the superior colliculus, and the thalamo-pulvinar region. The suggestion that the human visual attention system is comprised of distinct components is discussed further in relation to attentional bias in anxiety, particularly in relation to the delayed disengagement hypothesis in section 1.5.2.6.

The suggestions made by Posner and Petersen (1990) propose that attention is allocated to areas of visual space and objects that fall within that area are attended to. However, it has also been proposed that attention can be allocated to objects rather than areas of visual space (Neisser & Cervone, 1975). The crucial difference between these two suggestions is that if attention is spatially based objects within the spatial zone currently attended will be selected for conscious processing. If, however, attention is object based, it is possible that additional objects falling within the area that the attended object is located will be missed. Using a modification to the spatial cueing task, which allowed for additional object cueing, Soto and Blanco (2005) found evidence for both spatial and object based attention. Their argument suggests that object based attention is a top-down process which directs processing towards objects that are expected. As such, the object based attention system is dominant and spaced based attention is a 'slave' (P. 80) to object recognition in this process. However, they further suggest that space based attention may be stronger in a bottom-up capacity, redirecting processing resources to new or, as was the case in their study, cued, locations, making the systems interactive at different levels.

Therefore, there are a number of considerations to be made in terms of psychological theories of attention. Firstly, there is the distinction between endogenous and exogenous attention (which in turn, as suggested earlier, are related to eye-movements). The primary concern for the current research project is exogenous attention and its reflexive response to new stimuli in the visual environment. It is this attention system that is likely to respond to the critical stimulus in the inattentional blindness experiment. Similarly, the distinction between object based attention and spatially based attention is important for the present study. It is possible to suggest that spatial attention, which operates in a more bottom-up capacity to new stimuli, will be responsible for noticing of the critical stimulus in the inattention trial. Both of these factors, and the general implications for attentional theory, will be considered in relation to the findings of the experiments in the general discussion section.

1.3.5 Perception and attention – summary of implications for the study of inattentional blindness and cognitive psychopathology

The neurological basis of the visual system projects from the retinal through anterior regions of the brain before specialised processing of objects occurs in the occipital cortex in the posterior regions. Perceptual research (e.g. Koivisto & Revonsuo, 2004) provides evidence of hemispheric asymmetry and suggests that the right-hemisphere is involved in the processing of complete objects, and subsequently matching them with representations stored in memory, whereas the left cerebral hemisphere provides a more detailed perceptual analysis of the object. Similarly the research suggests that familiarity affects this, with participants being able to locate objects they are experts in faster than less familiar objects in visual search tasks (Thackral & Slotnick, 2009). Furthermore, it is suggested that the right cerebral hemisphere is particularly important in the processing of emotional stimuli. When considering the aims of the current thesis, this has important implications for spider phobic individuals as questions arise as to whether any attentional bias towards spiders is due to familiarity with the object. Psychological evidence suggests that perceptual analysis and subsequent matching with memory can occur both consciously and non-consciously, and visual consciousness is mediated by attention.

The neurophysiological basis of attention and psychological theories accounting for attentional processes both point to dual systems within the human brain. One system reflects more automatic processes that are not under strict volitional control. These processes are subcortical and are linked with involuntary eye movements. The other system reflects sustained attention that is strategically allocated to specific objects. This distinction is important when inattentional blindness and attentional bias to threat are considered. Firstly, the inattentional blindness paradigm (as discussed in section 1.4) engages focussed attention on the explicit line judgement task. However, recognition of the critical stimulus is based on the allocation of attention to that object and thus would require a reallocation of attention (when the object appears outside the hypothesised zone of attention. See sections 1.4 and 3.1.1.2). Finally, there is some debate as to whether visual attention is spatially based or object based. Current static inattentional blindness experiments are unable to address this question, however, modifications to this paradigm may permit inferences to be made.

1.3.6 Working Memory

So far this thesis has covered the theories and evidence of how the visual system initially receives information and how this information is selected for conscious processing. After the selection of information by the attentional system, it passes through to the memory system. Numerous memory sub-systems have been outlined (Eysenck & Keane, 2001). However, the most associated with attention is Working Memory (Baddley & Hitch, 1974).

The working memory model is comprised of three components: the central executive, the phonological loop and the visio-spatial sketch-pad. The central executive is sensory information modality free (as in it received auditory and visual information) and is linked to the attention system. In particular relation to visual information, information received by our eyes is brought to consciousness via the attentional system. After this, the information is passed on to the visio-spatial sketch pad, where it is held for manipulation and / or rehearsal before it is passed on to specific components of long-term memory (LTM). Similarly, auditory information is passed on to the phonological loop where it can be rehearsed and passed on to components of LTM. Baddley (2000) elaborated on the working memory model by adding a fourth component termed the episodic buffer. This component holds online an integration of information stored in the visio-spatial scratch-pad and phonological loop for a short period of time.

De Fockert, Rees, Firth and Lavie (2001) examined the link between working memory and attention. As suggested, the central executive represents the attentional system and, working from the hypothesis that if working memory load increases, the limited resources of the attentional system will decrease, found that as a working memory task increased in intensity, the ability of participants to ignore distracter stimuli on a concurrent attentional task diminished. This finding was established using behavioural and neuroimaging data, and suggests that the attentional and working memory systems interact and are interdependent in terms of task demands. These findings impact upon inattentional blindness and will be considered later in the thesis.

1.4 Inattentional Blindness

Despite some overlap, the introduction so far has treated perception and attention as distinct components of the visual system. These two systems can be separated on one factor: consciousness. Certainly, Mack and Rock (1998) follow this distinction when they discuss inattentional blindness. Inattentional blindness, simply put, refers to looking and not seeing. More specifically however, Mack and Rock (1998) conducted a series of studies designed to examine perceptual processes in the absence of attention. That is to say, they attempted to look at what is perceived when attention is absent. The broad conclusion to their 1998 monograph was that conscious perception cannot exist without attention. The following sections outline the experiment used to eliminate attention and the subsequent findings using this experiment. Further sections outline how this initial work has developed.

1.4.1 Separating perception and attention: the inattentional blindness experiment

Mack and Rock (1998) suggested that, at the time, traditional perceptual experiments investigating preattentive processes in terms of how a stimulus 'pops-out' (p.4) failed to eliminate attention. In such experiments, typically called visual search tasks (as described above and considered in more detail in section 1.6.1.3), participants are told that a stimulus will appear in an array of distracter stimuli and their task is to identify it as quickly as possible. Therefore, because the participant is expecting something, their attention is, to varying degrees, engaged and perception and attention have not been separated. Consequently, claims as to the existence of preattentive processes were not adequately validated. To ameliorate this difficulty, Mack and Rock (1998) created a paradigm that ensured, firstly, that participants had no prior knowledge that a stimulus would appear and, secondly, that the participants' attention was engaged in an extraneous and demanding attentional task. The experiment has two stages: the non-critical and critical trials. In both trials participants are presented with a circular visual display at a distance of 76cm. Each trial lasts for 2200ms and consists of three phases. In phase one, a small cross is presented in the centre of a circular display; this acts as a fixation point and participants are instructed to maintain focus on this point throughout each trial. In the second phase a larger cross is presented for 200ms (this time frame allowed for the elimination of any regular saccadic eye movement). The participant's task is to judge the lengths of the horizontal and vertical axes (while maintaining focus). In the third phase of the trial a visual mask, representing a random display of black and white boxes, is presented for 500ms. This serves to eliminate post-stimulus visual memory. At the end of the trial the participant is asked to report which line of the cross is longest. The critical trial follows the same procedure as the non-critical trial. However, in second phase, during the line judgement task, an unexpected stimulus appears in one of the quadrants of the box (in the original experiments this was a black box). After the visual mask, in addition to reporting which line was longest, participants are asked if they had noticed anything unusual and, if so, asked to identify it.

The original experiments required the participants to engage in focussed attention, however, two different conditions were also used. In the divided attention task, participants were told to judge which line of the cross was longer and to look out for an unusual stimulus. In the full attention trial, participants were again required to focus their gaze on the fixation point, however they were told to ignore the cross and, after the trial, report anything unusual. The findings from these original experiments found that approximately 25% of participants did not consciously perceive the unexpected object on the inattention trial (indicating inattentional blindness).

The original experiments were manipulated by Mack and Rock (1998) in two ways in order to test the robustness of the phenomenon. Firstly, the experimental format was altered, secondly, the types of stimuli were changed. Regarding the experimental format, in an original experiment the distracter cross was presented at fixation, and the unexpected stimulus was presented in the parafovea (2.3° from fixation). This was reversed so that, although participants maintained fixation on the central cross (stage 1), the distracter cross was presented in the parafovea and the unexpected stimulus was presented at fixation in the fovea. This manipulation increased inattentional blindness from 25% to between 60% and 80%, strengthening Mack and Rock's claim that there is no conscious perception without attention.

1.4.2 Evidence for inattentional blindness

The evidence from inattentional blindness experiments suggests that to a greater or lesser degree inattentional blindness is affected by the amounts of stimuli, stimulus size, motion, and shape; and of particular importance, meaningfulness. A series of experiments investigating how the amount of stimuli affect inattentional blindness, it was discovered that as the amount of unexpected stimuli increased to between four and sixteen black squares inattentional blindness was reduced from an average of 25% for one to 14% for sixteen (Mack & Rock, 1998).

The finding that increasing the amount of stimuli decreases inattentional blindness has been paralleled with the finding that stimulus size has a similar effect. Two aspects of stimulus size appear to be important when considering what factors can draw attention: retinal size and postconstancy size (Mack & Rock, 1998). Retinal size refers to the projection of the stimulus on to the retina and the retinal space it covers; this is relevant to lower level visual processing. Postconstancy refers to the perceived size of the stimulus in relation to other objects; this reflects visual processing that comes later in the visual chain. As such, it is suggested that the summoning of attention by size has a direct effect on early (e.g. Broadbent, 1958) and late (e.g. Deutsch & Deutsch, 1963) selection theories of attention. Mack and Rock (1998) found that an increase in retinal size, but not post constancy size, reduced inattentional blindness. This was interpreted as supporting early selection theories of attention, because the allocation of attention was based on low-level stimulus properties, rather than higher level stimulus attributes.

It appears that motion or the movement of an object is important when considering what factors contribute to the allocation of attention. Mack and Rock (1998) found that, when one element of a static display moves, motion was detected by 85% to 80% of participants (i.e. IB = 15% to 20%, respectively). That is, the participants indicated that they saw something move. However, of the participants who noticed this movement approximately 53% could not accurately locate which quadrant the stimulus appeared in. An additional factor affecting the perception of motion under conditions of attentional engagement appears to be perception of grouping (that is, a number of independent stimuli placed in geographical proximity). Mack and Rock (1998) found that the perception of stimuli spatially grouped together (whether by virtue of pattern or stimulus size) reduces inattentional blindness. When motion and grouping were combined, the experiment showed that, while inattentional blindness was reduced, the number of people who noticed the unexpected stimulus did not perceive the additional movement. Therefore, it appears that the additional feature of movement, in otherwise static presentations, is perceptible for less complicated displays. However, it appears that grouping (and thus, stimulus size) take precedent of movement in otherwise static displays.

The perception of shape under conditions of inattention has important ramifications for theories of perception. As discussed in section 1.3.2, Marr (1982) suggests a model of perception where objects go through three stages of analysis. An object is perceptually dismantled into its constituent parts based, firstly, on light and the primitive outlines and then, from this basis, is developed into a full and accurate percept. Biederman (1990) developed this theory by suggesting that complex objects are broken basic geometric shapes before full recognition can occur. Mack and Rock (1998) investigated how different shapes draw attention when it is otherwise engaged. It was found that shape alone did not appear to draw attention under conditions of inattention. In the standard inattentional blindness experiment, when geometric objects were presented parafoveally (that is, away from fixation), 25% of participants were unable to correctly identify shape. When the same objects were presented in the fovea, this percentage increased to between 78% and 83%. When these findings are considered with Marr's (1982) theory, it may be inferred that even very basic object recognition does not occur in the absence of attention.

The findings that stimulus quantity, size and motion affect the allocation of visual attention are important considerations. However, it appears that certain stimuli can draw attention for reasons that are conceptual, rather than perceptual. The two stimuli that reduce inattentional blindness significantly are the participant's own name and happy (i.e. smiling) faces. Firstly, using the traditional inattention paradigm, where the unexpected stimulus was presented in the parafovea, a participant's name was presented on the critical trial and 88% of participants saw the stimulus, the majority of whom also correctly identified it. This means that, in comparison to geometric shapes (e.g. a square), inattentional blindness decreased by approximately 63%. However, altering the participant's name by one letter (the vowel superseding the first letter; the first and last letters always remained constant) increased inattentional blindness to similar levels as observed for neutral stimuli. In an additional experiment examining this effect, the participants own name was exchanged for another name. In this instance, inattentional blindness increased. The effect reduced again for frequently used English nouns (i.e. *time* and *house*) (Mack & Rock, 1998).

A persons name is an important social cue, and the effect is reminiscent of the cocktail party phenomenon (Mack & Rock, 1998). Consequently, other factors that may have significant social meaning were explored. A series of experiments investigated the effect faces have on attention when it is otherwise engaged in a highly demanding task. Using a basic line drawing of a face with black squares for eyes and either an upturned (happy) or down turned (sad) line representing a mouth below the eyes, all within a circle; Mack and Rock tested the ability of this stimulus to draw attention. Furthermore, the face was distorted so that the features were not in the typical facial configuration; a blank circle was also used. Ranging from the happy face, through to the sad and distorted faces, and ending in the blank circle, inattentional blindness increased systematically from 15% (happy face) to 85% (sad face). The figures were similar for post-experimental correct identification tests.

Generally, the findings suggest that a facial stimulus is able to attract attention when other comparable stimuli (i.e. a black and hollow circle of similar sizes) do not. The only exception is that, while not statistically significant, the distorted face was able to draw attention to a greater degree than the sad face; inattentional blindness equalling 37% and 60% respectively. The fact that the happy face was able to draw attention, with the only difference between this and the sad face being the direction of the mouth may suggest that the perceptual system of the participants were diverting attention away from this object (or, as will be considered in the section on cognitive psychopathology, perhaps *protecting* the individual from a negative stimulus). However, Mack and Rock (1998) claim to have eliminated emotional affect as a possible cause by comparing the sad face to a neutral face, where there was no up, or down, turn on the mouth. There were no significant differences in inattentional blindness between the neutral and sad faces. Mack and Rock suggest that this provides evidence that it is something special about the happy face, rather than the affect transmitted by the sad face, which causes the reduction in inattentional blindness. However, in light of the literature from attentional biases in anxiety disorders, which will be discussed later, this conclusion appears to be premature.

These findings, again, have important ramifications for bottleneck theories of attention. The finding that inattentional blindness decreases significantly for a person's name and that the same was not true when one, relatively inconsequential, vowel was changed points to late selection bottleneck theories (e.g. Deutsche & Deutsche, 1963). The same appears to be true for faces. The evidence suggests that the perceptual system is getting a full representation of the face and making a decision whether or not to orient attention towards the stimulus. However, there is also evidence suggesting that retinal size affects the allocation of attention, which supports early bottleneck theories of attention (e.g. Broadbent, 1958). Therefore, from the evidence presented so far, it appears that both early and late selection bottlenecks are in operation between perception and attention. However, the fact that large retinal images draw attention to a greater extent than smaller ones (the cut-off point appearing to be 1.1 degrees), may also be an effect of stimulus meaning. The closer something gets to us, the larger its retinal size. Similarly, the closer something gets to us, the more chance it has of making contact and potentially harming us. Therefore, while not affective meaning per se, larger objects may have a threat value attached to them, which contributes to the drawing of attention. This opens up the possibility that danger or threat is a mediating factor.

Finally, in their series of studies Mack and Rock (1998) investigated what happened to the unexpected stimulus. That is, while the unexpected object was not consciously perceived there is reason to believe there may be some degree of perceptual registration and/or semantic activation (e.g. Corteen & Wood, 1973; Holender, 1986), a concept known as implicit perception (e.g., Holender, 1986).

Two attempts were made to experimentally ascertain this. The standard experimental procedure was manipulated so that the mask was removed and the trials were paced. After the inattention trials, participants were presented with a word stem completion task (WSC). Traditionally, WSC tasks involve a two stage experimental procedure designed to assess implicit memory (i.e. memory without conscious awareness). During the first stage participants are presented with a list of words to incidentally learn. In the second stage, which appears unrelated to the first, participants are presented with a series of word stems (e.g. st___), which they are required to complete with the first word that comes to mind. Evidence of implicit memory is said to occur when the participant completes the word stem with a word from the list presented in the first stage. Important controls for this experiment are, firstly, that during stage one the words must occur less frequently in the English language. Related to this, secondly, the stems in stage two must have a number of possible completions (e.g. st___ can be completed to produce stand, stripe, stake).

Effectively Mack and Rock (1998) replaced the incidental-learning task in stage one with their inattentional blindness experiments, and both implicit perception and implicit semantic activation were examined. Firstly, corresponding with the traditional word frequency controls and controlling against a group of participants who were asked to complete the word stems, without any priming (i.e. only stage two), it was found that participants who were inattentionally blind completed the word stems with the unnoticed word above chance level. This provides evidence that there is perceptual registration of the unnoticed stimulus. However, it does not provide evidence of semantic activation. Therefore, secondly, in the second phase of the trials the word stems were exchanged for a series of pictures. Each of the pictures began with the same two letters. However, they were all semantically different (e.g. a flag and a [snow] flake). The participants' task was to select the picture they preferred. Again, above chance level, the inattentionally blind participants selected the picture corresponding with the word presented in stage one. This suggests that stimuli not consciously perceived are semantically activated, again providing support for late bottleneck theories of attention.

The series of experiments so far presented had, as their intention, the assessment of (conscious) perception without attention and what types of stimuli draw attention. The experiments revealed that stimulus meaning appears to be a crucial factor. As Mack and Rock (1998) suggest, this finding was difficult to accept because it is at odds with the then current acceptance (e.g., Rock, 1985) that the perceptual system was rule based and acted independently from stimulus meaning. As such, it may be suggested that stimulus meaning was not the primary objective in the original inattentional blindness studies and, therefore, has not received adequate attention. Furthermore, the suggestion that retinal size may draw attention and the possibility of it having "threat value" opens up a new line of investigation. If threat is equated with meaning, are there other threatening stimuli that draw attention? And, while many things pose real and great danger (e.g., a gun being pointed at oneself) there are many things that have "subjective" threat and result in, for example, phobias. There is a wealth of literature investigating perceptual and attentional biases in anxiety disorders such as phobias. However, before moving on to this issue, there have been a number of other recent studies of inattentional blindness requiring consideration.

1.4.3 Further work on inattentional blindness: dynamic experiments and additional static tasks

The original experiments by Mack and Rock (1998) used static displays and, with the exception of the looming stimulus, static unexpected stimuli. However, prior to the publication of Mack and Rock's studies, a series of experiments investigated the effects of selective looking (e.g. Becklen & Cervone, 1983; Neisser & Becklen, 1975). In these experiments, dynamic scenes such as basketball playing were presented to participants who were required to engage in an attentionally demanding task. During the presentation an unexpected event occurred, which, while being clearly visible to observers not engaged in the concurrent task, was missed by the experimental participants.

More recently, Simons and Chabris (1999) replicated and developed this work. In their study, the visual display involved two teams of three people passing a basketball between themselves. The experimental task required participants to count the number of times members of one team (separated by colour [black vs. white]) caught the ball. During the scene either a person dressed in a Gorilla suit, or a lady carrying an umbrella entered from the right, stopped in the middle, beat his/her chest (gorilla) or performed a dance (umbrella lady) and exited on the left side of the screen. Generally, the results of this study found that almost half (46%) of the 192 participants did not consciously perceive the unexpected event. That is, participants were inattentionally blind to the Gorilla or umbrella lady, even though they passed directly across their visual field. More specifically, there are two important factors that affected attention to the unexpected stimulus, namely task difficulty and stimulus similarity. In regard to the first factor, participants were instructed to discriminate between different types of passes (making the task more difficult) and fewer noticed the unexpected event. The need to discriminate between passes was hypothesised to cause additional demands on the attentional system. Secondly, it appears that stimulus similarity affects noticing. For example, the umbrella woman was noticed more than the Gorilla; participants attending to the players in black noticed the gorilla more. These results suggested that, in the case of the umbrella lady, more people noticed her because she was similar to the actors in the dynamic event; and in the case of the gorilla, when the team being attended to were in black, more people noticed this because it shared the same colour as the actors in the dynamic event. Although it is unclear from the results, this finding might suggest that the umbrella lady was noticed more frequently because of conceptual reasons (indicating a late selection attentional filter, whereas the gorilla person was noticed because of the similarity in colour to the black team suggesting a perceptual bias (indicating an early selection attentional filter).

Simons and Chabris (1999), however, did not assess whether, of the observers who were inattentionally blind, any trace of the unexpected event remained. They suggest that potential evidence remains unclear whether the gorilla or umbrella lady left a cognitive trace. On the one hand, Mack and Rock (1998) present evidence of perceptual registration and semantic activation. On the other hand however, Simons and Chabris cite evidence that the same effect is not observed in dynamic scenes (e.g. Neisser & Cervone, 1983). As yet, this aspect of sustained inattentional blindness has not been developed, however, other areas have.

Memmert (2006) expanded the work of Simons and Chabris (1999) by assessing the effects of expertise and examining the directions of eye gaze. Regarding expertise, people with a professional history of basketball playing were compared to lay individuals. Using the same paradigm as Simons and Chabirs, significant differences in noticing were found between the two groups. Specifically, people with a professional history of basketball playing were more likely to notice the unexpected stimuli (the Gorilla) than were lay people in the medium difficulty condition. As such, it is suggested that expertise for the activity displayed in the dynamic scene can affect levels of inattentional blindness. There are three possibilities as to why this occurs. Firstly, it may be possible that the experimental task places less demand on the basketball experts and therefore they may be more distractible. Possibly refuting this suggestion, however, is the fact that there were no differences in the primary counting task, which might be expected if the novice group found the task more difficult. Secondly, taking into account the suggestions of De Fockert et al. (2001), it is possible that the basketball experts in the field gathered more information about the visual scene, due to their higher level of knowledge (for example, discriminating between different types of passes). This would have placed greater demands on these participant's working memory systems, which would have made them more distractible, thus decreasing inattentional blindness.

Another suggestion, while less parsimonious, may be offered. It is possible to relate these findings back to Mack and Rock's (1998) discovery that salient objects (e.g. a participants name) can attract attention under conditions of inattention. Furthermore, it may allow for inferences to be made about possible detection of threat. For example, the expert group in Memmert's study had a familiarity with basketball scenarios. As such, they may have preconceived schema about what to expect. If the perceptual system registers something that is not commensurate with this schema, then it may allocate attention to the object. Relating to fear being a possible factor, if something unusual occurs during an activity we are familiar with, it may be potentially threatening and consequently warrant further cognitive processing. This conclusion appears to be in line with Mack and Rocks (1998) suggestion that it is stimulus meaning that affects inattentional blindness and supports the suggestion that the perceptual system is not rule based, but actually assesses meaning. However, at this stage threat is only a speculative explanation of the experimental effects. The direction of the participants' eye gaze was measured. This is considered an important factor because when using a dynamic scene, where the to-be-attended stimuli move, experimenters cannot be sure if the person has fixated their gaze in the direction of the unexpected stimulus (Memmert, 2006). The findings from the eye tracking measure found no significant differences in the amount of time the identifiers and inattentionally blind participants fixated on the gorilla (both approximately 100ms) suggesting the inattentionally blind participants had sufficient time for conscious awareness.

A further study controlling for eye gaze direction, and spatial attention, converted the paradigm used by Mack and Rock (1998) by replacing cross judgement task with a sequence of expected stimuli (two digits presented in different, never diagonally opposite, areas of the traditional cross quadrants; varying in distance from fixation). The critical stimulus was a circle, which replaced the fixation cross. During this procedure, Koivisto, Hyona and Revonsuo (2004) asked participants to either maintain fixation on a central cross or direct their gaze towards the expected stimuli as they appeared. In addition, spatial attention was manipulated so that on the prior non-critical trials half of the participants in each condition could expect a digit to appear towards the centre of the display (centre attended condition), whereas for the other half of participants the stimuli always appeared in the outer area of the display.

Using eye tracking, the results indicated two patters of attentional / eye movement allocation. The first pattern involved movement from the central fixation cue to the first expected stimulus and then to the second. The second pattern involved switching from the first expected stimulus, back to the central fixation cue / unexpected object and then to the second expected stimulus. Despite the return to the fixation cue that had changed to the unexpected stimulus, no difference in noticing rates were found between the participants. The authors further found that replacing the critical stimulus with one that was more similar to the expected stimuli reduced inattentional blindness, suggesting that attentional set affects inattentional blindness.

There are a number of implications of this study. Firstly, the serial presentation task shows that attention was not engaged on an object per se, but on the expectation of an object, which provides converging evidence for the claims made using static displays, i.e., attention was absorbed on the area where the visual object was expected to appear, rather than the object itself (as is the case in the Mack and Rock (1998) studies). Secondly, across the experiments the unexpected stimulus was presented for longer than in the majority of the Mack and Rock (1998) studies, presenting confirmatory evidence that inattentional blindness can be sustained for greater durations, even when using static displays. The finding that when the critical stimulus was changed to one which more closely matched the expected stimuli led the authors to conclude that they assessed meaning. Indeed, the finding is similar to the to Mack and Rock's (1998) finding that facial stimuli break through inattentional blindness. This may suggest that people have a "preset attentional set" for faces. However, the results do not contrast so readily with the finding that a sad face is perceived less than a distorted face. The only difference between the happy and sad faces is that, for the latter, the mouth line is inverted. As such, it is more likely that the results from the Koivisto et al. (2004) study were due to attentional set, and that this is not the same as stimulus meaning per se.

Convergent findings about threat and inattentional blindness have been shown with studies using auditory stimuli. Wayand, Levin and Varakin (2005) developed Simons and Chabris' (1999) study to include unpleasant stimuli and the auditory sense modality. The dynamic scene used by Simons and Chabris remained constant, however, a lady and a chalkboard replaced the Gorilla or umbrella lady. During the scene, the actor entered from the left, stopped in the middle of the scene (where the basketball game was occurring), scraped her nails down the chalkboard and exited on the right. The sound of nails being scraped along a chalkboard is suggested to be unpleasant and was included in the video. Thus, observers had the chance of both seeing and hearing the unexpected event. The results of these experiments revealed similar rates of inattentional blindness as the previous investigations into sustained inattentional blindness; that is, 53% of observers did not notice the unexpected event. Furthermore, both removing and increasing the sound of the nails scraping did not affect noticing rates.

The results obtained by Wayand et al. (2005) confirm that inattentional blindness is a robust phenomenon and expand it further to demonstrate that attention is no more likely to be drawn when the unexpected event occurs simultaneously in the auditory modality. However, the fact that the unexpected event is highly unpleasant presents an important factor. It demonstrates that unpleasant stimuli can bypass the attentional system (i.e., nails down a chalk board). However, while the stimulus was unpleasant, it might be suggested that it is not greatly so. If unpleasantness is thought of on a continuum where at one end there are events that are uncomfortable (e.g. nails scratching down chalkboard) and at the other end, things that are harmful and threatening (e.g. being potentially attacked), it might be possible to suggest that the results of this study need to be developed by varying the levels of noxiousness to see how this affects inattentional blindness. It is important here to note that varying the level of threat or visual saliency will require manipulation of a single stimulus, rather than an increase in stimuli. This is because, as suggested earlier, grouping and an increase in the amount of stimuli have their independent effects.

1.4.4 Contrasting interpretations and Inattentional Amnesia and Perceptual Load

There are two further explanations of why the phenomenon of inattentional blindness occurs. Firstly, it is suggested that the stimulus is consciously perceived and then rapidly forgotten (a concept termed inattentional amnesia; Wolfe, 1999). It is suggested that in traditional inattentional blindness experiments, during the critical trials participants are asked to perform a task, report on it and then report if anything else is present. Wolfe (1999) suggests that the time it takes to report the line may allow for the rapid forgetting of the unexpected stimulus. Thus, inattentional blindness may be better conceptualised as 'Inattentional amnesia'. The effects, whether they are blindness or amnesia, are the same – limited or no conscious awareness of the unexpected stimulus. However, the literature on this subject appears to be in favour of the blindness interpretation. For example, Simons and Chabris (1999) suggest that, in evolutionary terms, the rapid conscious perception and then forgetting is counter-intuitive. Indeed, it would not aid survival if stimuli, particularly threatening ones (which, at points in human history the gorilla, perhaps, would have been), are perceived and then rapidly forgotten.

A second suggestion relates to the demands placed on the perceptual, attentional and working memory systems. For example, Lavie, Hirst, de Fockert and Viding (2004) found different effects when perceptual load and working memory load were manipulated. In a series of experiments, it was found that a high perceptual load (that is to say, an increase in non-target stimuli) reduces interference caused by distracter stimuli. That is, distracter stimuli are more likely to be missed because of the demands on the attentional system. However, it was also found that, on attentional tasks that require working memory, an increase on the load placed on the working memory system reduces cognitive control and thereby increases interference of distracter stimuli. In terms of inattentional blindness, these findings would suggest that if perceptual load is too high, it is likely that inattentional blindness will increase, whereas if working memory load is high, inattentional blindness is likely to decrease.

Cartwright-Finch and Lavie (2007) conducted a series of experiments in order to test the hypothesis that increased perceptual load reduces inattentional blindness by using the traditional cross judgement task (Mack & Rock, 1998) and a new visual search method. In the cross judgement task perceptual load was manipulated by having participants report the longer line of the cross (high-load) or reporting which line was coloured blue (low-load). It was hypothesised that discriminating between different colours would be easier than discriminating between distance. The results showed significant differences between high-load and low-load tasks, with more participants noticing the unexpected stimulus in the latter.

The visual search task required participants to locate a specific letter in either a series of other letters (high-load) or dots (low-load). Again investigating the effects of perceptual load, participants were required to identify a letter in a circle of distorted letters (high-load) or black dots (low-load). In this experiment all stimuli were black, thus eliminating the effects of colour (as found by Koivisto et al., 2004). The results showed that inattentional blindness increased in the high-load task. Subsequent experiments using these paradigms revealed that the majority of participants who noticed the unexpected stimulus were able to correctly identify it in a forced choice test, however, non-noticing participants could not. Furthermore, this was more pronounced in the high-load condition. Finally, when they controlled for response latency and thus the possibility of inattentional amnesia the same pattern of results was found, supporting the blindness, as apposed to amnesia, viewpoint. Consequently, this research demonstrates that one of the crucial factors creating inattentional blindness is perceptual load, supporting the suggestion of a variable attentional bottleneck, which moves with perceptual load (i.e. Lavie, 1995).

1.4.5 Inattentional blindness and meaning: The specificity of face and name stimuli

A smiling face, for the most part, transmits a positive emotional signal. The exception being that socially phobic individuals may perceive them as mocking (Gilboa-Schechtman, Foa & Amir, 1999). Further reinforcing the notion that such stimuli can draw attention in conditions of high attentional demand, Mack, Pappas, Silverman and Gay (2002) have reported a number of findings. Firstly, smiling faces, to a greater extent than inverted ones and non-emotional stimuli (i.e. the diagram of a tree), draw attention and avoid the attentional blink (Shapiro, 1994). The attentional blink is a phenomenon that occurs when stimuli are presented rapidly using the Rapid Serial Visual Presentation (RSVP) method. In a series of rapidly presented stimuli, when a participant has been instructed to look for a particular stimulus, the item superseding its presentation, at between 180ms and 500ms, regularly goes at least consciously unperceived (Shapiro, 1994). That is, if an additional stimulus is presented for a rapid duration too quickly after a "to be attended stimulus" the attentional system effectively "blinks" like an eye does and misses it. Thus, it is possible that emotional properties of stimuli may overcome inattentional blindness.

Using a similar procedure to the face experiment, Mack et al. (2002) compared post-experimental recognition of a participant's name with both words and non-words. Two superimposed stimuli, one a picture the other a word, non-word or participants name, were presented in rapid succession using the RSVP. Participants were instructed to attend only to the pictures and to ignore the words. The results showed that the participants had recognised their own names to a greater extent than words and non-words. Supporting the uniqueness of the participant's name, no differences were found between the latter two stimulus types. To control for the chance that participants were choosing their name due to familiarity effects, Mack et al. (2002) presented a control group with the same experimental procedure, except that the name appeared only in the recognition list (i.e. not in the

RSVP), none of the participants in this group chose their name. Finally, further supporting the importance of happy faces, Mack et al. found, compared to scrambled faces, happy faces were more perceptible under conditions of stimulus crowding.

This research demonstrates that, while the attentional blink is a robust phenomenon, certain stimuli have the ability to avoid it. This may be conceptualised another way, specifically, neutral unimportant stimuli do not demonstrate the full abilities of the cognitive system and this is only revealed when using salient stimuli. Furthermore, relating these findings back to attentional theory in section 1.2.2, there is a discrepancy between them and the variable bottleneck model proposed by Lavie (1995). This model proposes that under conditions of high attentional (perceptual) load items receive only basic processing, whereas under condition of low perceptual load, stimuli receive fuller, semantic processing. The RSVP task is considered a high perceptual load task and the findings from Mack et al. (2002) suggest that even under high load some stimuli still draw awareness. However, the authors do note that non-noticing rates are still greater on the RSVP compared to the inattentional blindness paradigm, which lends support to Cartwright-Finch and Lavie's (2007) findings. Therefore, it may be suggested that finding what stimuli are exempt from filtering and what individual differences may moderate this is an important area for future research. The conclusion drawn from Mack and Rock (1998) is that meaning may mediate the allocation of attention, and thus conscious awareness. Mack et al. (2002) go further to suggest that, before attention is engaged, a stimulus is perceptually analysed for meaning and, as with the inattentional blindness experiments, a face stimulus is able to attract attention when others are not.

1.5 Cognitive Psychopathology and attentional bias to threat in anxiety

The psychological work investigating the human visual system has largely focussed on perceptual and attentional processes within normal human functioning. Another body of literature, however, has focussed on how visual processing is affected by emotion. One particular strand of this research has focussed on how anxiety affects perception and attentional processes. Anxiety is a personality dimension characterised by fear and apprehension of danger in the environment. It is suggested (Edelman, 1995) that anxiety is an evolutionarily adaptive function, which allows the detection of threat in an environment and subsequently, through behavioural response, escape from danger. It is of little surprise, therefore, that there is a large body of literature elucidating this phenomenon. The following chapter outlines the theoretical contributions made by several authors and the experimental procedures used to assess visual (and, where relevant, auditory) responses to threat.

Central to models of emotional disorders is a three-way interplay between physiological arousal, preconscious perception and conscious cognitive processes. The interaction between the three has been of significant debate. Early theories centred on whether emotion precedes cognition (e.g. Zajonc 1980) or, alternatively, does cognition precede emotion (Lazarus, 1982). On the one hand, there is experimental evidence to suggest that a commensurate physically emotional reaction occurs to a subliminally (e.g. not consciously) presented stimulus (e.g. Zajonc, 1980). However, there is also contrary evidence demonstrating that physical response can be mediated by cognitive appraisal (e.g., Lazarus, 1982). Therefore, before examining cognitive theories of emotional disorders, it would be worthwhile exploring theories of emotion from a neurological perspective.

1.5.1 Neurophysiological Theories

LeDoux (1996) proposes two pathways by which visual information is processed. When sensory information, received by the eyes, reaches the thalamus it progresses via two channels. The first channel sends visual information to the primary visual cortex, where it is subsequently processed via the dorsal and ventral streams, reaching the inferior temporal lobe where conscious object recognition occurs. The second channel sends the sensory information to the superior colliculus, which is associated with eye movement and thus attention. However, LeDoux (1996) suggests that the superior colliculus and the amygdala, which is an important neural structure for emotional response, interact. When a stimulus is potentially threatening, interaction between the superior colliculus and the amygdala serve to allocate attention and increase physiological activation. In regards to the neurophysiology of the attentional system and psychological theories of attention, this accounts for the involuntary saccades and endogenous shifts in attention, respectively. As such, it may be predicted that physical and emotional response occurs before a visual representation of the object is achieved. The views of LeDoux (1996), that there are low and high-level pathways to the amygdala, which are responsible for threat detection, are supported by Öhman (e.g. 1996). Öhman suggests that the use of masking studies and physiological measures (e.g. heart rate and galvanic skin response), and behavioural patterns displayed by anxious participants in visual search tasks, confirm that low and high-level pathways, respectively, are active in the detection and perception of fear and which is more pronounced in individuals with elevated anxiety. The model goes further to suggest that the threat the low level threat evaluation system has an reciprocal relationship with physiological systems such as heart rate and adrenaline release. This suggests two interactions. Firstly, if threat is detected, physiological systems will react to produce the fight or flight response. Secondly, if the physiological system is already aroused by threat, the sensitivity of the low level pathway to threat will increase, thus making anxious individuals more sensitive to threat. Öhman also suggests that this processes can occur without the necessity for conscious awareness of the stimulus / threatening object.

Relating back to the findings of Mack and Rock (1998) and Mack et al. (2002), there is reasonable theoretical basis to suggest that factors lower down in the visual chain may contribute to the allocation of attention (i.e. stimulus size). However, the Mack and Rock (1998) studies have limited emotional relevance; with the most compelling evidence suggesting that negative emotional stimuli do not summon attention (i.e. that happy faces break through inattentional blindness to a greater extent than sad faces). The finding that participants in the inattentional blindness experiments are blind to sad faces, in comparison with smiling faces, suggest that at a low level the perceptual system avoids them. If the models proposed by LeDoux (1996) and Öhman (1996) are conceived as accurate, in the inattentional blindness studies, noticing would have occurred via the thalamus-amygdala-cortex route. However, as there was no control for anxiety, the inattentional blindness experiments are unclear. This receives possible support when it is considered that some of Mack and Rock's (1998) participants did notice the sad face. Therefore, consideration of further models of anxiety disorders may help to elaborate on possible mechanisms underlying the allocation of attention to different stimuli.

1.5.2 Cognitive Theories of Emotional Disorders

Early theories of emotional disorders suggest that emotion regulates cognitive processing in a global manner. Beck, Rush, Shaw and Emery (1979) and Beck, Emery and Greenberg (1985) suggest that, in emotional disorders, cognitive schemata operate. These schemata influence perception, attention and memory. As such an anxious person would selectively attend to threatening information and better recall past threatening events, whereas the same would occur for negative information in depression and such biases would not be seen in non-anxious (or depressed) individuals.

On the other hand, Bower (1981) suggests a top-down, associative network approach. Here emotion is characterised by a network with a series of nodes commensurate with that particular emotion. As one node is activated other nodes, incorporating behavioural response and thought patterns, are also activated. Therefore, Bower suggests that memory is the key that governs the influence of emotion on cognition. However, experiments in cognitive psychology have shown that, rather than a global influence on cognition, different, independent functions are affected by different categories of emotion. Williams, Watts, MacLeod and Mathews, (1988; 1997) review evidence that depression causes a bias in memory recall, while anxiety causes a bias in perceptual and attentional processes. For example, in the case of anxiety, Eysenck (1997) suggests that anxious individuals are characterised by a general bottom-up tendency to be hypervigilant. However, there are theories suggesting that, in the case of anxiety disorders, certain types of stimuli and not others may mediate attentional biases. Therefore, before considering the experimental evidence and the experiments employed it would be worthwhile considering the general models (i.e., models that are designed to accommodate a number of anxiety subtypes) predicting the rapid engagement of threat by anxious individuals (e.g., Williams, et al., 1988; 1997) and the models by Eysenck (1997; 2007), Mogg and Bradley (1998), and Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg & IJzendoorn (2007), and additionally, the delayed disengagement hypothesis (Fox, Russo, Bowles & Dutton, 2001).

1.5.2.1 General models predicting the rapid engagement of threat by anxious individuals

Williams et al. (1988) Theory of Emotional Disorders

In line with the information processing approach, more recent models of cognitive processing and emotional disorders emphasise the intricate influence of emotion on different aspects of cognition. Williams et al. (1988, 1997) propose a two-stage model that accommodates the differences in anxiety and depression. Working from the findings of Graf and Mandler (1984) that perceptual and semantic priming in implicit memory paradigms affect post-presentation recall, regarding anxiety the model works as follows. After stimulus input there is, at a pre-attentive (and therefore perceptual) level, an affective decision mechanism (ADM). This mechanism assesses the emotional valence (or threat value) of the stimulus. The next stage of the model is the resource allocation mechanism (RAM); based on the output of the ADM, the RAM controls the allocation of processing resources (in the case of anxiety, attention). If the threat value is high, attention is oriented towards the stimulus; if threat value is low, attention is oriented away from the stimulus and current goals are pursued. Therefore, the model accounts for the general finding that anxious individuals selectively attend to threatening objects. Further, it is suggested that state anxiety (acute, transient anxiety) is associated with pre-attentive judgements. Trait anxiety, on the other hand, is associated with the allocation of attention. Therefore, elevated state and trait anxiety will cause an individual to more frequently assess even mildly threatening objects as dangerous or harmful and subsequently orient towards them.

For non-anxious participants, the model predicts that the two options of the RAM (towards or away from threat) are reversed so that they orient their attention away from threat and towards neutral or positive stimuli (see figure 1.1). While evolutionarily speaking this suggestion is counter-intuitive, the findings from Mack and Rock (1998) that inattentional blindness increases for sad (negative) faces support this hypothesis, again if it is assumed that they were testing low anxious individuals. Furthermore, it may be suggested that, unwittingly and without explicitly controlling for anxiety, they have tested this claim. However, the face stimuli used in the inattentional blindness studies are, in terms of social anxiety, important stimuli. Their effect on participants with different levels of anxiety has produced varied findings. The various findings from the cognitive psychopathology literature are discussed in the proceeding sections. Their impact on inattentional blindness studies is discussed at the end of the experimental evidence sections.

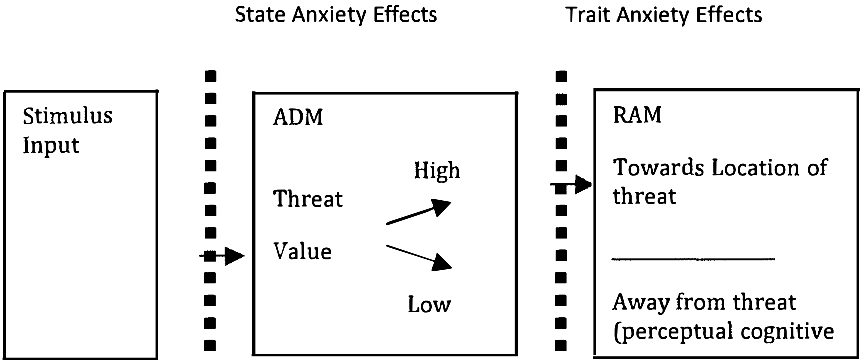

Figure 1.1 Williams et al. (1997) model of attentional bias in anxiety

Williams et al.'s (1997) Parallel Distributed Processing adaptation of the model for anxiety

In relation to anxiety, Williams et al. (1998) remodelled their cognitive model of attentional bias in to a Parallel Distributed Processing model (PDP). This model suggests that certain aversive stimuli have a higher resting activation level (i.e., the cortical stimulation they produce), which makes them more likely to be brought into conscious visual processing by highly anxious individuals. For example, in the case of the current investigation, a spider would have a higher resting activation level than a flower in a spider phobic individual. The model would predict that the spider phobic would be more likely to see the spider than the flower. Therefore, essentially, the model makes the same predictions as the

Williams et al (1988) model described above. Specifically, that anxiety causes a bias in the attentional system whereby anxious individuals detect threatening objects in their visual environment.

The Mathews, McIntosh and Fulcher (1997) and Mathews & McIntosh (1998) models

The Mathews et al. (1997) and Mathews and McIntosh (1998) models are functionally similar to the Williams et al. (1988) model in so far as they predict that anxiety leads to the rapid engagement of threatening stimuli by anxious individuals and so will not be described in great detail here. However, these models go further to suggest that if the stimulus is sufficiently threatening, the attentional response of rapid detection will be displayed by non-anxious controls. Therefore, this model, unlike the Williams et al. (1988; 1997) models suggest that increased anxiety causes the lowering of a "threat threshold" and makes anxious individuals more sensitive to milder levels of threat.

Beck and Clark (1997) model

Again, this model is similar to that of the Williams et al. (1988; 1997) models in that it suggests that preattentive mechanisms lead to the rapid and preferential allocation of visual processing resources to threatening objects. However, the model goes further to predict that, subsequent to threat detection, memory systems are activated in response to the stimulus and, like the Öhman (1996) model, physiological arousal increases.

1.5.2.2 Eysenck's (1997) hypervigilance model and the Eysenck et al. (2007) attentional control theory

Eysenck (1997) proposes that anxiety's major function is to detect and respond to threat in the environment. Eysenck's model was the first to suggest anxiety's specific effect on the perceptual and attentional systems (although, the model also predicts specific threat recall in the memory systems). Working from an evolutionary perspective on anxiety, it is suggested that perception and attention, in both the auditory and visual modalities, serve to alert us to threat in the environment. Anxiety's effect on the perceptual and attentional systems is to make them more active, which leads to the three predictions made by the model. These relate to neutral stimuli and hypervigilance, the interpretation of neutral and ambiguous stimuli, and reactions to definite threat.

Firstly, the model predicts that anxiety generally will make people more vigilant for new (i.e., stimuli that have rapidly entered the visual field) or novel (e.g., unexpected or unusual stimuli) in the environment. This, it is suggested, manifests itself in making anxious people more distractible generally, leading them to become aware of new stimuli regardless of their emotional valence. This prediction would lead to, for example, a socially anxious individual rapidly noticing the addition of a bird in their visual scene, even though that object is not related to the specific anxiety disorder. Secondly, the model predicts that anxious people are more likely to interpret emotionally vague stimuli as objects of potential threat. For example, the spider phobic individual rapidly detecting a piece of tangled black cotton on a light carpet and responding to it as if it were a spider (e.g., increased heart rate, galvanic skin response etc.). Thirdly, the model predicts a heightened sensitivity to specific threat. For example, the bird phobic individual more rapidly detecting birds in their environment, compared with an individual without a specific fear of birds.

The more recent attentional control theory was created to account for more recent findings that the disengage component of visual attention is affected by anxiety (see section 1.5.2.6). The model is functionally similar to the 1997 hypervigilance model in terms of rapid detection, however, in line with the suggestions of Posner and Petersen (1990), the model suggests that the higher-level disengagement component is also affected. Therefore, the original hypervigilance model proposed by Eysenck has been updated to account for the suggestions of Posner and Petersen (1990) that the attentional system is comprised of subcortical (i.e., the engagement component) and cortical (the disengage component) systems, and provides a more holistic view of attentional processes in anxiety.

1.5.2.3 The Cognitive-Motivational Analysis (Mogg & Bradley, 1998)

The cognitive motivational view suggests that, because the Williams et al. (1988; 1997) model predicts low anxious people will orient processing resources away from threat, which is, as suggested earlier, evolutionary unreasonable, there must be other factors involved in attentional bias to threat. Furthermore, Mogg and Bradley (1998) suggest that previous models have not accounted for the combined effects of depression and anxiety, which have a high co-morbidity rate. To address this question, they propose a two-stage model, which accounts for a multidimensional array of factors. Importantly, the Valence Evaluation System (VES) and the Goal Engagement System (GES) reflect motivational states. The VES operates on a bi-polar analysis system, where the stimulus is judged as having high or low threat value. The GES operates on a similar bi-polar dimension reflecting, at one end, external goal engagement, and at the other, external goal disengagement. This allows for the model to account for differences in attentional bias between anxious and depressed individuals. Further suggestions predict that anxiety is characterised by a tendency to judge stimuli as threatening (influenced by state and trait anxiety) and be externally focussed (e.g. looking for threat), whereas depression is characterised by low external goal engagement, as found on a probe-detection task assessing the effects of depression on attentional bias to threat (Bradley, Mogg, Millar & Bonham-Carter, 1997). Therefore, similar to the Williams et al. (1988; 1997) models, anxious individuals will appraise more stimuli as threatening and react accordingly to them and depressed individuals will not react in the same manner (i.e. attentional shifting to threat) due to their lowered motivational state (see figure 1.2)

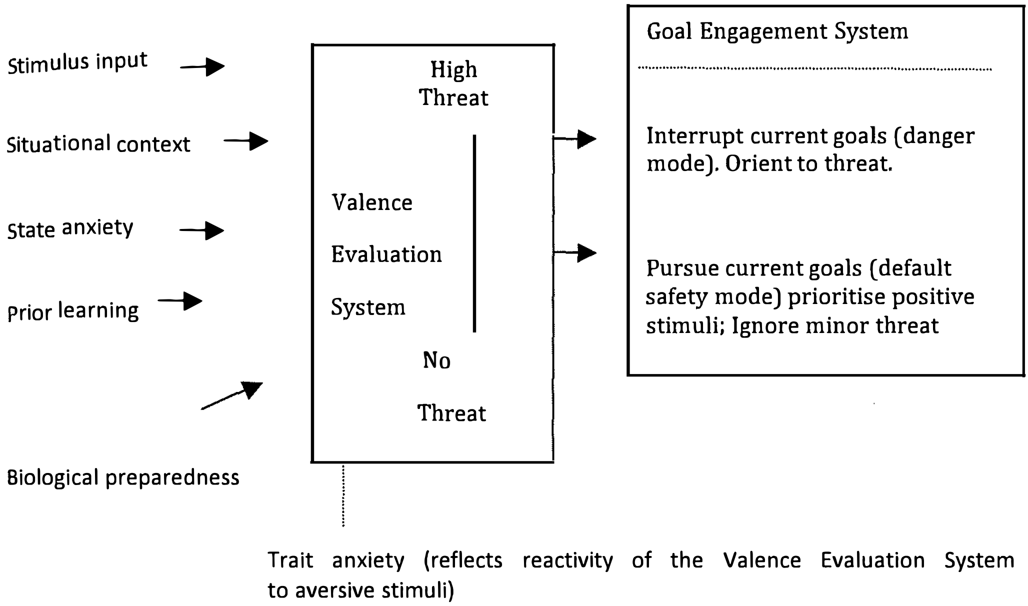

Figure 1.2. The cognitive motivational model of attentional bias in anxiety, adapted from Mogg and Bradley (1998)

The VES resembles Williams et al.'s (1988; 1997) ADM and evaluates the threat value of the stimulus at a preattentive level. However, there are a number of other factors that influence the high threat – low threat judgement. The VES accounts for levels of current state and trait anxiety and the nature of the stimulus input. So, for example, if stimulus threat value is high and state anxiety is high it will be more likely to be appraised as threatening. If stimulus threat value is low and state anxiety is low, it will be more likely to be appraised as non-threatening. Trait anxiety has an overall effect on the judgements made by the VES, which allows the model to account for the interaction between trait anxiety and the judgements made about stimulus type and state anxiety.In the example above, if state anxiety and stimulus threat value were low, we would not expect a high trait anxious person to react with a fear response (i.e. attentional engagement). However, if there is a dynamic interaction of state anxiety high and stimulus threat value low, we might expect to see an attentional engagement response for high trait anxious individuals. On the other hand, if state anxiety was low but stimulus threat value is high, the model predicts attentional engagement (in the absence of marked depression). Other factors that have been taken into account are biological preparedness, this allows for the model to account for the 'quick and dirty' (Mogg & Bradley, 1998. P. 812) response to danger, suggested by LeDoux (1996), thus, allowing for attention to threat in low anxious individuals. Prior learning is included, which suggests that attentional bias to objects may be caused by learned through observation of others (e.g., observing parents responses to threatening objects). Finally, situational context refers to the readiness of the VES to appraise stimuli as being threatening. For example, the VES would be more likely to appraise a small spider as threatening in countries where spiders have poisonous venom in comparison to countries where they do not. The goal engagement system resembles the RAM of the Williams et al. (1988; 1997) model. As suggested, in the case of anxious individuals, they will orient their processing resources (i.e. attention) to the threatening stimulus.

1.5.2.4 The Hybrid Bar-Haim et al. (2007) model of attentional bias to threat in anxiety

The Hybrid model of Bar-Haim et al. (2007) suggests that, similarly to the previous models, at the earliest stage of processing, a Preattentive Threat Evaluation System (PTES) operates and unconsciously evaluates a stimulus for threat values. If threat value is low, the Resource Allocation Mechanism (RAM) remains inactive. However, if threat value is high, the RAM allocates cognitive resources (i.e., initially attention) and physiological functioning (e.g. the fight or flight response) in order to facilitate action (e.g., escape). These two processes are in line with the previous accounts.

The Bar-Haim et al. (2007) model proposes two further mechanisms: the Guided Threat Evaluation System (GTES) and the Goal Engagement system (GES). The GTES reflects the influence of top-down processes such as situation; memory and beliefs about ones own self-efficacy. If this system judges threat to be low, it feeds back to the RAS and equilibrium is restored. However, if threat value is judged to be high (i.e. the person believes that they cannot cope with the situation/object) current goals are terminated and processing resources are allocated to the target. Thus, this model differs in so far as it goes further to account for the top-down influence on attentional allocation.

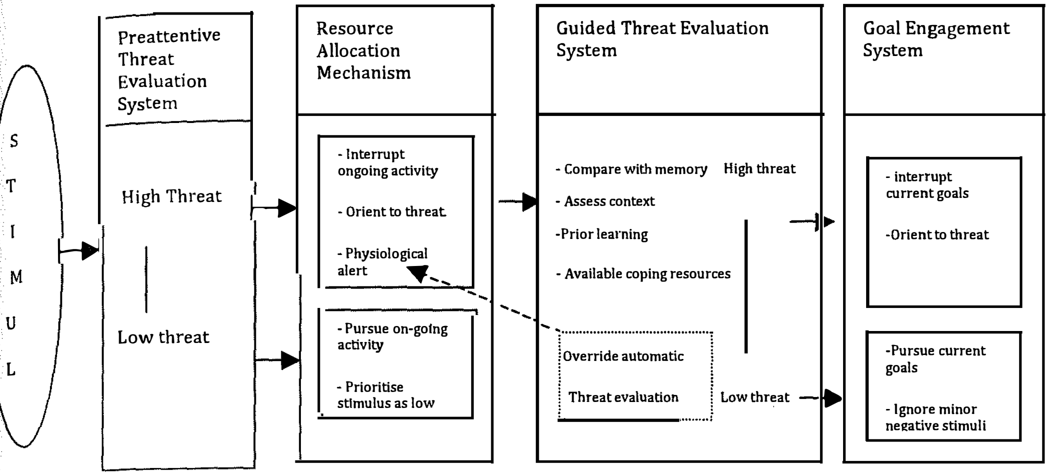

Figure 1.3. Bar-Haim et al (2007) model of attentional bias in anxiety

The Bar-Haim et al. (2007) model can account for the behaviour of, for example, spider phobic individuals in the following way. At the first stage the perceptual system of the spider phobic will "pick-up" a spider on a wall across the room from the individual. Subsequently, conscious processing resources are allocated to the spider; so far the model's predictions are in-line with those of Williams et al. (1988; 1997) and Mogg and Bradley (1998). However, at the next stage the GTES utilises top-down resources to further evaluate the threat value. Here two predictions can be made. Firstly, the individual may evaluate the spider as being harmless and furthermore across the other side of the room, which would mean that coming into contact is highly unlikely. In this case, physiological arousal will decrease and the individual will continue with their current activity. This would account for how many spider phobic individuals know that their fear response is irrational. However, if, for example, the person believes that their coping resources are low, attention will be reallocated and, while the model does not explicitly account for overt behaviour, presumably, in the case of anxiety response, behavioural avoidance will occur (Edelman 1995).

1.5.2.5 Delayed Disengagement Hypothesis

The delayed disengagement hypothesis draws from the work of Posner and Peterson (1990), which suggests that attention is comprised of stages, reflecting shifting towards a stimulus, engaging it and then disengaging from it. Fox, Russo, Bowles and Dutton (2001) suggest that traditional experiments are unable to differentiate between these processes and, thus, may reflect anxious participants not being able to disengage attention from a threatening stimulus, rather than the participants demonstrating facilitated engagement. This recent development in the literature is explored further in the experimental evidence section. Additionally, how the "traditional" experiments contribute to this hypothesis is also considered.

1.5.3 Summary of and comparison with inattentional blindness research

The cognitive models of emotional disorders have focussed on two types of disturbance: depression and anxiety. Early models predicted that emotion governs cognition in a global manner, affecting a number of cognitive functions. More recent models, however, have focussed on how depression and anxiety affect intricate cognitive functioning. Depression, it is suggested, affects recall and elaborative processing. Anxiety, on the other hand, is suggested to affect perception and attention. In the case of anxiety, the models proposed by Williams et al (1988; 1997), Mathews et al. (1997), Mathews and McIntosh (1997), Mogg and Bradley (1998) and Bar-Haim et al. (2007) have in common a preattentive affective decision mechanism. It is suggested that this mechanism operates at a subconscious level and its output influences the allocation of attention, which brings the stimulus to consciousness. Thus, all of the models predict that anxious individuals see more threat relevant objects in their environment. The models diverge on how different types of anxiety disorders (e.g. Generalised Anxiety Disorder, Social Phobia, Simple/Specific phobia) and different levels of anxiety (i.e. state and trait anxiety) affect these perceptual and cognitive biases. Additionally, the models also have in common the suggestion that the person is engaged in a goal and that attention is taken away from this when threat value, as assessed by capacity free preattentive mechanisms, is high.

In reference to the inattentional blindness literature, it is suggested that these studies have eliminated attention and thus have brought perception under more rigorous experimental control. Furthermore, this evidence has progressed far enough to allow suggestions that certain stimuli (i.e. faces and the participants name) are perceptually analysed and meaning is the attribute these features have in common. However, this literature does not explicitly suggest any threat element to be involved. Indeed, a study using noxious stimuli (Wayland & Levin, 2005) did not find that attention was allocated to any greater extent than non-noxious stimuli, and comparatively did not summon attention to a greater degree than positively valenced facial stimuli. Likewise, negative faces did not draw attention to any greater extent than a non-emotive stimulus. Similarly, a person's name, while having subjective meaning, and presumably a high rate of subjective frequency, is also a sign that possible danger might be approaching (e.g. a parent who calls out their young child's name when s/he is getting closer to a busy road). Thus, the cognitive psychopathology and inattentional blindness literature are estranged on the level of perceptual analysis that occurs, and what factors contribute to the drawing of attention and this seems like a critically important question on several levels. Firstly, it may help to clarify the features of the natural world that claim attention, possibly because of biological or evolutionary salience. Secondly, by considering these research domains together, it may help to further knowledge on the precise nature of anxiety and perception and attention's role in the disorder. Finally, such questions may advance understanding of the broader questions of why and how the brain allocates limited resources to incoming stimuli in affective states such as trait anxiety.

1.6. Experimental Evidence for Perceptual and Attentional Biases in Anxiety

The models outlined above suggest broadly that stimuli considered threatening by anxious individuals would be prioritised by the perceptual and attentional systems, making them more rapidly detectable. This processes leads to heightened awareness of threat by anxious individuals and greater exposure to threat. A range of experimental methods has evaluated this process that fall broadly into two categories. Supraliminal studies are used to assess conscious (attentional) processing biases, whereas subliminal studies are used to assess unconscious (perceptual) processing biases. The literature from these two areas will now be considered.

1.6.1 Supraliminal Exposure Studies

Supraliminal studies investigate conscious (attentional) visual responses to threatening stimuli. From these, inferences are made about perceptual activity (e.g., the ADM in the Williams et al (1988; 1997) models and VES in the Mogg and Bradley (1998) model). Three dominant paradigms have been used (the Emotional Stroop, the probe-detection task and the visual search task) as well as some additional peripheral measures that have received more limited use. These studies will now be considered in sections 1.6.1.1, 1.6.1.2, 1.6.1.3, 1.6.1.4, 1.6.1.5 and 1.6.1.6 respectively. The studies outlined below assess a number of different anxiety disorders (e.g., spider phobia, social phobia) and heighted levels of state and trait anxiety in general populations. While it may be possible that different anxiety disorders are characterised by different patters of visual processing, the models outlined above treat them in a uniform manner. Therefore, the proceeding sections will consider evidence from a range of different anxiety types. However, as suggested in 1.1, certain anxiety types will not be considered unless particularly relevant to methods of assessing attentional bias to threat.

1.6.1.1 The Supraliminal Emotional Stroop

The emotional Stroop has been the most widely used test in the cognitive psychopathology literature. Williams et al. (1997) review over forty-nine studies using the paradigm with different categories of anxiety-disordered patients, people with high-trait anxiety and controls (e.g., Mogg, Mathews, Bird, McGreggor-Morris, 1990 in high trait-anxious individuals under negative mood induction procedures). Of these, only three failed to find significant between-group differences. The emotional Stroop is a variation of the original Stroop paradigm (Stroop, 1935). In the original version, participants are presented with a list of words each representing a particular colour (e.g. 'RED') and presented in different colour inks. The participant's task is to name the colour in which the words are presented.

When the word and colour are the same, participants have no difficulty naming the colour. However, when the word and colour are incongruent (e.g. *Red* presented in yellow) there is response latency, and participants typically take longer to name the colour.

The emotional adaptation of this paradigm, used to explore attentional biases in anxiety disorders, involves exchanging the colour words for threatening words (e.g. 'cancer'). The general finding is that anxious participants take longer to name an emotionally salient word than either controls (between-participants design) or neutral words (within-participant design). These results have been found in high trait anxious individuals (Fox, 1994). Similarly, Richards and French (1990) found attentional biases towards threat words presented centrally but not parafoveally (i.e., outside foveal focus). Consistent findings have also been demonstrated for spider related words in spider phobic individuals (Watts, McKenna, Sharrock & Trezise, 1986). That is, spider phobic individuals demonstrated colour naming reaction time latency when spider words were presented. Similarly, Richards and Millwood (1989) found significant group differences between individuals scoring high and low on a trait anxiety inventory and Mathews and MacLeod (1985) found that patients currently being treated for anxiety were more sensitive to threat words (i.e. displayed longer response latencies) than were controls matched for age and gender. However, using facial stimuli, van Honk, Tuiten, de Haan, denHout and Stam (2001) found no bias for threatening faces in trait anxiety at supraliminal and subliminal exposure times, when trait anger was controlled for.

Lundh, Wilkstrom, Westerlund and Ost (1999) found supraliminal Stroop interference in patients with Panic disorder and co-mobrid Agoraphobia. Similarly, Lundh and Ost (2001) and Amir, Freshman, and Foa (2002) found Stroop interference in socially phobic individuals for social threat words (e.g., foolish). More recently, Wilkstrom, Lundh, Westerlund and Hogman (2004) found within-group differences in the response lag times for snake phobics on snake related words in comparison to neutral, spider, and mushroom words. Additionally, they found that the control group were also slower to name the colour when snake words were presented, thus suggesting that the effects may not be specific to anxiety. Similarly, Constantine, McNally and Horning (2001) were unable to detect a specific bias towards snakes in snake phobic individuals. They found that 'Bunny' (p.763) stimuli caused the same response latency as snakes.

Specifically regarding spiders, Lavy & Van den Hout (1993), and Thorpe and Salkovskis (1997) found spider phobic participants displayed colour naming latencies for spider related pictures and words. However, Olatunji, Sawchuk, Lee, Lohr, & Tolin (2008) found that, for spider phobic individuals, spider words only caused interference when participants were exposed before hand to a spider. *However, these participants also showed greater Stroop interference for non-spider related words. These results suggest that both spider words and spider images cause attentional bias and this effect can be caused by the presence of a feared object (i.e., a spider).*

In more general anxiety states, firstly, Russo, Whittuck, Roberson, Dutton, Georgiou and Fox (2006) found that highly trait anxious individuals were slower to name high threat words in comparison to low anxious controls (between-groups) and low threat words (within-groups). Additionally, emotional Stroop interference has also been found in individuals low in anxiety. Lee, Lim, lee, Kim & Choi (2009) conditioned a hypothesised fear response for certain words in participants by using mild electric shocks and found that they were slower at naming the colour words were presented in when that word was associated with the electric shock in comparison to non-feared words. Supporting the suggestion in the introduction that Obsessive Compulsive Disorder (OCD) should not be considered because of the lack of specific stimulus type and because of the more abstract nature of the disorder (Constantine, McNally & Honrig, 2001), Moritz, Fischer, Hottenrott, Kellner, Fricke et al. (2008) found no Stroop interference in OCD patients.

1.6.1.2 Methodological criticisms and theoretical contribution and Summary

The finding that anxious participants take longer to name the colour when a word is threatening is taken as evidence that anxious individuals preferentially allocate their attention to threatening stimuli. However, when relating findings from the emotional Stroop back to the various theories a number of issues are apparent. In relation to the models suggesting the rapid engagement of attention by a threatening stimulus, due to low-level neural processes, a number of issues are present. Firstly, the majority of Stroop tests involve the presentation of word stimuli. The quick and dirty pathway would not process this type of stimulus rapidly, because words in themselves are not threatening (i.e. it is the semantic meaning of the word that holds threatening connotations, which requires higher level processing). Furthermore, the test is not able to differentiate between what element of the stimulus has drawn attention first, because both stimuli (i.e., the word and the colour) are presented simultaneously and subsequent response is irrelevant to this aspect of the test (Fox et al. 2001).

Similar suggestions can be made in relation to the hypervigilance model proposed by Eysenck (1997) and Eysenck et al. (2007). As Fox et al. (2001) suggest, stimuli (i.e. word and colour) in the emotional Stroop are task relevant and presented within foveal vision. As such, there is no index as to whether participants have been hypervigilant. Furthermore, Fox (1994) found that, when threat words were presented away from foveal vision, no Stroop like effects were present, 'thus arguing against the notion that anxiety is characterised by a hypervigilance of the attentional system' (Fox et al., 2001. P.683).

In relation to the models proposed by Williams et al. (1988; 1997), Mathews et al. (1997), Mathews and Fulcher (1998), Mogg and Bradley (1998) and Bar-Haim et al. (2007) the task is unable to effectively discriminate between preattentive processes and attentional mechanisms. That is, there is no evidence that the threatening stimulus has drawn attention first. Furthermore, the results are open to a number of different interpretations. Mogg and Bradley (1998) suggest that heightened physiological response, due to the threatening stimulus, may be responsible for the delay in output. However, Wilkstrom et al. (2004) found no evidence of increased physiological reaction to negative stimuli presented during subliminal and supraliminal Stroop tests. That is to say, the negative image did not elicit increases in heart rate or galvanic skin response, which are typical physical reactions when exposed to threat.

Regarding the suggestions of Williams et al. (1997), that the delayed effect may be due to post-attentive processes such as self-referent activity or memory activation, a number of points can be made. The combined vagueness of their model, and the Stroop after the initial allocation of attention, leaves a wide array of possibilities as to why anxious people display a word output latency. It could be due to post-attentive cognitive processes, however, the test does not rule out the possibility that attention has been held on the threatening stimulus. In line with this, Fox et al. (2001) suggest the findings from the Stroop may be better conceptualised as delayed disengagement.

To summarise, the ambiguity of the emotional Stroop leaves open the question of whether threatening stimuli have the ability to rapidly summon attention. Likewise, the effects may be due to delayed disengagement, rather than rapid orienting. If the Stroop is due to delayed disengagement, the robustness of its finding across stimuli and anxiety subtypes lends considerable indirect support for the suggestions of Fox et al. (2001).

1.6.1.3 The Supraliminal Probe-detection Task

The supraliminal probe-detection task has gone some way to overcoming the difficulties of interpreting the Stroop. In a traditional probe-detection task, participants are required to look at two words or pictures, displayed either horizontally or vertically on a computer screen, and detect a probe when it replaces one of them. The time taken to locate the probe is regarded as a measure of where visual attention is allocated. Rapid detection of the probe reflects attention being allocated towards the image the probe replaced; long detection times infer attention has been allocated to the apposing side to where the probe was presented (Williams et al., 1997; Mogg & Bradley, 1998).

The emotional probe-detection task follows the same experimental format. However, the two stimuli differ in their emotional valence. In the case of testing individuals with anxiety disorders, one stimulus is neutral (e.g. the word 'banana' or a picture of a banana) whereas the other word has an emotionally negative meaning (e.g. inadequate, or a picture of an angry face). Using word stimuli, MacLeod, Mathews and Tata (1986) presented neutral and negative words for 500ms. They found that, in the case of anxious participants, they were faster to detect the probe when it replaced a negatively valenced word. Control participants, on the other hand, displayed the opposite bias, which suggests that this group were orienting their attention away from the threatening stimulus.

Using word stimuli, Xi, Jie & Mingyi (2004) found socially phobic participants attended preferentially to threat works when under a social evaluative task. Similarly, but without the need for a negative mood induction procedure, Asmundson and Stein (1994) examined the pattern of attentional allocation in participants with generalised social phobia. With exposure rates of 500ms, they found that all participants responded to all word types at comparable rates. Additionally, the socially phobic group showed a non-significant trend towards detecting probes faster than control participants regardless of position or preceding word type. However, the study is limited for a number of reasons. Firstly, there was no probe discrimination task (e.g. : VS . . or E VS F), as suggested by Mogg and Bradley (1999). The probe discrimination task is used to counteract the possibility that, if attention is allocated in the opposite location to the probe, participants may still quickly detect the probe by using their parafoveal vision to locate and respond to it. In asking participants only to respond to one of two types of probe, participants are required to discriminate between two visually similar objects, which requires foveal vision. Therefore, to respond accurately, participants will have to reallocate their attention, which will increase the reaction time and give a more precise indication of immediate attentional allocation.

Supporting the suggestion that facial stimuli may be more efficient than words at capturing the attention of socially phobic individuals, Pishyar, Harris, Menzies and Ross (2004) found no significant difference in response latencies between high socially anxious participants and controls towards threat words. However, when photographs of faces were employed, socially phobic individuals preferentially oriented their attention towards threatening stimuli, as compared to neutral stimuli; controls showed the opposite pattern. In a measure designed to further elucidate the effect, a second series of experiments used pictures of the participants own face paired with a threatening or neutral face. This experiment was designed to assess whether socially anxious individuals are more likely to direct attentional resources towards themselves in negative social situations. The findings showed the same effect as the first pictoral experiment. Briefly, in a follow-up to their 2004 study, Pishyar, Harris, Menzies and Ross (2008) found detection biases for socially threatening words and faces using probe-detection tasks. The biases, however, were ameliorated by Cognitive Behavioural Therapy administered in group settings.

It has been suggested, however, that socially phobic individuals do not display the same attentional bias as other anxiety disorders. This is because socially phobic individuals may not wish to engage in social interaction. Mansell, Clark, Ehlers and Chen (1999) found this using a probe-detection task where facial expressions were presented with neutral objects at an exposure time of 500ms to a group of clinical social phobic individuals. In a comparison between high and low social phobia, they found that individuals high in social phobia oriented their attention away from emotionally valenced facial expressions (positive and negative) but only when they were subjected to a stressful mood induction procedure, instructing them that they were required to give a speech, where psychologists would rate them on their ability (that is to say, they were more avoidant of facial expressions during activities where social judgements are made). Without the mood induction procedure, the authors found a general effect of emotion on the allocation of attentional resources to positive and negative faces. However, Sposari and Rapee (2007) failed to replicate this finding, and found that social evaluative mood induction procedures lead socially phobic individuals to attend to faces, regardless of their emotional valence (i.e., towards positive and negative emotional expressions).

Similarly to Sposari and Rapee (2007), Mogg, Philippot and Bradley (2002), using a probe-detection task with exposure durations of 500ms and 1250ms, found that, in the 500ms condition, individuals with clinical social phobia oriented towards negative faces, in comparison with neutral faces; a pattern not reflected in the non-clinically anxious group. This finding is supported by Garner, Mogg and Bradley (2006) in a study using eye tracking (and not the probe-detection paradigm[1]) but only when a social evaluation mood induction procedure was used, and the effect was generally emotional (i.e., the participants oriented their attention to positive and threatening facial expressions). The results of the 1250ms condition showed no significant differences on a within or between groups basis for the engagement of threatening stimuli. However, these findings have been replicated in high-trait anxiety by Bradley, Mogg, Falla and Hamilton (1998). Similarly, with regard to emotional facial expressions and high-trait anxiety, Fox (2002) found that, using a supraliminal probe-detection task study (500ms) highly anxious individuals demonstrated avoidance from happy faces and increased vigilance for threat faces. Furthermore, this was more pronounced in the left visual field of participants, indicating a right-hemisphere dominance. Low anxious individuals did not show the same bias and were generally more vigilant for faces irrespective of emotional valence. Similar results were reported by Mogg and Bradley (1999) However, recently, Lee and Knight (2009) found a general vigilance-avoidance pattern for emotional faces in older adults (mean age 71.8) despite varying levels of trait anxiety; the younger adults did not display vigilance for threat in either anxiety group. These latter two studies are considered further in section 1.6.2.4 in the subliminal probe-detection task.

Responses to faces have also been investigated in more general anxiety states. Firstly, Mogg, Bradley and Hallowell (1994) found a bias for faces at 500ms in high trait anxious students under examination

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[1] Although the experimental set-up was similar to the probe-detection task (i.e., two pictures placed side by side).

stress. Similarly, Bradley, Mogg, White, Groom and de Bono (1999) found that Generalised Anxiety Disorder (GAD) patients displayed a bias towards threatening faces at 500ms, as measured by Reaction Time (RT) data, but a bias towards positive (and not threatening) faces at 1250ms. These findings were partially supported by Mogg, Millar and Bradley (2000) but only in initial orienting by GAD patients, as indicated by eye-tracking data, but not RT data. The presentation of the latter two studies highlights a difficulty with the probe detection task that becomes apparent when it is combined with eye-tracking measures.

There are further discrepant findings between RT and eye-movement data when measuring anxiety. Bradley, Mogg and Millar (2000), found that medium to high levels of state anxiety produced and attentional bias to threatening faces, and that this was specific to threat and not sadness. Furthermore, the results indicated that, rather than a general emotionality effect, state anxious individuals avoided positively valenced faces. This work was again supported by the use of eye-tracking data. However, in this case the authors suggest that, for the majority of participants, shifts in attention were covert (i.e., they did not direct their gaze to the negative [or neutral or positive] picture) but the RT data confirm the direction of attention due to the faster RT times for threatening faces. This represents a further difficulty with using eye tracking in combination with the probe-detection task. While the authors suggest that covert shifts were operating, and therefore, eye tracking was not possible, it is still unclear from the RT data whether this was initial orienting or, as the Eysenck (1997) model proposes general increased vigilance which, in the case of this study, would have resulted in faster detection of the probe in the anxious group.

As suggested earlier in section 1.3.3., shifts of attention operate in two ways, either covertly or overtly. Covert shifts in attention operate rapidly and are independent of eye-movement; this shift of attention is more rapid. Overt shifts in attention occur more slowly and include movement of the eye (Banich, 2005; Posner & Peterson, 1990). As highlighted above in relation to Mogg, et al. (2000), this makes the use of eye-tracking equipment in the probe-detection task unreliable because, in traditional experimental formats, the pictures are sufficiently close as to allow either image to be seen through covert shifts.

To overcome this difficulty, Cooper and Langton (2006) used a probe-detection task with an stimulus exposure rate of 100ms, which eliminates covert shifts in attention but still allows for conscious, attentional processing. They found a non-significant trend for participants to orient towards the angry face and away from the neutral face; this pattern of results was reversed at 500ms. In a happy – neutral face pair, there was a similarly non-significant trend towards the neutral faces at 100ms but this was reversed at 500ms. Although these findings lack statistical significance, the authors' hypothesise that the relative ambiguity of the neutral faces, in relation to happy and angry faces, may be responsible for the effect. For example, in the angry – neutral pair, the neutral stimulus is the least threatening, thus demonstrating a bias towards the negative at 100ms. However, in the happy-neutral pair the neutral stimulus is, relatively speaking, the more threatening of the two. However, their study used emotional facial expressions and, while they suggested that anxiety is not their main purpose, it is not to say that anxiety did not affect the results: the lack of screening for anxiety does not eliminate the possibility of anxiety effects and, when using emotionally valenced stimuli, this can be considered an important control. A similar argument has been proposed by Fox (2002) in the case of neuroimaging studies that have not controlled for anxiety and have produced differential findings.

It is important to note that for socially phobic individuals the pattern of attentional allocation appears mixed. As Cooper and Langton (2006) suggest, 500ms allows for a switching of attentional resources between positions on the display and this may account for the discrepant findings between Mansell et al. (1999) and Mogg et al. (2002). This issue has been highlighted by Fox et al. (2001) who point out that the probe-detection task does not measure the engage component of attention, but rather the disengage component. It is also possible to suggest that the methodological limitations associated with the probe-detection task might be exacerbated by the nature of the phobia. For example, while the initial response might be the detection of threatening faces by the visual system, a subsequent avoidance of the face (i.e., that person) might be required to avoid social interaction.

Attentional bias has also been studied for threatening scenes, rather than specific phobic stimuli (e.g., faces) in high and low trait anxious individuals. Firstly, Yiend and Mathews (2001) found no association between trait anxiety and attentional allocation to threatening scenes. This finding was not supported by Mogg, Bradley, Miles and Dixon (2004). Examining attentional response to threatening scenes containing pictures of injury and blood, they found that, at 500ms exposure times, individuals with heightened trait anxiety were faster at detecting probes replacing high but not low threatening scenes in comparison with low trait anxious individuals. However, the Mogg et al. (2004) are incompatible with the view that low trait anxious individuals should orient to threat if it is sufficiently high. Mogg, McNamara, Powys, Rawlinson, Seiffer and Bradley (2000) investigated the attentional allocation pattern of high and low trait anxious individuals to black and white and coloured scenes of high and low threat in a 500ms probe-detection task. These scenes were not traditional stimuli associated with a particular phobia, but ranged from military combat (high threat) to newborn babies (low threat). The results for both experiments showed that, on a between-groups basis, high trait anxious people displayed more vigilance for threat than did low trait anxious individuals. However, on a within-groups basis, low trait-anxious individuals still oriented to high threat, in comparison to low threat scenes.

Similarly, Wilson and MacLeod (2003) found a similar effect for faces using a 500ms probe-detection task. By varying facial expressions in graded intensity from low, through moderate, to high, they found that high and low trait anxious individuals both avoided low threat stimuli, but at a moderate level, only high trait anxious individuals oriented to threat. At the highest level of threat, both groups oriented towards threat. The findings from these two studies are suggested to support the Cognitive Motivational account (Mogg & Bradley, 1998) that, while high trait anxious individuals will orient to threat in comparison to low trait anxious individuals, low trait anxious individuals will still orient to threat if the threat is sufficiently high. However, the findings that low trait anxious individuals still orient to threat was not replicated by Yiend and Mathews (2001) and further contested by Koster, Grombez, Verschuere and De Houwer (2006) [500ms]. These studies are not considered further here, or included in table 1.1, as low trait anxiety is not a primary focus of the current thesis. However, both studies support the argument that anxiety causes difficulties in the disengagement component of visual attention, and are considered further in section 1.6.3.

Spider phobia has only received limited attention in the probe-detection literature. Firstly Mogg and Bradley (2006) exposed spider fearful individuals, who were significantly higher in state and trait anxiety and depression than were controls, to images of spiders and non-aversive stimuli for 200ms, 500ms and 2000ms. The results from this supraliminal probe-detection task revealed that, in the 200ms condition, spider phobic individuals exhibited an initial orienting bias. However, the same bias was not found in the 500ms and 2000ms conditions. Furthermore, compared with controls, spider fearful individuals did not show a reaction time latency in the 2000ms condition, which suggests that, at this time interval, the experimental group did not engage in deliberate cognitive avoidance strategies. Similarly, in relation to the 500ms expose time, Wenzel and Holt (1999) found no existence of an attentional bias in spider phobics and blood phobics. More recently, however, Lipp and Derakshan (2005), in a comparison between attentional response to spiders and snakes found that, at 500ms exposure, attentional bias was found for spider phobic individuals towards spiders, and in people scoring low on the self-report spider phobia scale. Interestingly, no bias was found for snakes in either low or high snake phobia (additional findings were that heightened state and trait anxiety did not cause attentional bias towards the fearful images). The results, therefore, of an attentional bias towards spider images remains equivocal using the probe-detection task. Additionally, a bias towards snake words was found in snake phobics (Fawzy, Hecker & Clark, 2006). Finally, Harkness, Harris, Jones & Vaccaro (2009) and found that patients with OCD do not display attentional biases using the probe-detection paradigm, supporting the suggestion in section 1.1 that OCD might not have the same cognitive pathology as other disorders; this study is not considered further.

1.6.1.4 Methodological criticisms and theoretical contribution

Methodological criticisms

The emotional probe-detection task overcomes some of the pitfalls associated with the emotional Stroop. Firstly, the experimental procedure eliminates output bias because the critical stimulus is an inanimate object, which requires the pressing of a button rather than verbalisation. Secondly, the process is more focussed on visual attention, due to detection of the probe, rather than possibly measuring post-attentive processing. Like the emotional Stroop, findings from the probe-detection task are taken as evidence that anxious individuals selectively orient their attention towards threatening stimuli. However, when considering some of the criticisms of the paradigm, in combination with the theoretical models outlined above, this conclusion becomes less apparent.

Mogg and Bradley (2006) suggest two difficulties are associated with the visual probe-detection task. Firstly, due to the sensitivity of the dependent variable (i.e. reaction time), the probe-detection task is sensitive to 'disruption effects' (p.1249), which may be more pronounced in emotionally disordered individuals. Secondly, although images are preferential to words, they are still not as emotionally salient as the objects or events themselves and, thus, experiments may lack sufficient levels of emotional sensitivity and ecological validity. Additionally, Mogg and Bradley (1999) highlight that emotionally disordered patients' have difficulty in completing long tasks; this is a problem when using the task in clinical studies because patient's attentional processes are likely to fluctuate during the course of the experiment.

The probe-detection task has been criticised on two further counts by Fox et al. (2001; 2002) on the basis that both stimuli are task relevant. In a typical probe-detection task experiment, firstly, participants are shown a central fixation point. Subsequently, two pictures are displayed for 500ms (e.g. one neutral picture, one threatening, presented side by side either horizontally or vertically on a computerised display). Finally a probe-detection task appears which the participant, having detected it, must respond to by pressing a button. Fox et al. (2001; 2002) suggest that in the 500ms duration task, the participant is able to attend sequentially to both stimuli, while engaging one for a longer duration. This can take one of two patterns depending upon which stimulus is attended to first. For example, if, as models of cognitive psychopathology suggest, the threatening stimulus is recognised first, the participant engages this. Then, overcoming delayed disengagement, moves to the second stimulus and processes this. Subsequently, the participant returns to the threatening stimulus and detects the probe. Furthermore, as suggested earlier, until the advent and wide availability of eye tracking equipment, it was difficult to control for where participants were overtly looking, therefore, if saccadic eye movements are included, this adds approximately 400ms (involuntary saccades) to 600ms (voluntary saccades) to the experiment. Thus, the initial allocation of attention to threat appears unlikely given the 500ms limit.

If, on the other hand, the participant engages the neutral stimulus first, attention (and possibly gaze) need only be switched once and then there is disruption to the disengagement process, which is what Fox et al. (2001; 2002) suggest occurs. This reduces the time substantially and appears more plausible. However, it also means that, contrary to what earlier models of attentional bias suggest, the attentional system does not process threatening stimuli favourably compared to neutral or positive images (at least initially). Therefore, it appears that the rapid engagement of attention by threatening stimuli requires further investigation.

Theoretical contribution

With the above criticisms in mind, it is worthwhile relating the findings from the probe-detection task back to the theories of threat processing and attentional bias in emotional disorders. In relation to the models that predict threat detection in the absence of attention, via the 'low-road' (LeDoux, 1996; Öhman, 1996; 2001 [P.954]), the studies using word stimuli (i.e. Asmundson & Stein, 1994; Fawzy et al. 2006; Macleod et al., 1986; Pishyar et al. 2004 [experiment 1]; Wenzal & Holt, 1999k; Xi et al. 2004) can be discounted because, as suggested earlier, words do not have the same low level effects as pictoral stimuli. Likewise, in line with the suggestions of Fox et al. (2001; 2002), studies with an exposure time of greater than 500ms (i.e. Bradley, Mogg & Millar, 2000; Chen et al., 2001; Cooper & Langton, 2008; Fox, 2002; Lee & Knight, 2009; Mansell et al., 1999; Mogg & Bradley, 1999; Mogg & Bradley, 2006 [experiments 2&3]; Mogg et al. 2002; 2006 [500ms experiment]; Mogg et al., 2004; Mogg et al., 2000; Yiend & Mathews, 2001) can be discounted because they are unable to definitively show where attention is initially allocated. This means, of the supraliminal probe-detection task studies discussed here, only the 100ms experiment conducted by Cooper and Langton (2006) and experiment 1 from Mogg and Bradley (2006) are of relevance. However, the results of the spider experiment conducted by Lipp and Derakshan (2005) will be further considered due to the limited probe-detection tasks focussing on spiders. The Cooper and Langton (2006) study shows that in a non-anxious sample, participants initially orient towards threat, thus supporting the suggestions of Öhman (2005) that threatening faces are evolutionarily important. However, this study is not conclusive, as the analyses between threatening faces and other emotional expressions did not reach statistical significance. Lipp and Derakshan (2005), present findings that pertain to spiders having an evolutionary threat basis, as suggested by Öhman (1996) because there was a bias in both high and low fear individuals. Mogg and Bradley's (2006) experiment 1 finding provides more substantial evidence of rapid engagement, the evolutionary basis of the spider image, and biases being more pronounced in anxious individuals. Their findings are supported by shorter presentation times, which reduce the possibility of covert and overt shifts of attention.

In relation to the general hypervigilance model proposed by Eysenck (1997), a similar analysis can be applied. The studies with an exposure time of greater than 500ms are of limited relevance because of time duration. However, the finding from Asmundson and Stein (1994), that anxious participants detected probes faster than non-anxious participants, regardless of stimulus valence, provides support for the model. As does the Mogg and Bradley (2006) study. In the 200ms experimental trials, anxious participants, phobic of spiders, were faster to detect a probe replacing a threatening picture (i.e. a spider) than were low anxious participants. The 200ms presentation speed reduces the possibility that participants were switching attention between the two stimuli. Although, in line with the suggestions of Cooper and Langton, that covert shifts in attention can occur within 100ms, switching between stimuli has not been entirely eliminated. The Lipp and Derakshan (2005) study, however, which specifically controlled for state and trait anxiety found no evidence for general attentional bias associated with either anxiety state.

The models proposed by Bar-Haim et al. (2007), Mathews et al. (1997), Mathews and McIntosh (1998), Mogg and Bradley (1998) and Williams et al. (1988; 1997) share, at the initial stages, the preattentive mechanism similar to the suggestions of Öhman (1996) and LeDoux (1996), and the probe-detection task has already been assessed as having limited relevance. Nevertheless, the studies conducted by Asmundson and Stein (1994), Pishyar et al. (2004) and Wenzel and Holt (1999) can be discounted because they used word stimuli, which may not be effective enough to produce biases (Mogg & Bradley 1998). The 200ms experiment investigating biases towards spider images, in spider phobics (Mogg & Bradley, 2006), does provide some support for the model and is less open to the criticism of attentional switching.

While the studies conducted by Fox (2002), Mogg et al. (2002), and Pishyar et al. (2004) provide some support for the suggestions of LeDoux (1996) and Öhman (2005) – that there is a low level fear detection system – there is additional evidence from the probe-detection that is contrary to these hypotheses. For example, Chen et al. (2001) and Mansell et al. (1999) found that social phobic individuals oriented away from threatening faces. Here two issues become apparent. Firstly, it can be suggested that the discrepant findings for social phobic individuals may reflect inadequacies in the probe-detection task. If the suggestions of Öhman (1996) and LeDoux (1996), and the commensurate experimental findings, are correct, then it may be the case that social phobic individuals did orient towards threat, but by the time the probe appeared, they quickly avoided it. Secondly, as suggested earlier, in the studies with positive findings, they still do not show conclusively if the social phobic group initially oriented towards threat.

Because of the 500ms exposure times, the findings from these studies need to be considered in relation to the delayed disengagement hypothesis. Firstly, negative findings can be discounted because they show neither rapid engagement nor delayed disengagement (i.e. Mogg & Bradley, 2006 [500ms]; Wenzel & Holt, 1999). In the case of studies using exposure times of greater than 500ms (i.e. Mogg & Bradley, 2006 [2000ms]; Mogg et al., 2002 [1250ms]), these studies are also unable to show delayed disengagement because inspection of mean disengagement times for participants in the Fox et al. (2001; 2002) studies show that disengagement takes approximately 380ms. For the studies showing rapid engagement of a probe replacing a negative stimulus (Fox, 2002; Lipp & Derakshan, 2005; MacLeod et al., 1986; Mogg & Bradley 2006 [200ms]; Mogg et al. 2002 [500ms]; Pishyar et al. 2004), these studies can be interpreted as the presence of delayed disengagement biases in anxiety. However, of these, the studies that tested social phobia contrast with other studies testing social phobia that did not find a bias. A similar argument to the one made in relation to the models of Williams et al. (1988; 1997) can be offered. If, as suggested by the theories of Öhman (1996) and LeDoux (1996), and the partial evidence from Cooper and Langton (2006), then it may be the case that social phobic individuals rapidly engaged the threatening face and subsequently disengaged from it, with relative ease and within 500ms. This suggestion is difficult, however, to reconcile with the evidence presented by Fox et al. (2001). Therefore, further investigation of both rapid and delayed disengagement is required, particularly the rapid engagement of social phobics attention by negative facial expressions, because it directly impacts upon delayed disengagement.

To summarise, findings from the probe-detection task provide limited support for lower level theories of threat detection. Likewise, because all stimuli are task relevant and presented simultaneously, there are only limited inferences to be drawn regarding Eysenck's (1997) hypervigilance model. The substantial models proposed by Williams et al. (1988; 1997), Mogg and Bradley (1998) and Bar-Haim et al. (2007) accommodate some of the findings. However, their generality leaves alternative explanations possible. The suggestion that anxiety is characterised by delayed disengagement is partially supported by findings from the probe-detection task. However, in the case social phobia and spider phobia, there are discrepant findings requiring reconciliation. Visual search tasks have gone some way to resolving the issues present in the probe-detection task literature and will be considered next. Table 1.1 presents a summary of the findings from studies using the probe-detection task.

Table 1.1. Summary of Probe-detection task studies discussed in this thesis and the findings

Authors and Date	Exposure Time	Group	Stimuli	Sig. Bias towards threat
Asmundson & Stein (1994)	500ms	Social Phobia	Words	No
Pishyar et al. (2004) Experiment 1	500ms	Social Phobia	Words	No
Pishyar et al. (2004) Experiment 2	500ms	Social Phobia	Faces	Yes
Pishyar et al. (2008)	500ms	Social Phobia	Words	Yes
Pishyar et al. (2008)	500ms	Social Phobia	Faces	Yes
Chen et al. (2001)	500ms	Social Phobia	Faces	No
Mansell et al. (1999)	500ms	Social Phobia	Faces	Yes[1]
Sposari & Rapee (2007)	500ms	Social Phobia	Faces	Yes[2]
Fox (2002)	500ms	Social Phobia	Faces	Yes[3]
Mogg et al. (2002) Experiment 1	500ms	Social Phobia	Faces	Yes[3]
Mogg et al. (2002) experiment 2	1,250	Social Phobia	Faces	No
Bradley et al. (2000)	500ms	State Anxiety	Faces	Yes
Lipp & Derakshan (2005)	500ms	State and Trait anxiety	Snakes and Spiders	No
Mogg & Bradley (1999)	500ms	Trait anxiety	Faces	Yes
Mogg et al. (2000)	500ms	Trait anxiety	Threat scenes	Yes
Wilson & MacLeod (2003)	500ms	Trait anxiety	Faces	Yes
Yiend & Mathews (2001)	500ms	Trait anxiety	Threat scenes	No
Lee & Knight (2009)	500ms	Older adults & Trait anxiety	Faces	Yes[4]
Lee & Knight (2009)	500ms	Young adults & Trait anxiety	Faces	No
Bradley et al. (1998)	500ms & 1250ms	High Trait anxiety	Faces	Yes (only at 500ms)

Bradley et al. (1999)	500ms	GAD	Faces	Yes
Bradley et al. (1999)	1250ms	GAD	Faces	Yes[5]
Lipp & Derakshan (2005) Spider experiment	500	Spider phobia	Spiders	Yes
Lipp & Derakshan (2005) Snake experiment	500ms	Snake phobia	Snakes	No
Mogg & Bradley (2006) Experiment 1	200ms	Spider Phobia	Spiders	Yes
Mogg & Bradley (2006) Experiment 2	500ms	Spider Phobia	Spiders	No
Mogg & Bradley (2006) Experiment 3	2000ms	Spider Phobia	Spiders	No
Wenzel & Holt (1999)	500ms	Blood and Spider phobia	Words	No
Cooper & Langton (2006)	500ms	NAC	Faces	No
Cooper & Langton (2006)	100ms	NAC	Faces	No

Notes:

[1] Not when social evaluative mood induction procedures were used

[2] When social evaluative mood induction procedures were used

[3] Bias more pronounced in left visual field.

[4] In both high and low trait anxious older adults

[5] Bias also towards positive faces

1.6.1.5 The supraliminal visual search task

Visual search tasks (e.g., Hansen & Hansen, 1988) require participants to locate a particular stimulus from an array of distracters. If the time to find the stimulus increases as distracters increase, participants are engaging in serial search. However, if detection time is independent from the number of distracters, participants are suggested to be engaging in automatic parallel search. In the case of individuals with increased anxiety, differences in detection between neutral and negative stimuli are used to examine perceptual and attentional processing biases. If anxious individuals are faster than non-anxious people to locate negative stimuli (or faster to detect negative, in comparison to neutral stimuli), it is suggested that they have a preattentive (parallel) processing bias towards threatening information. If, on the other hand, anxious participants are slower to detect a neutral stimulus in an array of negative "distracters", they are suggested to have an attentional bias towards threat. As such, results from visual search paradigms are directly relevant to models of perceptual and attentional bias anxiety disorders.

Many variants of the visual search task exist, although experiments differ on what stimuli they use, what anxiety types they examine, the amount of distracters and, crucially, whether they display a target before hand. Rinck, Reinecke, Ellwart, Heuer and Becker (2005) suggest that the differences between studies presenting and not presenting a target stimulus beforehand result in two different paradigms. When the target stimulus is presented prior to the task, the experiment is called target search. Where there is no prior presentation, the experiment is known as the odd-one-out paradigm. This is because, in the latter, the participant is required to discriminate all of the stimuli on the screen (e.g., between smiling and frowning schematic faces) on the basis of a distinguishing feature. In the former, however, they are instructed to match one of the stimuli with one they are shown, or discriminate on a more categorical basis (e.g., distinguishing between and spider and a mushroom). In addition, Rinck et al. (2005) suggest that the visual search tasks provide a way of examining the delayed disengagement hypothesis. Distraction effects, caused by threatening distracter stimuli, may reveal whether anxious participant have difficulty disengaging attention. However, this is only achievable in studies that have employed eye tracking. The current discussion will follow the distinction provided by Rinck et al. (2005). Where studies have not provided a picture but have instructed participants to find a specific target (for example, a spider from an array of other stimuli) they will be categorised as target search, because the participant is still looking for a specific stimulus and not to see whether one differs from the others. Studies not using prior targets will be described as odd-one-out experiments.

The first reported visual search task relating to threat detection employed a normative sample of participants. Hansen and Hansen (1988) used an odd-one-out task, where either a happy face or a sad face was inserted into a group of faces with the opposing emotional valence. The results showed that an angry face in a happy crowd was located faster than a happy face in an angry crowd. These results suggest that, in the former case, participants were engaging in parallel search, whereas in the latter case, participants were engaging in slower serial search. The conclusion from this study was that, in normal populations, threat has a superior power to summon attention, a concept known as the "threat-superiority effect". However, this study has been widely criticised, as Juth, Lundqvist, Karlsson and Öhman (2005) point out, low-level visual features may have allowed participants to more easily discriminate the angry face, thus confounding the results. Byrne and Eysenck (1995) replicated the study controlling for the earlier confound with anxious and non-anxious participants. They found that the threat superiority effect was present in all participants but was more pronounced in anxious participants.

Similarly, Giboa-Schechtman et al. (1999) used an odd-one-out task to examine attentional bias in generalised social phobia patients. Each visual display was of one person who, in all but one of the photographs, displayed a particular emotion, whereas in the remaining one displayed an incongruent emotion. The results showed that, for angry compared with happy faces, both groups detected the angry face faster than the happy face. However, a within-group analysis showed that the social phobic group processed angry faces faster than happy faces. Similar findings were achieved with angry and neutral faces in a happy crowd. Regarding distraction, generally individuals with social phobia were more distracted by angry faces than were non-anxious controls. Comparing angry faces with facial expressions of disgust demonstrated a bias towards anger in the socially phobic group. The authors suggested that there is a general threat superiority effect for all participants and, on a between-groups basis, socially phobic individuals did not present a significant threat bias. This bias only became evident on a within-group comparison for the phobic group. Giboa-Schechtman et al. (P.316) suggest that 'angry faces do not appear to "pop-out" at general social phobics'. Rather they suggest that there is an asymmetrical processing style, where anxious individuals take longer to process happy faces. This study, therefore, questions the contribution of preattentive mechanisms and, furthermore, questions whether there is, theoretically, a negative bias to threat, or whether the processing of positive expressions is disrupted.

Using natural facial stimuli, Juth, Lundqvist, Karlsson and Öhman (2005) compared detection rates for happy and angry faces amongst natural distracters in controls, high-trait social phobia, clinical social phobia and with a mood induction procedure. The authors found that, in an odd-one-out study, for natural faces, happy emotional expressions were detected faster and more accurately than angry or fearful faces. This effect was replicated despite a social mood induction procedure, designed to elevate state anxiety, and the use of socially phobic patients who had greater social anxiety. However, the findings were attributed to perceptual differences. This was supported by separate reaction time experiments that required participants to categorise the emotional valence of a schematic face as rapidly as possible. The results showed that, for schematic faces, angry mood was detected faster than happy mood. Subsequently, in a schematic face visual search task, the same participants who detected happy faces in natural presentations displayed a bias for angry faces in schematic presentations. However, this bias was only found for accuracy (i.e. not reaction times) and was more pronounced in the high social anxiety group that were subjected to the mood induction procedure. Furthermore, Juth et al. (2005) suggest that the accuracy bias was not due to better performance for angry faces, but rather due to poor performance for happy faces when they were presented amongst angry distracters; signifying possible delayed disengagement.

The results of the Juth et al. (2005) study again provide little support for rapid engagement of threat in either natural or schematic faces. The bias found for happy expressions in natural faces was attributed to perceptual differences, and possible familiarity effects. The issue here is that the lack of effect for negative faces provides and ecological anomaly, suggesting that in "real world" situations the negative rapid engagement bias is even less pronounced.

In a cohort of socially anxious female participants, Rinck and Becker (2005) used a target search task with word stimuli. The target word was presented before each display and the results showed that, while socially phobic participants were no faster than controls or depressed individuals at detecting socially phobic words in neutral distracters, they were significantly slowed at detecting words that appeared in social phobia related distracters. While this suggests that socially phobic individuals do not rapidly orient to threat a number of considerations need to be made based on the stimuli used in the experiment. Word stimuli (as suggested in relation to both the Stroop and the probe-detection paradigm) may not elicit as strong effects as, for example, pictures of faces that portray differing emotional expressions. The finding that socially phobic people were slower to detect target words when they appeared in social phobia related distracters is reminiscent of the interpretation of the emotional Stroop task, in so far as it is possible that self-referent activity or cued memory retrieval caused the target detection lag. However, it is also possible that the distracter words caused a delay to disengagement of visual attention, as suggested by Fox et al. (2001).

Again using word stimuli, Rinck, Becker, Kellerman and Roth (2003) examined rapid engagement and distraction in individuals with speech phobia and GAD. For both groups they found no enhanced detection of disorder relevant words. However, in the GAD group they found that threat related words (which were varied in specific emotional valence) did cause distraction effects, as evidenced by the slowing down to target detection. This again suggests that self-referential activity, or delayed disengagement might be present in visual search tasks. It is important to note, as Rinck et al. (2003) suggest, that GAD is a disorder characterised by fear and apprehension towards a number of different situations. As such, it may be difficult to test GAD because the disorder is so varied. Similarly, testing with pictures might also prove difficult.

Focussing on spider stimuli, a series of experiments by Rinck et al. (2005) compared the two versions of the visual search task (i.e. the target search and the odd-one-out tasks) with behavioural data (i.e. reaction times) and eye-tracking data. For the target search task, the reaction time data revealed no significant difference between spider phobic individuals and non-anxious controls in detection of the spider images, suggesting that the phobic group did not show facilitated detection. However, when target stimuli were embedded in spider distracters, the spider phobic group took longer to respond to targets, a finding that was supported by significantly longer gaze duration on the spider distracters for the phobic group. These findings contrast with the odd-one out task, where phobics showed facilitated detection. For anxious participants and fearful stimuli, interference effects between experiments were comparable and this was supported by both eye tracking and behavioural measures.

Rinck et al. (2005) suggest that, effectively, because the target search task presented the image before hand, control participants might have been facilitated in detecting the stimulus. It is also possible that prior presentation may have triggered avoidant behaviours in the phobic group, which may have slowed participants. In an attempt to merge the two experiments, Rinck et al. (2005) removed the target presentation from the beginning of the target search experiment. This modification revealed that phobic participants to be faster than controls in detecting the spider image. Regarding distraction, again, when spiders were the distracters, phobic participants took longer to respond to the target and spent more time fixating on spiders. Finally, in attempting to explain the effects of rapid engagement being only present in the odd-one-out task, Rinck et al. (2005) suggest that parafoveal processing in phobics may be enhanced. That is, stimuli presented outside foveal vision, and thus the zone of attention, may be better detected by phobics when they are commensurate with their fear, therefore, implying that preattentive processes may be enhanced in socially phobic individuals. Similar findings were reported by Soares, Esteves and Flykt (2009) in spider phobic and snake phobic participants.

Using a modification of the visual search task, Miltner, Krieschel, Hecht, Trippe and Weiss (2004) conducted a series of experiments investigating attentional bias in spider phobia. The modification involved presenting a distracter target in addition to the critical stimulus. In a series of experiments they found that on a within-groups basis, spider phobics were no faster at locating a spider than they were at locating a (neutral) mushroom. This finding was supported on a between-groups basis; phobic and non-phobic participants did not differ in their response rates to spider or mushroom images. When, however, an additional distracter was presented covertly, the groups showed response latency differences. On a within groups basis, when a spider image was the distracter, spider phobics showed a response latency to the neutral mushroom, as compared to a spider image being the target and the mushroom being the distracter. This finding was supported with between-group comparisons: non-phobic controls did not show the same response latency. The results of this experiment led the authors to conclude that spider images, presented without expectation, are able to draw attention in phobic individuals.

Subsequent experiments provided additional evidence that a spider image was able to attract attention and hold it on the image. The behavioural data replicated the first experiment – spider phobics were no faster at detecting the spider than the mushroom. The additional eye tracking data revealed that, during trial four (mushroom target, spider distracter), on 30% of trials spider phobics initially oriented to the spider. On a further 40% of trials, saccades to the mushroom were interrupted and the spider was brought to foveal vision. These findings were significantly greater than for the control group. Finally, no differences between groups for detecting spiders or differences within groups for detecting spiders and mushrooms, suggest that spiders do not hold a special place in visual processing. However, when these are task irrelevant they appear to distract participants, and there is the possibility that they delay disengagement from them (supported only by the reaction time data). The finding that, on 40% of trials, saccades were interrupted and reoriented towards spiders relates to the suggestions for Rinck et al. (2005) that an image in the parafovea may result in faster detection.

Finally, Miltner et al. (2004) suggest that there is something unique about presenting the spider covertly that enhances detection or significantly interrupts participants. However, the study is open to the criticism that participants were, at least partially, expecting a spider, as they had been tested for spiders on previous trials. It may also have been the case that participants initially thought the spider was the target. These suggestions, however, appear less plausible because the same effect was not found for mushrooms in the phobic group or in the non-phobic group. Additionally, a combination of priming, increased state anxiety and confusion may be possible. The findings, nevertheless, open up the possibility that a spider presented against expectation is particularly able to draw attention, particularly in phobic individuals. This suggestion requires further investigation with more rigorous controlling of expectation and prior knowledge.

Additionally in relation to spiders, Flykt and Caldara (2006) supported Miltner et al.'s (2004) finding that spiders are preferentially processed. This finding was the case for the spider phobic individuals in comparison with the detection of neutral stimuli, however, spiders were also processed faster, in comparison with other neutral objects, by snake phobic and non-phobic participants, suggesting that spider stimuli may occupy a special place in visual processing. However, while the RT times were commensurate with previous studies using the visual search task, the EEG data did not indicate that spiders were processed preferentially by the attentional system, rather they received more elaborative perceptual analysis of the stimulus facilitating the more rapid RT times.

In typical visual search tasks, fearful images (e.g., spiders) are included in arrays of non-feared objects (e.g., mushrooms as used by Miltner et al., 2004). This procedure has been challenged by Lipp (2006) who suggests that biases towards feared objects found in phobic individuals is an experimental artefact of comparing these stimuli with images of non-animal stimuli (e.g., flowers or mushrooms). A series of experiments firstly confirmed that spiders were detected faster than mushroom or flower stimuli, and that flower or mushroom targets were not detected faster when they were included in arrays of non-phobia specific, but hypothetically evolutionarily dangerous stimuli (e.g., wolves). However, for mushrooms, the speed of detection increased when hypothetically non-fearful animals were used (e.g., horses). These results suggest that comparing, for example, spiders with significantly non-threatening items may enhance the effect observed, but such findings do not present an ecologically valid approach. Additionally Lipp (2006) comments that the slowed detection of mushrooms when they were included in feared animals suggests that difficulties disengaging attention from the threatening stimuli, which supports the suggestions of Fox et al. (2001). Lipp (2006) does not report the effects of anxiety status and its interaction with the different stimuli. The contribution made by this paper, therefore, is procedural and it does not give information about anxiety. As such, it will not be included in table 1.2 at the end of this section or discussed further.

In a different adaptation of the visual search paradigm, Pflugshaupt, Mosimann, Wartburg, Schmitt, Nyffeler et al. (2005) used eye-tracking equipment to test the hypervigilance – avoidance pattern of attention. The visual search task involved pictures of typical domestic rooms embedded into which were spiders. After separating their participants into high and low spider phobia, the researchers found that spider phobics were faster to detect spiders (as measured by first accurate fixation). Secondly they found that, after a spider had been attended, the phobic group's next fixation point was further away from the spider than the control group. The authors claim that these findings support the vigilance – avoidance pattern in spider phobia.

The experiments described here suggest that there is little consistent evidence produced by variants of the visual search task. Therefore, an analysis of how the findings relate back to the relevant theories is required. As with the summary of the probe-detection task studies, the lower level and evolutionary theories of LeDoux (1996) and Öhman (1996) will be considered first. Next how the experimental evidence fits with the hypervigilance model proposed by Eysenck (1997) will be assessed. The Williams et al. (1988; 1997), Beck and Clark (1997), Mathews et al. (1997), Mathews and McIntosh (1998), Mogg and Bradley (1998) and Bar-Haim et al. (2007) models will be considered collectively. However, where the models diverge and have specific predictions, these will be considered when relevant (e.g., Mogg & Bradley, 1998). Finally, the compatibility of the evidence with the delayed disengagement hypothesis will be examined. The overall pattern of findings for the visual search task is outlined in table 1.2.

Table 1.2 This table shows the visual search tasks discussed in the thesis, including the type of task, the findings.

Authors and Date	Group	Stimuli	Target search (TS) or Odd-one-out (O)	Target detection (within [W] or between [B])	Distraction effects	Preattentive bias
Hansen & Hansen (1988)	Anxiety not measured	Faces	O	Angry (W)	N/A	Yes[1]
Eysenck and Byrne (1995)	High-trait Anxiety	Faces	O	Angry (B)	N/A	Yes Anxious
Gilboa-Schechtman et al. (1999)	Clinical Social Phobia	Faces	O	Angry (B)	Anxious group	No[2]
Rinck et al. (2005) Experiment 1	Spider Phobia	Spiders	TS	No	Yes Anxious	No[3]
Rinck et al. (2005) Experiment 2	Spider Phobia	Spiders	O	Yes (B)	Yes Anxious	Yes Anxious[3]
Rinck et al. (2005) Experiment 3	Spider Phobia	Spiders	Hybrid	Yes	Yes	Yes[4]
Miltner et al. (2004) Experiment 1	Spider Phobia	Spiders	TS (no prior presentation)	No	Yes (with distracter)	No[5]
Miltner et al (2004) Experiment 2	Spider Phobia	Spiders	TS (no prior presentation)	No	Yes (with distracter)	No[3]
Flykt & Caldara (2006)	Spider Phobia	Spiders	TS	Yes	No	Yes
Rinck & Becker (2005)	Social phobia	SP words	TS	No	Yes (SP words)	No
Rinck et al. (2003)	GAD	GAD words	TS	No	Yes	No
Rinck et al. (2003)	Speech Phobia	Speech Phobia words	TS	No	No	No
Juth et al. (2005) Experiment 1	Social Phobia[6]	Faces (natural)	O	Happy faces (W) (B)	--	No
Juth et al. (2005) Experiment 2	Social Phobia	Faces (schematic)	O	Angry faces (B)	--	No[7]
Pfugshaupt et al. (2005)	Spider Phobia	Spiders	TS natural scene	Spider (BO	N/A	Yes

[1] Confounded by low-level perceptual differences in the angry face

[2] Possible bias against happy faces

[3] Supported by eye-tracking

[4] Conclusion: Controls facilitated by prior presentation

[5] Distraction effects only present when spider was unexpected; localised only to phobics

[6] Same effect for high trait and clinical

[7] Bias only in accuracy, not speed of detection.

1.6.1.6 Methodological criticisms and theoretical contribution

The differences between methodologies and the discrepant findings within them require a systematic consideration of how they relate to theories of threat detection and levels of anxiety. In the case of theories focussing on lower level processes in threat detection and the evolutionary basis of certain stimuli, such as those of LeDoux (1996) and Öhman (1996, 2005), the odd-one-out paradigm has had frequent use and provides the greatest support for these models. Firstly, however, the findings from Hansen and Hansen (1988) shall be eliminated in light of the criticism that low-level perceptual features, rather than the emotional expression, may be responsible for the findings (e.g. Juth et al., 2005). Similarly, Rinck and Becker's (2005) study will not be considered further because of the use of word stimuli. In the case Eysenck and Byrne (1995), the finding of a general threat superiority effect, which is more pronounced in anxious individuals, provides support for the preattentive detection of threat, via the thalamo-amygdala pathway. The finding also meets the suggestions of Öhman (1996, 2005) that this "threat advantage" is present in all individuals and anxiety is characterised by an enhancement or, perhaps, over activation of an adaptive evolutionary mechanism.

Similar support can be found from the odd-one-out experiment conducted by Rinck et al. (2005). This study is supported further by the use of eye tracking and a comparison analysis between the odd-one-out and target search, showing the former had the greatest effect. The suggestion that parafoveal processing may have enhanced detection suggests low-level, preattentive, facilitation. However, this suggestion is not immediately compatible with the findings of Fox et al. (1994) of the suggestions of fox et al. (2001), that negative stimuli presented away from fixation do not affect processing. However, this may have been due to the stimuli used. For example, Fox (1994) used word stimuli, which will not affect lower level processes. Therefore, the specific effects of parafoveally presented pictures on threat detection requires further investigation.

The findings from Giboa-Schechtman et al. (1999) provide partial support for the theories of Öhman (2005) and LeDoux (1996), in so far as there was again a threat superiority effect. However, anxious participants were no better than controls at detecting angry faces, rejecting the notion of enhanced detection in this group. Giboa-Schechtman et al. (1999) suggest that, rather than being facilitated for angry faces, the anxious group showed poorer performance on happy faces. Therefore, it is possible that a poorer processing bias for happy faces may have, incorrectly, been attributed as facilitated performance for threatening faces. These results again require further investigation, particularly to examine whether there are perceptual deficits in detecting happy faces.

In contrast to the Gilboa-Schechtman et al. (1999) study, Juth et al. (2005) found that, across all participants there was a bias for processing happy faces, when natural faces were used. However, Juth et al. suggest that this processing advantage was due to the perceptual differences between faces, which made happy faces easier to detect via bottom-up processes, masking any threat superiority effect. When contrasting the two studies, support for this assertion can be found by the different methodologies used. In the Gilboa-Schechtman et al. study, the same picture of a face was used; all that differed was the emotional expression. In the Juth et al. study different faces where used, which may have, indeed, exacerbated perceptual differences. As such, there is still reason to suggest that the processing of happy facial expressions may be dysfunctional in anxious individuals, rather than a threat superiority effect.

Further arguments against the suggestion of enhanced threat pick-up in anxious individuals come from Juth et al.'s (2005) finding that the bias was only affected the of accuracy for the phobic group, i.e. in identifying and not in rapid detection. Similarly, converging evidence for spider phobia is presented by Miltner et al (2004), who found no within-group differences for spider and mushroom detection and no between-group differences for the phobic and non-phobic participants. The finding that a covertly presented spider draws attention does, however, support the suggestions of LeDoux (1996) and Öhman (2005), that there is a low-level neural system that responds to threat.

The study by Pfugshaupt et al. (2005), however, provides support for the rapid detection of threatening stimuli, which is more pronounced in phobic individuals. In their experiment, which may be considered a variant of the target search paradigm, phobic participants were faster to detect spiders than were non-phobic controls. These findings support the suggestion that phobic individuals are quicker to detect their feared stimulus, and this speeded detection may be facilitated by preattentive, bottom-up, mechanisms. This experiment, however, requires further replication for these assertions to be fully accepted. Furthermore, from the assessment of the visual search evidence, it appears that new experiments are required in order to confirm the models of LeDoux (1996) and Öhman (2005).

The findings from studies using visual search tasks impact on the hypervigilance model proposed by Eysenck (1997) and Eysenck et al. (2007). Firstly, in relation to the odd-one-out studies, as suggested earlier, the original study by Hansen and Hansen (1988) will be omitted due to the confound of perceptual differences, as will the study by Juth et al. (2005) using natural faces. The Eysenck and Byrne (1995) study supports a general hypervigilance model by the finding that anxious participants were faster to detect an angry face in a happy crowd, as do the studies by Rinck et al. (2005) and Miltner et al. (2004) in specific to spider phobic individuals.

The findings from Gilboa-Schechtman et al. (1999) suggest that anxious participants were no faster than controls in detecting targets, particularly negative ones, which, therefore, provides little support for the model. The suggestion that anxious participants perform poorly for positive emotional valence implies that, for these stimuli, perceptual and attentive processes are dysfunctional, arguing against the notion of general hypervigilance. The Juth et al. (2005) study using schematic faces again only provides limited support for the model because the only between-groups difference was found in accuracy and not speeded detection. Finally, in the Miltner et al. (2004) study, they suggest that in target search, anxious individuals, while not significantly so, were slower to detect spiders, when these were presented as the target, which argues against the hypervigilance model. Although, the rapid detection of spider stimuli presented covertly is difficult to reconcile with these findings, particularly in terms of Eysenck's (1997) model. Of the target search tasks, Pfugshaupt et al. (2005) provide the most convincing evidence for hypervigilance. They found that spider phobic individuals were quicker to locate spiders than were non-phobic individuals. However, the experiment used here is considerably different to those used in traditional visual search studies. In a more conventional target search experiment, Rinck et al. (2005) suggest that anxious participants displayed slower detection rates than controls, arguing against the suggestions of hypervigilance.

In relation to the models provided by Williams et al. (1988; 1997), Beck and Clark (1997), Mathews et al. (1997), Matthews and McIntosh (1998), Mogg and Bradley (1998) and Bar-Haim et al. (2007), the results for early, preattentive, detection have been considered in relation to the theories of LeDoux (1996) and Öhman (1979). Therefore, only findings of additional significant importance to other aspects of these theories will be considered here. Of particular relevance is the finding from Miltner et al. (2004), suggesting that covertly presented spiders had a significant effect on phobic individuals. This finding can be readily explained by the Mogg and Bradley's (1998) model. These authors suggest a number of factors influence threat appraisal, one of which being the situational context. If, during Miltner et al.'s experiment, participants were not expecting a spider (i.e. situational context), the appearance of one may have enhanced its detection. Furthermore, the findings from Miltner et al. (2004), that saccades were reoriented away from mushroom stimuli and towards spiders, support preattentive detection and, furthermore, provide strong evidence for the interruption of current goals (i.e. detecting the mushroom) in favour of negative stimuli. The general attentional bias to threat models (e.g., Williams et al., 1988; 1997), and the Mogg and Bradley (1998) and Bar-Haim et al. (2007) models place greater emphasis on the behavioural effects of negative stimuli relative to, for example, the model of LeDoux (1996). The use of distracter stimuli shows that anxious participants are more distracted by threatening stimuli (i.e. Gilboa-Schechtman et al. (1999), Rinck et al. (2005) Miltner et al. (2004) and Juth et al. (2005). These findings support the models' predictions of interrupting task performance. However, it is not specified how they do this or what procedures are in operation. Finally, the findings from Rinck et al. (2005) of disruption effects support the suggestions of Fox et al. (2001) and Fox et al. (2002) that delayed disengagement is occurring in anxious individuals. However, as this was not directly assessed the suggestion is only tentative.

1.6.1.7 Other Supraliminal Paradigms

Despite the popularity of the supraliminal emotional Stroop, probe-detection task and visual search tasks, some alternative methods have been employed for supraliminal studies. Merckelbach, Kenemans, Dijkstra, and Schouten (1993) asked participants to decide whether lines, presented simultaneously with either a picture of a flower or a spider, were horizontal or vertical, as quickly as possible. The results showed that, irrelevant to which stimulus was presented (i.e. flower or spider), spider phobics were slower at reporting the orientation of the lines; a finding that became more pronounced as the trials continued. However, Eysenck (1997) notes that the lack of specificity to spiders may be due to the spatial proximity of the task stimulus. In the Stroop task, response latencies, specific to threat, are found in anxious people. However, when they are presented non-centrally there is a non-specific, generalised delay. This is similar to the suggestions of Fox et al (2001) in relation to Fox's (1994) finding that stimuli presented away from fixation do not produce Stroop effects. That is to say, the results from this method, and the Stroop task, suggest that parafoveally presented stimuli do not produce a delay specific to the phobic image. However, this suggestion stands in contrast to those of Miltner et al. (2004) who suggest that phobic individuals have enhanced parafoveal processing, and notice spiders presented away from fixation. This discrepancy is addressed by the experiments in this thesis.

The suggestions that task irrelevant stimuli do not interfere with processing, particularly when they are presented away from fixation, is supported by Lavy, van denHout and Arntz (1993). An experimental discrimination paradigm involving the presentation of three stimuli (combinations of neutral animals and spiders) showed that, when a spider image was presented, spider phobics were quicker to respond than when neutral images were used. However, when spiders flanked a neutral image, there was no delayed response. The authors suggest that the effect may have been due to the spatial proximity of the flanker images, thus questioning the existence of biased preattentive processing.

An additional method, borrowed from perceptual and cognitive psychology that has received limited use is the change detection paradigm. Change detection studies examine a person's ability to detect changes to attended objects in their visual environment. A number of studies have found that in non-anxious people (or more specifically, without controlling for anxiety) there is a generally poor ability to detect change in the visual scene (Levin & Simons, 1997). Mayer, Muris, Vogel, Nojoredjo & Merckelbach (2006) presented participants with a series of scenes that changed rapidly. In some scenes a spider would begin to appear, whereas in others, a non-fear relevant object was presented. The results showed that, across all participants, spider changes were detected more frequently than non-feared objects. Furthermore, spider fearful individuals detected spiders more frequently than did controls. However, when detection rates were collapsed across all stimuli and participants were divided into high and low trait anxiety, the groups did not differ, which does not support the general hypervigilance model proposed by Eysenck (1997).

Another paradigm, examining the attentional blink (discussed in relation to Mack et al., 2002), has been used to demonstrate that threatening stimuli can be processed to a greater degree than non-threatening stimuli. The rapid serial visual presentation (RSVP) task presents participants with a rapid sequence of images (e.g. at 110ms). On some trials there are two targets, whereas on others there is only one. The participants' task is to identify the targets (i.e. attend to them). In the general literature (e.g. Mack et al. 2002) findings show that, on dual target trials, a participants ability to consciously perceive the second target depends upon where it is presented; the closer the presentation to the first target, the more difficult the target is to detect.

Fox, Russo and Georgiou (2005) used the RSVP task to examine detection of happy and fearful faces in individuals with anxiety. On dual target trials, individuals low in anxiety showed no different detection rates for happy and fearful faces, suggesting the emotional expressions have similar effects. Fearful participants showed comparable rates to low anxious individuals for happy faces at 220ms and 440ms. However, they were able to detect fearful faces more rapidly than low anxious individuals but still showed difficulty at the 220ms presentation. The findings from the study suggest that anxious individuals are able to detect threatening stimuli at a preattentive level but, due to still showing difficulty at the 220ms interval suggests the processing is not completely automatic.

Lee and Telch (2008) used the parafoveal inattentional blindness task (see section 1.4.1) to investigate attentional response to schematic facial expressions in socially phobic individuals. They found that elevated social phobia was associated with higher noticing rates for the critical stimulus when it conveyed a negative expression. The procedure they used is discussed in greater depth in the general method section (chapter 3). However, there are particular problems with their method. Most importantly, the authors recruited participants for their socially phobic status by, firstly, placing internet advertisements explaining that the project was investigating social phobia using the inattentional blindness experiment. This creates a problem because, considering the experimental requirements, the participants will be somewhat primed for socially negative stimuli. Secondly, were recruited from a pool of university students from a psychology department and may have acquired prior knowledge of the paradigm. These factors could have contaminated the findings of the experiment.

1.6.1.8 Theoretical contribution and Summary

It is necessary to examine how these studies relate back to the theories of threat detection and the effects of anxiety on perceptual and attentional processes. The line-judgement task used by Merckelbach et al. (1993) has less impact upon the suggestions of LeDoux (1996) and Öhman (2005) because of its similarity with the emotional Stroop task, i.e. there is no way of examining whether preattentive mechanisms were in operation. The study by Lavy et al. (1993), however, provides some support for "low-road" models: the phobic group were consistently faster at recognising spiders when they were (centrally) presented. However, the finding that participants did not show the expected delay in response to neutral pictures, when they were flanked by spider images, suggests that preattentive / perceptual processes may not be sensitive to threat material. Nonetheless, this finding is at odds with the suggestions of parafoveal processing advantages in the visual search task, as suggested by Rinck et al. (2005). Therefore, it is difficult to assess the contribution this study makes to the suggestions of Öhman (2005) and LeDoux (1996).

It is also difficult to assess the contribution made by the change detection study used by Mayer et al. (2006) because of the influence of prior screening. Although a week between screening and testing, it is possible that the screening primed participants and this caused the enhanced detection rates for spider images. However, there is limited evidence to suggest that spiders were preferentially picked up because of their evolutionary basis. In the case of the Fox et al. (2005) study using threatening and happy faces, the finding that, at a preattentive level, anxious individuals performed better than controls again supports preattentive mechanisms and the evolutionary basis of threatening images, which may be more pronounced in individuals with anxiety.

In the case of the theory presented by Eysenck (1997), the findings from Meckelbach et al. (1993), that phobic participants were slower to name the orientation of the lines when all stimuli were present (i.e. it was not specific to spiders), and the RSVP study by Fox et al. (2005) supports the notion that anxiety is characterised by a general hypervigilance. The Lavy et al. (1993) study suggests that the increased vigilance is specific to salient stimuli in phobic individuals. Similarly, there was no evidence for facilitated detection outside the task zone, which, similar to the suggestions of Fox et al. (2001) in the case of the Stroop, contrasts with the notion of a general hypervigilance. Finally, when Mayer et al. (2006) collapsed their results across all stimuli (i.e. fear relevant and non-fear relevant) and separated their participants into high and low trait anxiety they found no increased detection rates for the latter group, thus arguing against hypervigilance. In short, the diverging evidence on hypervigilance presented here suggests further testing of the model.

In regard to the Bar-Haim et al. (2007), Beck and Clark (1997), Mathews et al. (1997), Mathews and Mclntosh (1998), Mogg and Bradley (1998) and Williams et al. (1988; 1997) the analysis here will relate to the later stages of processing proposed in the models (i.e. the ability of emotionally salient stimuli to interrupt current goals). The Merckelbach et al. (1993) study has the most relevance to this aspect of the models. In their study, while spiders caused a delay in response, it was not specific only to these images, suggesting that anxious individuals are generally disrupted by task irrelevant stimuli. This assertion, however, must be taken with some caution because other evidence from the emotional Stroop (e.g., Wilkstrom et al., 2004) suggests only specific effects. In contrast, however, the Lavy et al. (1993) study suggests that salient stimuli presented away from fixation do not have an effect on processing. Consequently, there are discrepancies as to the effect of different stimuli, presented parafoveally, on anxious individuals and whether salient stimuli do interrupt current goals when presented away from fixation.

Therefore, while there is some evidence for preattentive mechanisms (i.e. Fox et al. 2005; Lavy et al., 1993 [spider presented centrally]), other evidence points towards salient stimuli presented away from fixation not being able to draw attention (Lavy et al., 1993 [parafoveally presented spider images]). This brings into question theoretical models suggesting preattentive detection of emotionally salient or threatening material, and suggestions of an anxiety based hypervigilance system. In particular regard to the suggestions of Öhman (2005), that there is an evolutionarily adaptive mechanism for detecting things detrimental to survival, it seems that detecting objects outside our immediate zone of attention, but within our field of vision, would be evolutionarily adaptive. However, within the studies described here, there are differences in exactly where in parafoveal vision these object are placed, an issue that requires further consideration. These issues are also present in the some of the more traditional paradigms described above. However, consideration of studies designed specifically to examine preattentive biases may shed further light on the role of preattentive processes.

1.6.2 Subliminal Exposure Studies

In contrast to the supraliminal studies presented so far, subliminal exposure studies are designed to investigate subconscious (perceptual) biases towards emotionally salient stimuli. Typically, in subliminal studies, stimuli are presented rapidly (e.g., below 14 ms) and subsequent responses are measured in a variety of ways. For example, in the subliminal emotional Stroop task response lag is measured for the colour presented. In the probe-detection task the speed of probe engagement is measured. In auditory studies, conscious recognition of words and psychophysiological measures are taken (e.g., galvanic skin response). Before each of these is considered, the concept of perceptual defence will firstly be discussed.

1.6.2.1 Perceptual Defence

Perceptual defence experiments involve presenting stimuli for very brief periods, below the consciousness threshold, and systematically increasing exposure time until are consciously recognised. Typically, in normative samples it takes longer for threat words to be recognised in comparison to neutral words, and anxiety is said to be a lowering of perceptual defence (Williams et al., 1997). However, it is also suggested that rather than not-perceiving the word, participants are reluctant to output them until they are certain they have occurred (Minard, 1965).

The perceptual defence hypothesis can be interpreted in light of the findings from the inattentional blindness studies. Specifically, Mack and Rock (1998) found that while a happy face reduced inattentional blindness, the same did not occur for a sad face (i.e. inattentional blindness remained at similar levels to that of basic geometric objects). Furthermore, a distorted face reduces inattentional blindness to a greater degree than the sad face. If it is assumed that a face is an important stimulus, it is it conceivable that a perceptual defence mechanism operating to inhibit perception of (albeit, perhaps mildly) threatening stimuli. This converging evidence serves to undermine the suggestion that participants are reluctant to output what they have seen until they are certain. Additionally, any possibility that participants were reluctant to output the stimulus because they did not wish to say they had seen something negative can also be rejected because, in the first instance, the post experimental questions did not require participant to say what they had seen, only that they had seen something additional on the screen. Thus, while it is possible, it is unlikely that participants will have been reluctant to say they did not see anything. Therefore, the evidence from the inattentional blindness experiment may suggest that anxiety is characterised by a reduction in perceptual defence. It might also be appropriate to speculate that this reduction is due to increased activation of the thalamo-amygdala pathway. That is to say, low-level neural circuitry is the mechanism that controls perceptual defence, if activation in this area increase, there will be a lowering of the perceptual defence mechanism. This would allow for more mildly threatening stimuli to be brought to conscious processing, which would, in turn, increase exposure to the stimulus, thus maintaining anxiety states.

However, as Mack and Rock (1998) did not control for anxiety, it is difficult to say if this is possible. It is the purpose of this thesis to examine the interaction between anxiety and inattentional blindness in more detail.

1.6.2.2 Perceptual biases in the auditory modality

In the auditory modality, a key early paradigm in the subliminal literature is the dichotic listening paradigm. Dichotic listening experiments involve presenting a different message to different ears. The participant is required to attend to one message and ignore the other, to ensure that participants are listening only to one ear they are required to shadow (i.e. repeat aloud) the attended message, thus the allocation of attention is controlled. Mathews and MacLeod (1986) combined this with a traditional probe-detection task to explore dual modality attentional response. The results from the experiment showed that, when threat words were presented to the unattended ear, anxious participants were slower at detecting the probe that was presented on the probe-detection task. Furthermore, the authors report that, while the performance on the dot probe task was poorer for anxious participants when threat words were presented, these participants did not consciously hear the words. These results are similar to those found by Corteen and Wood (1973). However, these results appear to contradict the model proposed by Williams et al. (1988; 1997), in so far as this model predicts that when threatening stimuli are noticed preattentively the Resource Allocation Mechanism (RAM) allocates attention to them. However, it is also suggested that rather than attention shifting, participants have some level of attentional control, which stops salient stimuli breaking through, but attentional resources are still depleted and task performance drops. This contradiction shows that the models proposed by Williams et al. (1988; 1997) may be too simplistic.

Mogg and Bradley (1998), however, suggest that, in the dichotic listening experiments, it is not clear if attention did not briefly switch to the stimulus and then switch back. This suggestion highlights two possibilities. Firstly, the participants have a response bias and are reluctant to output the word because of the fear it induces. Secondly, if attention means conscious awareness (e.g. Mack and Rock.

1998), it is possible they rapidly forgot what they had heard. This latter suggestion may support the claims of Wolfe (1999) that inattentional blindness is better conceptualised as inattentional amnesia. Nevertheless, the findings do support the suggestion that preattentive mechanisms are sensitive to threat in the auditory modality.

1.6.2.3 The Subliminal Emotional Stroop task

The Subliminal Emotional Stroop procedure involves changing the paradigm so that the word or picture is presented subliminally, while the colour remains on the screen. This procedure involves the serial presentation of coloured slides, with a word in the centre that is masked after, for example, 14ms. In regards to face stimuli Putman, Hermans and van Honk (2004) found that anxious participants are slower to name the colour than controls, when masked threatening faces were displayed. However, in the case of this experiment, it is possible that participants knew that they were being tested for anxiety and this may have served to lower a person's perceptual threshold, permitting conscious recognition. Mogg and Bradley (1998) suggest that checking post-test recognition and eliminating from the analysis any participants who consciously perceived the items controls for this. Contrary evidence however is provided by Wilkstrom et al. (2004) who found that words presented below an objective threshold level did not elicit the expected colour naming latencies in snake phobic participants, and increasing levels of state anxiety did not affect this. It is likely in this case that words do not produce the same effect as images, as words in themselves are not threatening. However, evidence from the subliminal probe detection task confounds this suggestion.

1.6.2.4 Subliminal Probe-Detection Task

The subliminal probe-detection task uses the same experimental set-up as the supraliminal version, however, as with the subliminal Stroop, a mask is used to cease processing of the presented pictures and words. The assumption, similar to that of the supraliminal version is that, if participants detect a probe rapidly when it replaces a threatening stimulus, visual attention (due to preattentive processes) has been allocated in this direction.

Firstly, using masked word stimuli, Mogg et al. (1994) found that trait anxious individuals were faster to detect a probe that appeared in the place of a masked threat word (14ms) than were low anxious controls. Using facial stimuli, Fox (2002) presented high and low anxious groups with threatening and happy emotional expressions for 17ms. The results showed that the high anxious group showed a greater vigilance (i.e. were faster to detect the subsequent probe) when it was preceded by an angry facial expression. Relating to hemisphere dominance, a within-participants analysis of the high anxious group revealed that the bias was more pronounced in the left visual field, suggesting a right hemisphere dominance. Fox (2001) suggests that two factors support these findings. Firstly, while not statistically significant, a comparison between supraliminal (see Fox, 2002 in section 1.6.1.2) and subliminal experiments revealed a stronger effect for subliminal presentation. Secondly, a case study of a patient with hemi-neglect showed that, while pictures of fruit and neutral facial expressions showed higher levels of extinction, emotionally valenced expressions were more likely to be reported, suggesting that emotional facial expressions received preferential neural processing, in the absence of awareness. Similarly, Lee and Knight (2009) found that both high and low trait anxious older adults (mean age 71.8) displayed a bias for emotional faces presented at 20ms. This finding supports the suggestions of Öhman (2005) that threat is preferentially processed preattentively.

Similar findings have been reported by Mogg and Bradley (2002) in regard to social phobia. In this study, threatening faces were presented with neutral faces below conscious awareness. The findings showed that high social anxiety was associated with a bias towards threatening stimuli. Moreover, this was more pronounced for images presented in the left visual field, again suggesting right hemisphere dominance in the preconscious detection of threat. Similar findings to those of Fox et al. (2002) and Mogg and Bradley (2002) have been reported in spider phobic individuals (Van denHout, Tenny, Huygens & de Jong, 1997), although these authors did not measure hemisphere dominance.

Therefore, although the work on subliminal detection of threat is not as substantial as the work on supraliminal studies, the evidence for preattentive mechanisms is contradictory and requires further exploration.

1.6.2.5 Theoretical Contribution and Summary of Subliminal Studies

The work on subliminal exposure times is considerably more limited than the supraliminal work in the field of cognitive psychopathology. The hypothesis that a perceptual defence system operates to protect individuals from mildly threatening stimuli, and that anxiety is associated with a lowering of perceptual defence has been substantiated by subliminal paradigms. However, there are some general issues in regard to the literature. Firstly, it is apparent that, while the studies appear to be pre-attentive, this suggestion is based on reports made by participants in the study. For example, due to consciousness thresholds varying, (e.g., the ability for a stimulus to pass through preattentive processing levels and reach consciousness varies on a number of factors including the properties of the stimulus, the subjective state of the individual and interactions between the two) post-experimental checking is required, as suggested by Öhman (2005). If an experimenter asks the participant if they saw, for example, the spider, two possible factors might affect response. Firstly, due to a Hawthorne effect (e.g., Diaper, 1990) the participant may respond negatively, thus giving a false-positive response. Secondly, the nature of the experiment (i.e., the experimental instructions) may exaggerate the lowering of the consciousness threshold because the participant is informed that the study is about, for example, spider phobia. Due to their higher levels of fear, this might be more pronounced in the experimental groups (this analysis is possible for all of the experimental procedures described above). Therefore, while there is a suggestion that pre-attentive affective decision mechanisms operate, and serve to allocate attention to threatening stimuli, as the models described earlier (e.g., Williams et al., 1988, 1997; Mogg & Bradley, 1998), much of the evidence for this could be an experimental artefact. This analysis is similar to that provided for the visual search task, i.e., that prior indication that a stimulus will appear may advantage phobic individuals.

Therefore, further studies assessing preattentive processes without the limitation of alerting the participants to the possible appearance of their feared object are required.

1.6.3 Evidence for Delayed Disengagement

The delayed disengagement hypothesis (e.g., Fox et al. 2001) stands in contrast to models proposing rapid engagement of attention by threatening material. While the major strand of research in the areas of anxiety and cognitive psychopathology have focussed on how stimuli are initially processed by the perceptual and attentional systems, a more recent direction has looked at how the attentional system responds beyond initial draw. Working from the suggestions made by Posner et al. (1978) and Posner and Peterson (1990), Fox et al. (2001) propose that the emotional Stroop and probe-detection tasks do not show whether attention is rapidly drawn initially by a salient object or whether once attention is drawn, anxious participants have difficulty disengaging their attention from the stimulus. Fox et al. (2001) conducted a series of experiments in order to test the hypothesis that anxiety is characterised by delayed disengagement of threat relevant stimuli. The first experiment presented high and low state anxious individuals with a series of images. Each presentation involved three boxes presented horizontally, the central of which had a fixation cross. The left and right boxes contained the cues on the second trial and probe on the fourth. The first trial, presented for 1000ms, served as a fixation point. The second presentation, for 100ms, had either a positive, neutral or negative word cue in the boxes towards the left or right of the fixation point. The third trial, presented for 50ms, masked the previous presentation and the fourth trial contained the probe in the left or right box. Valid presentations involved presenting the cue and target in the same position; invalid presentation involved presenting the target in the apposing box to the cue.

The results from the first experiment showed that, for both high and low state anxious individuals, when a threat word was presented, participants took longer to find the cue in the invalid condition. This suggests that threat related information delays disengagement from that spatial location. The failure to find differences between the high and low state anxious groups was attributed to a failure in the mood induction procedure. Experiments two and three replicated the first but replaced word stimuli with schematic faces. The results revealed that response latencies for the high anxious group, in invalid cue trials, were greater when angry faces were presented, in comparison with neutral or positive faces. The results of experiment four confirmed that the findings were due to delayed disengagement rather than the salient stimuli affecting motor response. Experiment five involved a verbal response to a letter presented after a negative, neutral or positive word and again confirmed the delayed disengagement hypothesis. Similar findings have been reported using the Posner spatial cuing paradigm in a number of anxiety disordered groups, including high-trait anxiety (Loster, Crombez, Verschuere, Van Damme & Wiersema, 2006; Yiend & Mathews, 2001), social phobia (Amir, Elias, Klumpp, & Przeworski, 2003) and variations of the probe-detection paradigm (Salemink, van den Hout & Kindt, 2007) and using the RSVP task and facial expressions of disgust (Cisler, Olatunji, Bumi, Lohr & Williams, 2009).

Further work by Fox, Russo and Dutton (2002) found that, additional to angry faces, happy faces produced the same delayed disengagement. As such it is possible that there is a general emotionality effect, whereby emotional stimuli affect the attentional system irrespective of a positive or negative valence. This suggestion is supported by the suggestions made by Gilboa-Schechtman et al. (1999), who propose that, particularly in social phobia, positive social signals such as a smile might be perceived as mocking. Furthermore, generalising across paradigms, Fox et al. examined how the inhibition of return (IOR) response is affected by threat faces. IOR reflects an attentional mechanism where, when one area of visual space has been attended, attention returns to a central position and the original area has a lower priority in subsequent visual processing, thus inhibiting return to that location.

While the experiment was not able to distinguish between high and low trait anxious groups, the hypothesis that validly cued target detection would be facilitated because the IOR response would not be activated, due to the threatening stimulus, was confirmed. Finally, when a jumbled angry face was included in the IOR experiments, it produced comparable results to an angry schematic face in its regular configuration, suggesting that there may be some low-level visual feature that causes the effect, which supports the suggestion that anxiety causes a bottom-up processing bias of the visual system.

Georgiou, Bleakley, Hayward, Russo, Eltiti and Fox (2005) conducted a series of experiments examining whether delayed disengagement occurs for fearful and sad faces. It was discovered that fear, but not sadness, was associated with delayed disengagement, which was more pronounced in highly anxious participants. As fear is considered to symbolise potential threat to a greater extent than sadness, the results of this experiment confirm that it is threat and subsequent fear causes delayed disengagement. These findings lend support to the proposals for an evolutionary basis of anxiety and the superiority of threatening objects in our visual environment (e.g., Öhman, 2005).

Finally, there is clinical evidence suggesting that anxiety leads to difficulties disengaging attention from threat, and that this disruption to the attentional system preserves anxiety states. Schimidt, Richey, Bunker and Timpano (2009) found that providing attentional retraining therapy to socially anxious individuals, to enable them to more rapidly disengage attention from threatening faces, produced a reduction in DSM-IV-TR (APA, 2000) symptoms, which was still present at 4-months. Similar findings were reported by Amir, Taylor, Elias, Beard, Klumpp, Burns and Chen (2009) in generalised social phobia.

1.6.3.1 Theoretical contribution and summary of evidence for delayed disengagement

The delayed disengagement hypothesis, therefore, suggests that heightened anxiety may be better characterised by difficulty diverting attention away from threatening stimuli, rather than the rapid detection of stimuli. Much like the suggestion that attention being drawn initially to threat in our environment can cause and maintain increased anxiety (e.g. Williams et al., 1997), delayed disengagement may have a similar effect, albeit through different means. For example, while it may be the case that anxiety is maintained by increased exposure to the feared stimuli, rapid engagement theories suggest that this is quantitatively based (i.e., that anxious individuals are exposed to *more* threatening stimuli). The delayed disengagement theory suggests that increased exposure is more qualitatively based. That is to say, once the object is attended, the prolonged exposure time means that the individual is exposed to the image for a longer duration.

It is also important to note that as both an alternative to the rapid engagement theory or as an additional hypothesis, the suggestion that anxious people "lock on" to the threatening image does not fit with current evolutionary explanations of anxiety and fear. The evolutionary suggestion for anxiety and fear is that it facilitates escape from danger. A cognitive mechanism that, effectively, prolongs exposure to an image, which may result in a delay in escape, is not evolutionarily adaptive. Finally, while the evidence presented for delayed disengagement converges across a number of paradigms, it requires further experimental validation and theoretical formulation, as the hypothesis is still relatively new and is contrary to evolutionary reasoning.

1.7 Hemispheric asymmetries in visual processing and attentional bias in anxiety disorders

As suggested in section 1.2.1, there are hemispheric asymmetries in the processing of visual information. It is suggested that post V1, the right hemisphere is specialised for general vigilance across both visual fields. However, this processing is more global and less detailed, with the left hemisphere processing the constituent parts of an object. It has also been documented in both the cognitive psychopathology literature (Fox, 2002, Mogg & Bradley 2002) and in the more general neuropsychological literature (e.g., Compton, Hekker, Banich, Palmieri & Miller, 2000), that anxiety may affect the cerebral hemispheres differently. Specifically, Fox (2002) and Mogg and Bradley (2002) found that, using the supraliminal and subliminal versions of the probe-detection task, anxious participant's attentional bias towards threat was more pronounced to stimuli appearing in the left visual field. From this it was inferred that there is a right hemisphere mediates attentional bias to threat. Additionally, Compton et al. (2000) found, using an emotional stroop task with word stimuli, that across all participants there was a left hemisphere advantage for naming the colour, however, when colours were presented in conjunction with threatening words to the right cerebral hemisphere, all participants were slower to name the colour, but this was particularly pronounced in the highly anxious group. These findings suggest that threat perception is processed by the right cerebral hemisphere and that such hemispheric specialisation is more pronounced in highly anxious individuals.

Currently, there is evidence form the cognitive psychopathology literature suggesting a right hemisphere dominance for visual threat detection, however, this particularly asymmetry has not yet been investigated in individuals fearful of spiders. However, it appears, from the literature discussed above, that due to the stimulus driven nature of spider phobia, a bias would be more prominent for images projected to the right cerebral hemisphere. The current thesis, therefore, seeks to investigate hemispheric specialisations in spider phobic individuals.

1.8 The Application of the Inattentional Blindness Paradigm

The two main themes described throughout section 1.6 are whether anxiety causes the rapid engagement of stimuli, or whether anxiety causes a difficulty with the disengage component of visual attention. When considering this debate within an evolutionary context, it seems likely that the rapid engagement of threatening stimuli would be beneficial for the survival of a species. As suggested by Edelman (1995) and Öhman (2005), anxiety can be conceptualised as state where the anticipation of danger is heightened. Therefore, in relation to the rapid engagement of threat, the question remains as to whether this function exists independently of anxiety. Therefore, the questions remaining are: 1) do all human beings have this rapid engagement bias? And secondly, does anxiety cause heightened sensitivity to threat, which causes anxious individuals to attentionally respond to lower threat than individuals lower in anxious states? These issues might be best evaluated by the inattentional blindness paradigm. The current section addresses this possibility.

When considering the inattentional blindness paradigm in relation to the emotional Stroop and probe-detection tasks, it appears to have many advantages. Aside from the apparent similarity to the Stroop, of presenting two stimuli of differing emotional valence simultaneously (which is necessary to examine how stimuli of differing emotional valence compete for attention), the inattentional blindness paradigm has the advantage of participants having no knowledge that a negative stimulus will appear. Due to this, the behavioural measure (i.e. whether they noticed the critical stimulus) is directly relevant to attentional processes, and is less open to interpretation difficulties. This greater clarity of findings is the same for the probe detection task. However, additionally, while two stimuli are presented, the inattentional blindness task has other strengths, namely, the task relevancy of the neutral stimulus, the lack of knowledge of the appearance of the emotional stimulus, combined with noticing rates being the behavioural measure and the short (200ms) presentation time. This means that the rapid drawing of attention by emotional stimuli can be better assessed in the inattentional blindness than the probe-detection task. Additionally, attention already being allocated to the neutral stimulus (or expectation of the neutral stimulus) of the inattentional blindness task allows for an assessment of degree of attentional control people have. To summarise, the advantages possessed by the inattentional blindness task are that, unlike the Stroop task, the behavioural measure is directly relevant to attentional processes and, unlike the probe-detection task, the emotional stimulus returns to being a critical element of the task and thus the inattentional blindness task a more pure measure of attentional processes. Moreover, in relation to the suggestions of Mogg and Bradley (2006), that parametric data is often contaminated in probe-detection tasks, the inattentional blindness paradigm uses relatively simple nominal data (i.e. noticing rates).

Regarding stimulus properties, the inattentional blindness experiment lends itself well to the use of pictoral stimuli, but not word stimuli. Word stimuli will have limited use in the paradigm for two reasons. Firstly, in regard to the inattentional blindness literature, Mack and Rock (1998) found that the only word stimulus that is able to draw attention is a participant's specific name. Furthermore, changing this name by one letter increases inattentional blindness. In the monograph by Mack and Rock (1998) it is stated that this effect is likely to be due to either familiarity effects or meaning. While it is still possible that meaning is the factor, it is also possible that familiarity effects are the cause. Although it was not investigated, because of the low exposure time, it is possible that the participants perceived their name as a pattern and this caused awareness, rather than, or additional to, them accessing the semantic content of the stimulus. The finding that other words with high frequency in the English language were unable to produce the specific effect partially supports this suggestion. Secondly, in relation to the cognitive psychopathology literature, it is well documented (e.g., Mogg & Bradley, 1998; Öhman, 2005; Williams et al., 1997) that word stimuli may lack the salience to produce threat effects. This is because, unlike pictoral stimuli, words themselves are not threatening, rather it is the semantic content. Therefore, with both of these factors considered, it will be suggested that word stimuli will be inefficient when using the inattentional blindness paradigm for the investigation of attentional bias in anxiety.

In the case of stimulus location, by task virtue in the inattentional blindness paradigm, stimuli are presented parafoveally. This allows for an assessment of whether emotional stimuli presented in the parafovea can draw attention. Again, this question appears important because, as previous work in inattentional blindness has demonstrated (e.g. Mack & Rock, 1998), certain stimuli can draw attention when they are presented parafoveally. Similarly, there are discrepancies in the cognitive psychopathology literature, with some studies (e.g., Fox, 1994; Lavy et al., 1993) suggesting parafoveal processing biased in anxiety states, whereas others, (e.g., Miltner et al., 2004) suggesting parafoveal processing might be enhanced in anxiety states, particularly in spider phobia. Supporting the latter, it could be considered evolutionarily adaptive to be able to rapidly engage objects within our field of vision but not directly in the fovea to facilitate escape before the object becomes dangerously close. Therefore, it is possible for the inattentional blindness paradigm to assess whether parafoveal stimuli (i.e., stimuli not directly in the fovea) can be detected.

The many variants of the visual search task have produced differential findings, with some studies showing facilitated detection and others not. These issues are present in spider phobia (e.g. Miltner et al., 2004) and social phobia (Gilboa-Schechtmann et al., 1999). An issue perhaps contaminating the findings is that of expectation. Of the studies reviewed in this thesis, it is possible to suggest that there are three types of experiment, which differ in terms of levels of expectation of target appearance. In ascending order of prior stimulus presentation, firstly, there are the target search tasks, in which it is possible that the prior presentation of stimuli advantages control participants and serves to mask biases present in anxious individuals. The next level of limited prior presentation is the odd-one-out paradigm. Here, as suggested in section 1.6.1.7, the findings from studies are still equivocal. The third reduction in expectation was created by Miltner et al. (2004), where participants were not told of the presence of the distracter stimulus. Here spider phobic participants, but not controls, showed a delayed detection of the neutral target and overt orienting to the unexpected emotional one. This evidence suggests that there may be something particularly salient about covertly presented stimuli, which corresponds with Mogg and Bradley's (1998) prediction that situational context may be important for demonstrating anxiety based attentional processing biases. This issue requires further testing because, as suggested above, the findings do not generalise well across paradigms. The inattentional blindness experiment can contribute to the investigation of issues present here. In relation to parafoveal processing, the nature of the inattentional blindness task requires the critical stimulus to be presented in the parafovea. Therefore, the inattentional blindness experiments allow for a systematic assessment of whether different categories of emotional, and in relation to the models of general hypervigilance, non-emotional, stimuli can draw attention, and how this is associated with levels of anxiety.

Regarding the analysis provided above, in relation to the systematic reduction in expectation, which can be considered necessary to investigate anxious response to threatening stimuli, it is important to note that, while Miltner et al. (2004) lowered expectation for the spider stimulus considerably by including it in the array of distract stimuli without it being the target, they did not eliminate expectation. Participants had been exposed to spiders before hand and were aware of being tested because of their phobia. In contrast, the important element of the inattentional blindness experimental procedure is that participants are required to have no knowledge that an additional (critical stimulus) will be presented. As such, use of this procedure for an exploration of attentional biases in anxiety will reduce expectation or prior knowledge to a greater extent than other methods. As suggested earlier, it would be cognitively draining for phobic participants to be constantly consciously vigilant for the feared object, but, if as models suggest, they nevertheless see them more frequently than do non-fearful individuals, the inattentional blindness paradigm may be a more ecologically attractive measure of attentional bias in anxiety. Due to the lack of expectation for the negative stimulus in the inattentional blindness paradigm, but the sufficiently high expectation for the cross judgement task, it would be safe to suggest that attention will be initially allocated to the cross in the latter task. Therefore, as Mack and Rock (1998) suggest, if attention is then reallocated to the unexpected stimulus, this will be because of perceptual processing of the latter. As such, the inattentional blindness paradigm might be considered a dual test of the perceptual processing of phobic stimuli and initial drawing of attention by a phobic stimulus.

It is also important to note that, in the case of subliminal studies using the array of methods described in section 1.6.2, participants are normally are aware of why they are being tested. For example, a subliminal study investigating attentional allocation to spiders will typically recruit people on the basis of their spider phobia. In relation to subliminal exposure studies this might serve to lower the perceptual threshold of the participants to allow for conscious recognition. While studies (e.g., Mogg, & Bradley, 2002) have attempted to eliminate this possibility by asking individuals if they were consciously aware of the stimulus. This procedure leads to two possibilities. Firstly, it is possible that participants will say that they have not seen the image due to an experimenter bias, i.e., a Hawthorn effect might be present (Diaper, 1990), causing a false-negative response. It is also possible that the same phenomenon could happen in the other direction, again due to a Hawthorn effect, but this time causing a false-positive response. Therefore, ascertaining whether conscious recognition had occurred is problematic in the traditional subliminal experiments presented in section 1.6.2, and this leads to problems interpreting the results as a preattentive bias towards threat in anxiety.

The inattentional blindness paradigm is again able to overcome the difficulties associated with the previous subliminal methods described above. As highlighted in the experimental evidence section above, with the exception of the visual search tasks that have their own methodological difficulties, the traditional literature has treated preattentive and attentional processes as distinct. That is to say, experimental methods assessing pre-attention and attention have treated the two as distinct and have not followed the natural continuum in the visual processing chain. As suggested earlier, because the inattentional blindness paradigm absorbs attention on the cross initially, perceptual processes will still be assessing the surrounding visual scene, which includes the critical stimulus. This allows for an assessment of how / whether the stimulus goes from preattention to conscious attention in one experiment.

Finally, an issue present in all the methods contained in the current literature is the use of static images that, while being preferential to words, are still suggested to lack strong sensitivity[2]. The inclusion of dynamic experiments would allow for a more ecologically valid assessment of many anxiety disorder sub-types. For example, in reference to spider phobia and social phobia, the threat typically perceived in these disorders is spiders and faces, respectively. Both categories of threat are dynamic. For example, spiders move on walls and faces can become closer and more distant. The absence of this type of dynamic experiment in the cognitive psychopathological literature can also be addressed by the use of inattentional blindness methodology. For example, the method used by Simon's and Chabris (1999) presented a dynamic scene with a gorilla or umbrella woman passing by (see section 1.4.3). A similar argument to the one proposed for the static inattentional blindness experiment can be applied to the dynamic inattentional blindness experiment. Namely, that an adaptation of the procedure and stimuli used by Simons and Chabris (1999) may contribute to the assessing attentional biases in anxiety disorders.

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[2] With the exception of a recent study by Vrijsen, Fleurkens, Nieuwboer and Rinck (2009), which is considered in the dynamic experiment. See chapter 5.

The assessment provided above suggests that the inattentional blindness paradigm is able to overcome many of the pitfalls associated with earlier experimental procedures. In addition, it is able to answer further questions posed by recent research. As such, it is possible for experiments using this approach to contribute to models of threat detection in cognitive psychopathology. In relation to appraising the low-level theories of Öhman (2005) and LeDoux (1996), and early stages of the models proposed by Bar-Haim et al. (2007), Beck and Clark (1997), Mathews et al. (1997), Mathews and McIntosh (1998), Mogg and Bradley (1998) and Williams et al. (1988; 1997), there are several strengths of the inattentional blindness paradigm: the short presentation time, the use of pictoral stimuli, the lack of knowledge that the phobic stimulus will appear, with this being a behavioural measure that allows for assessment of initial allocation of attention. Furthermore, in much the same way as the Miltner et al. (2004) study, because the participants' task in the inattentional blindness experiments is to ascertain the relative lengths of the horizontal and vertical lines, the experiments can measure if participants are disrupted on this task and hence measure the level of attentional control they display. Similarly, due to the covert nature of the inattentional blindness paradigm, it provides a measure of situational context, which is suggested to contribute to attentional biases in anxiety (Mogg & Bradley, 1998). That is to say, it, relatively to the previous methods discussed, places participants in a situation where they have no reason to expect a spider. As such, the following chapters describe a series of experiments assessing the use of the inattentional blindness paradigm to the study of attentional bias in spider phobia. The next section specifies the specific aims of the current thesis.

1.9 Aims of the current Thesis

In consideration of the suggestions above, the current thesis has a number of aims:

1.) to assess whether there is attentional bias to threatening images within the context of the inattentional blindness paradigm

2.) to assess key psychological factors that may affect any such bias or IB, namely phobias, anxiety, depression

3.) to address and resolve methodological issues regarding the investigation of these issues

4.) to appraise dominant models of attentional bias to threat, especially regarding the issues of whether any such bias

    (a.) occurs at an early or late stage of processing

    (b.) yields engagement or disengagement with the threatening stimulus

    (c.) is linked to specific or more generic hypervigilance in phobias and anxiety

Chapter 2

Pilot Study

2.1 Introduction

The purpose of this thesis is to examine whether spiders draw attention under conditions of inattention. The experimental process involves presenting spiders that will, hypothetically, be detected by the perceptual system of participants and then attended to. The inattentional blindness experiment requires consideration of a number of parameters. Firstly, psychophysical conditions (e.g., the size of the experimental images) and previous findings (i.e., the 1.1° retinal size threshold effect. Mack & Rock, 1998, which suggests that stimuli over a certain size will draw attention by virtue of size alone) restrict the visual parameters of the experiment. To address this concern, the choice was made in the majority of the studies to use schematic spiders. Schematic spider images are configured of the constituent parts of a spider, but are drawn on computerised image editing software, as apposed to photographic images, which provided better control of psychophysical parameters than do photographic images. Because of the proposal that the subcortical thalamo-amygdala pathway responds to degraded images that are fearful (Mogg & Bradley, 1998), it was predicted that schematic images would be sufficient to draw the effect. Additionally, however, an image of a spider more typical of a real image (i.e., asymmetrical), necessarily above the retinal size threshold effect, will also be used. The purpose of this pilot study, therefore, is to determine the characteristics of the stimuli to be used in the experiments.

Figure 2.1a presents a typical United Kingdom house spider (acquired from Google images with search terms "UK" and "house spider"), pictured in canonical view. Figure 2.1b is a diagram of a spider image, indicating it's major body parts (bumblebee.org). The spider here has eight legs that are attached to the Prosoma. Below this (to the left in the picture) is the Opisthosoma (abdomen). To the right is the Chelicera, which contains the spider's eyes. Constituently therefore, in absence of a close up, detailed image, the spider contains two body parts, to which eight legs are attached.

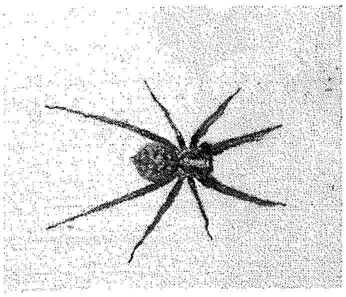

Figure 2.1a

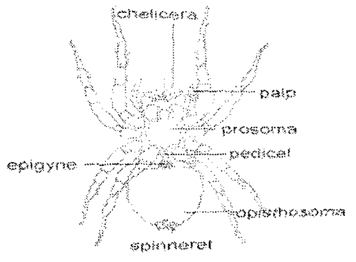

Figure 2.1b

A literature review for articles publishing images of schematic spiders yielded a limited number of two studies. Firstly, Rakison and Derringer (2007) examined whether infants have an evolved spider detection mechanism. The authors used both real and schematic spiders; an example of the schematic spider used in the experiment is presented in figure 2.2. In their example, the image contains the two major body parts (the Opisthosoma and the Prosoma). However, unlike the images presented in figures 2.1a and 2.1b, only the rear legs are attached to the Opisthosoma, with the forward legs being attached to the Prosoma, rendering the image more like an insect than an arachnid.

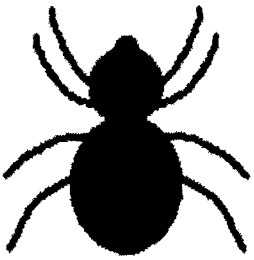

Figure 2.2. Schematic spider used in Rakison and Derringer (2007).

The second paper detailing the schematic spider images used in the study is that of Kolassa, Musial, Kolassa and Miltner (2006). Figure 2.3 presents the schematic spider images used. In these images, the body consists of one circular object, which has 8 legs attached. As such, the spider in their experiment lacks at least one major body part. The necessity for this was to keep the spiders psychophysically similar to flower images that are comprised of one central part containing the ovary and stigma areas, which from a canonical view resemble a circle. In their study, this was done to compare images that are considered threatening (i.e., spiders) with images that are considered non-threatening (i.e. flowers).

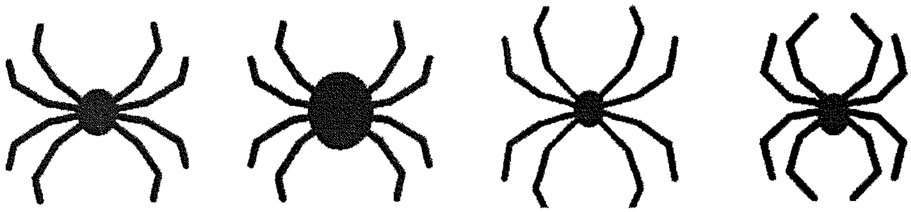

Figure 2.3. Schematic spider stimuli used by Kolassa, Musial, Kolassa and Miltner (2006).

Due to the limitations with the studies outline above (e.g., the lack of body parts and different configuration of the body and legs), the current study used a new spider image (see figures 2.4a and 2.4b), which consists of the two body parts and eight legs detailed in figures 1.1a and 1.1b. Figure 2.4a represents the spider used in the schematic spider studies. The image was presented at a visual angle of 0.6° (small spider experiment) and 1.0° (large spider experiment). Two different visual angles were chose to examine if size had an effect fear response. The 1.0° maximum large size was chosen to eliminate any possibility that the spider would have been seen purely on the basis of its size (i.e., to reduce the possibility of a retinal size threshold effect, as suggested by Mack and Rock, 1998).

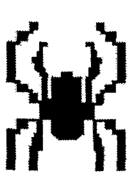

Figure 2.4a

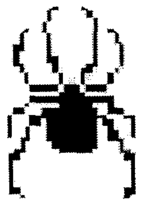

Figure 2.4b

Figure 2.4b is an approximate representation of a real spider used in the real spider experiment, and was taken, roughly from Figure 2.5, which is a red back spider. The image was converted to black and white to eliminate the possibility that colour would contribute to the summoning of attention and artificially increase noticing rates.

Figure 2.5. Red back spider used to create the real spider image displayed in figure 2.4b.

The four images (Figures 2.2, 2.4a, 2.4b and 2.5) were used in the pilot study, and participants were asked to rate them on a ten-point Likert scale for how frightening they were (1= not frightening; 10 = very frightening). The aim was to determine the levels of fear the spider images induce in order to create a hierarchy of threat. The images used by Kolassa et al. (2006) were not used because of their compromised realism to actual spiders due to the requirement that they were psychophysically similar to schematic flowers.

2.2 Method

2.2.1 Design

The experiment employed a within-participants design. The independent variable represented the spider image (Figures 2.2, 2.4a, 2.4b and 2.5). The dependent variable was the fear rating.

2.2.2 Participants

Participants were 6 males and 54 females recruited from the undergraduate population of the University of Gloucestershire (mean age 22.03 , SD = 6.34).

2.2.3 Materials

A consent form was used to provide details of the study and to inform participants of their right to withdraw. Additionally, the images in the introduction (Figures 2.2, 2.4a, 2.4b and 2.5) were presented with 1-10 Likert scales next to them (1 = not frightening; 10 = very frightening).

2.2.4 Procedure

Students attending an undergraduate course in psychology were provided with an A4 size booklet containing the spider images arranged horizontally and left aligned. Firstly, the students were asked to read and sign the consent form if they wished to participate (see appendix A). The participants were asked to return the completed booklets at the end of the class. Students not wishing to complete the study did not return a completed form.

2.3 Results

The data were screened prior to the analysis to inform the choice of statistical test. Parametric tests require a number of assumptions to be met (that the data are: 1. Interval or ratio; 2. are normally distributed). Firstly, the 10-point Likert scales used to measure how frightening the spider images are yield ordinal data. However, Greene and D'Olivera (1999) suggest that ordinal data can be considered for parametric use if the data is normally distributed. Secondly therefore, the ratings for the spider images were assessed for distribution. For each of the four stimuli, the data were skewed.

The data did not meet the assumptions for parametric testing. As such a non-parametric Friedman test was conducted to compare the four spider types. The analysis shows a significant effect between the four images, χ^2 (4, N = 61) = 98.586, df = 3, p = .00. Table 2. 1 presents the mean fright scores for each stimulus in the pilot study.

Table 2.1. Mean fright scores and standard deviations for each of the spider images used in the pilot study.

Spider Image Type	Mean fright score	SD
Schematic	2.97	2.48
Rakison & Derringer (2007)	4.01	2.74
Real Spider	3.87	2.75
Redback Picture	6.15	3.05

Post-hoc comparisons were conducted between each of the four conditions. In all cases the Wilcoxon Signed Ranks test was used. Table 2 presents the comparisons and the *p* values for each test analysis. Table 2.2. presents the Z scores and *P* values for each of the post-hoc comparisons.

Table 2.2. Results from post-hoc comparisons for the comparisons made between the spider stimuli used in the pilot study.

Comparison	Z score	*P* Value
Schematic *vs* Real	-4.153	.00
Rakison & Derringer (2007) *vs* Real	-.873	.38
Redback *vs* Real	-5.941	.00
Rakison & Derringer (2007) *vs* Schematic	-4.264	.00
Redback *vs* Schematic	-6.281	.00
Rakison & Derringer (2007) *vs* Redback	-5.649	.00

2.4 Discussion

Four stimuli ranging from a basic schematic spider, to one used in previous literature, to a computerised real spider and a photograph of a spider were compared for how threatening a cohort of 61 participants thought they were. The spider image used by Kolassa et al. (2006) was not used due to lack of two body parts, as suggested in the introduction. The results revealed a significant overall effect for type of image. Follow-up analyses revealed, with the exception of the Rakison and Derringer

(2007) spider and the real computerised spider, all of the stimuli differed. In order of least frightening to most frightening, the analysis shows that the schematic spider presented the lowest threat, this was followed by the real computerised spider and the Rakison and Derringer spider, with the Redback spider photograph being the most threatening. The analysis of these stimuli suggests that, in the inattentional blindness experiment, a photographic image of a spider will draw the strongest effect. However, for the static inattentional blindness experiments to follow, the least threatening image will be used initially, as to provide a floor level indication of any phobic response. If this stimulus is proved ineffective, an increase in saliency will be made using the additional images in accordance with the ratings in the pilot study.

Chapter 3

3.1 Introduction to General Method Section

The following series of experiments are broadly designed to examine a range of factors affecting the hypothesis that anxiety causes a hypervigilance of the perceptual and attentional systems, leading to increased noticing of general (in the case of general anxiety) and fearful (in the case of spider phobia) stimuli. Chapter 3 will firstly provide a general method section, outlining the design, materials and general procedure used (including a section on ethical requirements). Following on, in chapter 4, a series of experiments will be described. A brief introduction will be provided outlining the rationale for the experiment and the specific hypothesis. The method sections for each of these experiments will be provided in the American Psychological Association (APA) scientific format, however, where the experiments are the same methodologically, only a brief description will be given and the reader is encouraged to refer to the general method section. The results of the experiments will be provided in the traditional format and will be followed by a brief discussion section describing the results and outlining their impact on the theories of anxiety and visual processing biases because this is the primary objective of the research. A more detailed analysis of how the results compare with previous work on inattentional blindness, and theories and previous studies into visual processing biases in anxiety and will be provided in the general discussion section.

3.1.1 General Design

Across each of the experiments, three analyses were conducted. Firstly, general noticing rates were assessed. Secondly, the association between noticing rates and spider phobia were analysed. Thirdly, the association between noticing rates and general anxiety were analysed.

a. General Noticing Rates

An experimental design was employed; participants were allocated to groups depending upon whether they noticed the unexpected object (e.g., spider) on the inattention trial. Unlike the analysis provided in section 2.1.2.2, the purpose of this analysis is to examine levels of inattentional blindness. Therefore, because both the detector and identifier groups show a certain level of attentional processing (i.e., awareness of something additional present on the screen or awareness of what the object was, respectively), these groups will be collapsed into one group called 'attentional responders' and compared with the inattentionally blind group, who showed now awareness of an additional object. The data from the divided and full attention trials will not be inferentially analysed for the reasons outlined in the procedure (see section 3.1.2.2).

b. Association with Fear of Spiders

A quasi-experimental between participants design was employed to assess the influence of fear of spiders status on noticing. The independent variable represented the participant's fear of spiders status (low vs. moderate to high) as measured by the FSQ (Szymanski & O'Donohue, 1995. See appendix A). The appropriateness of the scale and the relevant cut-off points are discussed further in section 3.1.2.1). The dependent variable represented the noticing status of the participants, as defined above.

c. Association with Anxiety

A quasi-experimental between-participants design was employed to assess the influence of anxiety of noticing rates. Participants were separated into low and moderate to high anxiety using the anxiety subscale of the HAD Scale (Zigmond & Snaith, 1986. See appendix B). The appropriateness of the scale is discussed further in section 3.1.2.1) and this represented the independent variable. The cut off points for the two groups were 0-10 for the low anxiety group and 11-21 for the moderate to high anxiety group. The dependent variable represented the noticing status of the participant, as defined in above.

3.1.2 General Materials

3.1.2.1 Psychometrics

The current study aims to assess a series of personality attributes and clinical or subclinical difficulties, and associate them with measures of attention and inattention. All participants in the study were screened for general anxiety and depression: the former because the purpose of the study is to examine hypervigilance of the attentional system in anxious participants; the latter because depression may nullify the effects of anxiety on the visual attention system (Mogg & Bradley, 1998). In addition, depending upon the purpose of the experiment, participants were assessed for spider phobia, in the experiments containing a spider image.

While there are a number of tools available for the assessment of components of anxiety (including specific phobias) and depression, the choice open to researchers is constrained by a number of factors that are scientific and practical. Scientifically, psychometric scales need to have adequate reliability and validity to ensure accuracy of the findings. Practically, scales need to be easy to complete and within a limited time. This is of particular importance when asking a large number of people to spend time participating in the study. The following sections will assess each of the scales being used in the current study on these dimensions.

The Hospital Anxiety and Depression (HAD) Scale

Originally developed to allow physicians to assess how psychological factors contribute to physical illness and recovery from illness, the HAD scale (Zigmond & Snaith, 1983) is a fourteen item questionnaire designed to assess anxiety (seven questions) and depression (seven questions). Because depression and anxiety have physical symptoms (e.g., sleep disturbance, heart palpitations) questions pertaining to these symptoms were eliminated by Zigmond and Snaith (1983) due to the similarity they have with various physical diseases. As such, the HAD scale measures the cognitive and emotional disturbances associated with anxiety and depression.

For depression, questions on the HAD scale include 'I can enjoy a good book or radio or TV programme', 'I feel as if I am slowed down' and 'I can laugh and see the funny side of things'. For anxiety, questions include 'I feel restless, as if I have to be on the move', I get a sort of frightened feeling like butterflies in my stomach' and 'I get sudden feelings of panic'. Each of the fourteen items is scored on a 4-point Likert scale with 0 being equal to infrequent or total absence of feelings, to 3 indicating frequent or severe symptoms. The interceding scores relate to a systematic increase in either frequency or severity.

Psychometric Properties

The original validation study, conducted by Zigmond and Snaith (1983), assessed 100 outpatients attending a general health care clinic. Internal consistency was found to be within the range of +0.41 to +0.76 suggesting that the anxiety questions were sufficiently similar to be measuring the same construct. For depression similar results were found. The scores on the scales were then assessed and compared with psychiatric interview findings and the authors suggest a number of cut-off points for severity: 0-7 = non-cases, 8-10 = mild cases, 11-14 = definite, 15-21 = Severe, for both depression and anxiety.

Utilising a large sample of participants (n= 65,648) a recent validation study by Mykletun, Stordal and Dahl (2001), further confirmed that the subscales HAD-A and HAD-D were independent despite the high co-morbidity rate between anxiety and depression. Furthermore, the authors suggest that the HAD scale has sufficient Cronbach's alpha values (.73-.85) across a number of different samples separated on different demographic variables (e.g., age, gender, employment status), recommending the scales use as both a research and clinical diagnostic tool.

Utility for current study

Importantly, the HAD scales' ability to differentiate between depression and anxiety makes it a useful tool for the present study, because of the different effects depression and anxiety have on the attentional system. For example, Mogg and Bradley (1998) suggest that anxiety increases the vigilance of the attentional system, resulting in anxious individuals noticing more [threat] in their environment. Depression on the other hand has an opposite effect; depressed individuals are more likely to ruminate on negative memories and be more inwardly focussed and miss things in their visual surroundings. According to the Cognitive Motivational Analysis (Mogg & Bradley, 1998), depression serves to nullify the effect anxiety has on the attentional system. This means that the scales ability not to confuse depression and anxiety allows for a greater deal of certainty that, via statistically controlling for depression, that the effects of anxiety on the visual system are fully elucidated.

The HAD scale was originally designed with two primary purposes in mind. Firstly, to provide clinicians with an effective and non-time consuming way to assess the contributing effects of depression and anxiety on physical disease states. The scale is relatively short and the Likert scale response allows patients and participants to complete it without the clinician being present. Secondly, the scale was created to detect depression and anxiety in individuals without psychiatric disorders, therefore, the scale can be used within the general population (Zigmond & Snaith, 1986; Tyson, Crone, Wilson, Brailsford & Laws, in press). These factors make the HAD scale an appropriate measure for anxiety and depression in the current project.

The Fear of Spiders Questionnaire (FSQ)

The FSQ (Szymanski & O'Donohue, 1995) is an 18 item self-report measure of spider phobia. Items on the scale can relate to the cognitive, behavioural, and physical responses to spiders and contains such items as 'If I saw a spider now, I think it would try and get me', 'if I came across a spider now I would leave the room' and 'If I saw a spider now, I would probably break out into a sweat and my heart would beat faster'.

Different studies have used a range of different measurement scales for scoring. In the original validation study, Szymanski and O'Donohue (1995) used a seven point Likert scale (1-7) with a range of 18-126. Huijding and De Jong (2006) used an 8 point Likert scale (0-7) with a range of 0-126; therefore, lowering the floor level of the scale. Cochrane, Barnes-Holmes and Barnes-Holmes (2008) used a used a seven point scale (0-6) with a range of 0-108, which lowered the floor and ceiling levels. Whichever scales have been used 0 or 1 represents 'not at all like me' and 6 – 7 represents 'very much like me', with interceding values increasing in severity.

Due to the different floor and ceiling levels used in different studies, cut-off points for low medium and high phobia are difficult to interpret (Cochrane et al., 2008). This may be in part due to the original validations study not suggesting suitable clinical and non-clinical markers. However, converting the scores from the Huijding and De Jong (2006) and Cochrane et al. studies to those used in the original validation study and the present project shows that, for Cochrane et al., < 33 signifies low phobia, 33 – 50 denotes moderate phobia and >50 represents high and clinical phobia. Huiding and De Jong used <29 for low phobia, 29 – 73 for moderate phobia and >73 for high and clinical phobia. The lack of concordance across studies for cut off rates for different levels of phobia make the scales use problematic and this is considered below.

Psychometric Properties

Despite its limited use, the FSQ is reported to have good psychometric properties, with the original validation study (Syzmanski and O'Donohue, 1995) reporting a Cronbach's alpha value of .92 for internal consistency and split-half reliability co-efficient of .89. More recently, Cochrane et al. (2008), report a Cronbach's alpha value of .96, within an undergraduate population. Furthermore, both

Cochrane et al. and Huijding and De Jong (2006) report correlations between FSQ and variants of the Behavioural Avoidance Test (BAT), where participants must place their hands in a series of jars with a systematically increasing likeliness of a spider being in one, to be significant and moderate to high, ranging from -.64 to -.72, respectively. This suggests that, as phobia increases on the FSQ, participants show an inability to place their hands in jars that have an increased likelihood of containing a spider.

Utility in the current study

The FSQ appears to be a useful tool for the present project because the project seeks to examine attention bias to spider images in both spider phobic and non-spider phobic individuals. The suggestions made by Cochrane et al. (2008), that the scale is sensitive to subtle differences near floor level – in addition to the scale accounting for clinical levels of phobia – means that it is suitable for the range of phobia that may be present across any randomly sampled population.

The lack of a wide literature base with the scale, coupled with the inconsistency of fear of spiders level cut-off points across studies, make using the scale in the current study problematic. However, in the present project, a mean split procedure is being used to separate between high and low phobia. The mean score for the first two experiments was 30, which, for the cut-off between moderate to high and low fear of spiders status, is the same as those used by Huijding and De Jong (2006). Therefore, because of the correspondence between the mean spilt procedure and Huijding and De Jong (2006) study, the separation of fear of spiders into moderate to high (equal to or greater than 30) and low (equal to or less than 29) remained for each experiment.

3.1.2.2 The Inattentional Blindness Paradigm

Description of Available Experimental Procedures

The inattentional blindness task involves presenting participants with a series of images contained in a white circle on a black background, which they must judge the length of lines presented in a cross formation. In the foveal version of the experiment, the participant's task is to fixate a central asterisk (the fixation point). Subsequently, the cross is presented in the place previously occupied by the asterisk. The cross is the object of attention and one of the lines (horizontal or vertical) is longer than the other. The participant's task at this stage is to judge which line is longest. The circle then fills with a visual mask. The object of fixation (the cross) is a distraction task. After three trials, where the longest line varies pseudo-randomly between the horizontal and the vertical, an additional object is presented in one of the quadrants. Unknown to the participants, the experiment's dependent variable is noticing this object; the experimenter measures the DV with a series of questions after the fourth presentation (Mack & Rock, 1998).

Using the foveal trials, the level of inattentional blindness found in the experiments varies according to where the critical object is placed. Mack and Rock (1998) found reasonable evidence that during the task, a virtual circular shape, the size of which is determined by the longer line of the cross, defines the zone of attention. Mack and Rock found that when the critical object was placed within the zone of attention, inattentional blindness rates were 20%. When the critical object was placed in the same location, but the zone of attention was reduced by decreasing the length of the lines that make up the cross, inattentional blindness increased to 66%. Therefore, the level to which a researcher wants to elicit inattentional blindness can be manipulated by where they place the critical object in relation to the zone of attention.

In the parafoveal task version of the task, the procedure was modified by Mack and Rock (1998) so that the cross and critical stimulus swap locations. This creates an experiment where the participant must fixate the asterisk, then, while maintaining that fixation point, attend to the cross that is appearing in the parafovea. Thus, the participant must covertly move attention to the location in which the cross is expected to appear. On the third or fourth trial, the unexpected critical stimulus appears in the location of the fixation point (i.e., at fixation). Using this experiment, inattentional blindness between 65% and 75% of participants *miss* the critical stimulus and are inattentionally blind. Thus, with this modification, inattentional blindness increases relative to the foveal cross presentation task.

There are a number of factors that need to be considered when applying the inattentional blindness task to the study of attentional and perceptual bias in anxiety disorders. Firstly, there is the issue of which static task can be used – either the foveal or parafoveal cross presentation tasks. Secondly there is the issue of where to place the critical stimulus (specifically, its eccentricity from the fixation point). Thirdly, there is the issue of how to conceal the presentation of the critical phobic stimulus, and how to best eliminate expectation. Each of these issues will now be addressed.

Due to the parafoveal cross presentation task eliciting a higher level of inattentional blindness, its use is appealing from the perspective of increasing the effect size of the experiments. Theoretically, however, there are difficulties in its use. In the task, the participant must attend to the centrally placed fixation cue. When the cross is presented and the cue is removed, the participant must covertly move their attention towards the cross that is presented in the parafovea. There are two issues present with this procedure. Firstly, without the use of eye tracking equipment, it is not certain if the participant has not moved their eye focus to the cross. As such, it is not possible to say whether, on the critical trial, an inattentionally blind participant has fixated the critical stimulus. Therefore, the higher rates of inattentional blindness might be an artefact of fixation movement, so conclusions drawn may be tentative with this procedure.

Other possibilities to explain the findings are also present. The parafoveal cross judgement task requires two allocations of attention. The first allocation of conscious processing is towards the centrally presented fixation cue, subsequently, attention is allocated (assumedly covertly) towards the cross, which is presented in the parafovea. Nevertheless, due to this dual allocation of attention, it is possible that the higher rates of inattentional blindness are due to the inhibition of return phenomenon (IOR), where, to facilitate detection of new objects in the visual environment, attention is less likely to return to objects or visual space that has already been attended - in this case, the critical stimulus. For example, Posner and Cohen (1984) found that reaction times were slower for targets presented in already attended locations. Therefore, it is possible, as is the case with Lee and Telch's (2007) study of inattentional blindness and social phobia, that rather than measuring the engagement component of attention, findings in inattentional blindness studies are due to the inhibition or return to the critical stimulus, rather than solely the engagement component. This suggestion is in line with those of Mack and Rock (1998), although they suggested that attention was inhibited but not by the IOR phenomenon specifically.

The foveal cross task produces lower rates of inattentional blindness compared with the parafoveal task. As suggested above, this may be due to the different process being used and that some individuals are able to break through the IOR phenomenon. With the foveal task attention is, firstly, allocated to the central fixation point. Subsequently, it remains in the same location but is allocated to the cross where, again, the participant must judge which line is longest. Finally, the mask appears and the experimenter ascertains the noticing status of the participant after the trial in which the critical stimulus appears.

It was suggested that with the parafoveal cross judgement task, attention is required to move, therefore, it might be inhibited from returning to its original location where the critical object was placed and this accounts for the increase in inattentional blindness. This foveal cross judgement task does not have the same attentionally inhibiting procedure. The location of the critical stimulus is not in an already attended location, and attention may move more freely to the location of the critical object. Therefore, the foveal cross judgement task may be better at examining the rapid engagement of threatening objects since it does not have the confound of whether IOR is operating to affect noticing rates to the critical stimulus.

The second issue to address with the foveal cross presentation task is the location of the critical stimulus. Mack and Rock (1998) found that noticing rates for a specific object were at their highest when they were placed within the hypothesised zone of attention (defined by the longest line of the cross). As the size of the cross size reduced, so that the zone of attention was smaller, noticing rates decreased. This suggests that stimuli presented further out of the zone of attention are less likely to be perceived by most individuals. In relation to the study of attentional bias to threat in individuals with increased anxiety, it was hypothesised by Miltner et al. (2004) that the rapid engagement bias will be present in the parafovea, i.e., to stimuli typically presented out of the zone of attention on a visual search task (as they used).

In assessing the procedures available, the foveal cross judgement task appears to be the most appropriate for studying attentional bias to threat in anxiety. Additionally, due to noticing rates being reasonably high when the critical stimulus is presented in the zone of attention - and to take into account the suggestions of Miltner et al. (2004) – placement of the critical stimulus just outside the hypothesised zone of attention appears necessary for the task to be able to effectively discriminate between anxious and low anxious individuals and to assess whether anxious individuals have parafoveal bias towards threatening images.

Defining Noticing Rates on the Inattentional Blindness Task

The dependent variable for the inattentional blindness task is the noticing status of the participant (inattentionally blind, detector, identifier) The experimenter will ask questions to ascertain whether the critical stimulus has been perceived. The questions will follow the format below:

1. 'Did you notice anything additional on the screen that time?'
2. If yes = Where was it located? If no = 'did you see anything in the bottom left side of the screen?'
3. If yes = 'Can you tell me what it was?' If no = proceed to next trial.

The majority of participants will respond in one of five ways, for example:

1. They did not notice anything.
2. They were aware of something, but did not identify an additional object (for example, saying the cross had moved from its typical location).
3. The participant says something was on the screen but failed to identify the correct location or identify the object.
4. The participant was aware that something additional was presented, and correctly identified its location, but is unsure what it is.
5. They were able to correctly identify the location of the object and what the object is.

NB. The above responses are described in more detail in table 3.3, which as presents the classification of response in terms of the level of noticing / inattentional blindness displayed by the participant.

Additionally, Mack and Rock (1998) used a forced choice test. Presented after the inattention trial, the forced choice test presents, for example, five pictures. One of the pictures is the object presented during the inattention trial. The other pictures are random. Mack and Rock found that for certain stimuli, the inattentionally blind group selected the image used in the experiment beyond chance level. The forced choice test has a number of possible uses to be discussed below.

Some debate needs to be made as to how to categorise these responses. Response 1 reflects inattentional blindness (i.e., the participant being totally unaware of anything else on the screen). Response 2 can be argued to be the same; the participant has not made any correct identification. Response 3 represents inattentional blindness, also, because participants' say that something else appeared on the screen but do not correctly identify it and, importantly, fail to identify the location. This false-positive response may be due to a Hawthorne effect (Diaper, 1990). Their response again meets none of the criteria for correct detection or identification. Response 4 requires more discussion. This participant has located something additional that was not present on the preceding trials. Furthermore, they have correctly identified the object's location. As such, they are clearly separable from inattentionally blind participants (groups 1 2 and 3). However, they are also definable as a separate group from the participants who are able to correctly identify the object, and so treating them appropriately, particularly in relation to phobic response, requires incorporation of literature on attention, inattentional blindness and cognitive psychopathology, and the precise experimental procedures being used.

Previous work, conducted by Lee and Telch (2008), examined the interaction between social phobia and inattentional blindness, using Mack and Rock's (1998) parafoveal static task. The participants were treated as either 'inattentionally blind', 'detectors' (noticing something but unable to correctly identify the stimulus) or 'identifiers' (correctly identifying the location and being able to verbally identify the stimulus).

Moving on to the nature of the inattentional blindness task, it is also possible that, because of the line judgement task using a high level of (limited) attentional processes, correct object identification may not be fully possible for certain (perhaps more visually complicated) stimuli. Indeed, by manipulating the perceptual load of the static inattentional blindness task, Cartwright-Finch and Lavie (2007) found that when perceptual load was low (by using a colour discrimination task and not a length judgement task) inattentional blindness reduced significantly. Following this logic, it is possible that if an image is complicated enough, participants may not be able to correctly identify the unexpected object due to limited attentional resources, but the stimulus may nevertheless have been processed to some level (e.g., in phobic individuals by the subcortical "quick and dirty" amygdala pathway).

The above suggestion has some support from the literature on cognitive psychopathology (e.g., Mogg et al. 1998) in the case of the versions of the emotional Stroop task and the modified probe-detection task (see section 1.6.2). These experiments present participants with anxiety or phobic related stimuli under conditions of restricted awareness (for example, <15ms). Generally, results show that on the emotional Stroop task high anxious participants display colour-naming latencies when aversive stimuli are presented subliminally. On the probe-detection task, high anxious participants are faster to detect the probe when it replaces a subliminally presented threatening picture (see Mogg & Bradley, 1998 and Williams et al. 1997 for a review of the studies). In both cases, the subliminal presentation of the stimuli affected the behavioural response of the participants. This was hypothesised to be due to the subcortical "quick and dirty" amygdala pathway. As such, it appears that threatening stimuli can be detected and affect response by anxious individuals when they are not consciously perceived.

An additional factor that must be considered when conducting inattentional blindness experiments relating to phobia and anxiety is that, unlike the probe-detection task (see section 1.6.1.2), the phobic object is the critical stimulus and so must be identified. During classical inattentional blindness experiments, participants are asked to verbally identify the critical object if they can (e.g., saying it was a black square). However, in psychopathological experiments this procedure may not be fully revealing; Williams et al. (1997) suggest that anxious participants may be reluctant to verbally output something that they are afraid of, for example, a spider phobic person would resist saying 'spider'. As such, verbal responses alone may not be fully accurate.

It is worthwhile assessing the distinction between detectors and identifiers in terms of the current study. As has been demonstrated, eliminating the possibility that participants' might expect a spider (i.e., reducing the signal value confound), assuming the cross judgement task and spider image equal a high perceptual load, and accounting for word out-put bias, means that the detectors group must be treated appropriately so that if they are reluctant to say the word spider, they have an alternative option. The forced choice task may provide a way of more finely categorising the detectors. Mack and Rock (1996) used the forced choice test to assess implicit perception; in the current study (see below), the tool is being used for the same purposes. However, it is also possible that it could be used to check for correct identification. For example, if a participant is aware of the critical object being placed in the lower right quadrant of the cross on the critical inattention trial, but is unable to say accurately what it is, they will be asked to identify it on the forced choice test. Here they will have a choice of five stimuli (square, circle, triangle, distorted spider, and spider). This gives them a one-in-five chance of being correct. If a participant selects the spider, it is possible that this is due to either the high perceptual load of the experiment, or the participant's reluctance to out-put the word spider because of the fear it induces. Therefore, detector participants who select the spider image from the forced choice test will be categorised as noticing the spider. With respect to using the forced choice test for the identifier group, it is probable that they will select the spider image in addition to saying it was a spider (the term bug or insect will be categorised as correct identification because, although not completely accurate they may not wish to say the word spider, as suggested above). Including the forced choice test with this purpose creates six responses that can be categorised into three groups (see table 3.3).

Table 3.3. Types of response and categorisation for the inattentional blindness experiment

Response	Type of response	Category
1	Did not notice	Inattentional Blindness
2	Inaccurate description (e.g. saying 'the cross had moved')	
3	Incorrect identification of location and object	
4	Identifying correct location but incorrect object identification verbally and on forced choice test.	Detector
5	Identifying correct location, incorrect verbal identification but correct forced choice test selection	Identifier
6	Correct location, correct verbal identification and correct forced choice selection	

The Emotional Inattentional Blindness Task: Stimulus details

All of the images were displayed in the centre of a white circle (10.6cm) on a black background. The first image was an asterisk in the centre of the circle (0.6°), serving as the fixation point (displayed for 1500ms). The second image consisted of two bisecting lines of different length (displayed for 200ms). The long line measured 4cm and subtended a visual angle of 4.6°. The small line measured 3.5cm and subtended a visual angle of 4°. The third image was a visual mask consisting of black and white boxes (displayed for 500ms). The unexpected critical stimulus will be placed at a distance of 2.5cm (2.9° eccentricity) from fixation in all experiments. The specific critical image and its size will be described in relation to the specific experiment.

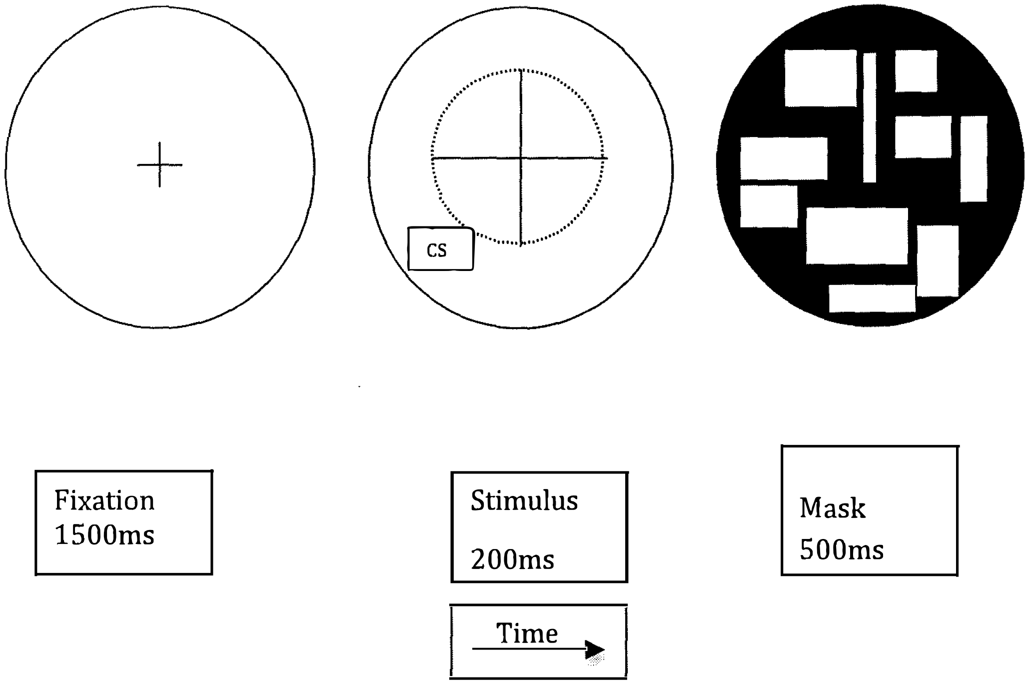

Figure 5. Example of static inattentional blindness experiment with zone of attention (dashed inner circle) and indication of where critical stimulus (CS) will be placed in relation to the zone of attention (Not to scale)

Three presentations will be given of the stimuli in Figure 5 but without the critical stimulus. A fourth trial will then be presented containing the critical stimulus. After the mask for the fourth trial has disappeared, the post-experimental questions and forced choice test will be administered.

A forced choice test was used to examine object recognition (as defined above) and implicit perception on all experiments containing phobic images. A card contained five distinct images of equal size (cm). Three images were geometric objects (circle, triangle, square). The remaining two images were the spider appearing in the experiment and a reconfigured image of the spider. The specific stimuli used for the forced choice test will be provided for each experiment.

3.1.2.3 Additional Materials

Before the experiment was conducted, a consent form indicated the partial purpose of the study (see appendix C) and the participants right to withdraw. No indication was given about the appearance of the critical stimulus or that any of the experiments were investigating spider phobia. The experiment was conducted on a Toshiba Satellite Pro Notebook computer with a 15" monitor (pixel resolution 800*600), running E-Prime V1.2 (Psychology Software Tools, Inc.). A chin rest was used to maintain viewing the 50cm viewing distance. A debriefing form was used to inform participants of the full purpose of the study, including the experimental hypothesis (see appendix D). Finally, an information sheet on anxiety, including where to seek appropriate healthcare support was provided.

3.1.3 Ethics and procedure

3.1.3.1 Ethics

In the static inattentional blindness tasks, there are ethical considerations because the participants are unable to give fully informed consent before the experiment begins (due to concealment of the spider image being presented and the use of a spider phobia scale). Furthermore, ethical concerns are heighted because it is possible that participants will be exposed to a stimulus that induces fear, particularly as the purpose of the experiment is to examine whether individuals with increased phobia have a preattentive bias to threat. The primary ethical concern, therefore, is the presentation of a phobic stimulus without gaining fully informed consent, and any potential harm this may cause participants.

Documentation guiding ethical decision-making

Two documents have been instrumental in guiding ethical decision making for the current project – The BPS Code of Ethics and Conduct (BPS, 2006) and The University of Gloucestershire's 'Research Ethics: A Handbook of Principles and Procedures' (UoG, 2005). The following will provide a summary of how each document has guided the ethical decisions made for the project.

The BPS Code of Ethics and Conduct suggests that psychologists (including students) must be aware of the professional code of conduct when practising and / or conducting research. The document contains three themes that impact on ethical considerations for this project. Firstly, prescriptions are made for the general rights of participants in a research project, including informed consent before participation, debriefing after participation and the safeguarding of personal information taken from participants (i.e., data). Secondly, specific considerations are made about what is meant by informed consent, and procedures are outlined if deception is used. Thirdly, guidance is given for a practising psychologist or research psychologist if they believe potential harm (physical or psychological) may be caused to a participant.

Research participation must be on a voluntary basis and a participant must be fully informed of the scope of their participation and their right to withdraw. Additionally, withdrawal from an experiment or the removal of personal data should be allowed on request. As suggested above, the consent form for the current study does not fully inform the participants of the full nature of the project. As such, consideration of what is meant by deception, circumstances when deception can be used, and guidance for objective assessment of the project is required.

It is suggested that fully informed consent includes an explanation of what the research project is investigating, the hypotheses that have been generated, and the nature of the participant's task. Because this cannot be given at the preliminary stage of the experimental procedure, by definition of the BPS Code of Conduct, the project involves deception. The document recognises that in some instances, particularly to protect the integrity of the research, deception may be necessary. It is further suggested that in order to decide whether deception can be used, scientific evidence is required. In addition, approval by colleagues, supervisors and an independent and objective ethics panel at the host institution should be sought. If the decision is upheld by these three factors, deception can be used. If deception is used, the document suggests that participants must be informed, as soon as possible, about the nature of the project.

The University of Gloucestershire Research Ethics: A Handbook of Principles and Procedures (REHPP) offers specific guidance on covert research. The university acknowledges that, rather than being either entirely covert or overt, there is a continuum on how much information can be revealed about the participant's involvement in the research project. In the case of research that is restricting any of the basic information outlined above, the research will be classified as covert. Special advice is given for covert research. Firstly, it is specified that for any covert research, a proposal must be submitted to the Research Ethics Sub-Committee (RESC). The RESC provides and objective judgement of the nature of the research based on an assessment of the practical issues, the empirical evidence to suggest the deception is necessary, and the physical and psychological risks posed to the participants and researcher.

Ethical Decision Making

The documents outlined above state that there must be scientific and / or practical reasons to justify the use of deception. They also suggest that measures to reduce harm (physical or psychological) to the participants or the researchers must be included. In terms of the scientific rationale for deception, the inattentional blindness paradigm assesses whether certain objects can draw attention when they are not expected. The elimination of expectation is the crucial aspect of the research paradigm, as this is anticipated to provide a measure of what stimulus properties and individual variables, may contribute to the summoning of attention. To give the participants an indication that a spider will appear will confound the experiments in two ways. Firstly, if the procedure prior to administering the consent form involved informing participants that the purpose of the study was to examine spider phobia, participants would be aware that a spider would appear; the same is true if spiders were mentioned on the consent form or if the spider phobia questionnaire was given before the experiment. This would serve to increase the amount of participants who would notice the stimulus by virtue of priming and not the properties of the stimulus or the participant's phobic status.

Secondly, informing participants that a spider would appear, or giving however subtle indications that it might, would serve to confound the interpretation of the results. To exemplify this concern, using a change blindness task, which included "unexpected" images of spiders, Mayer et al. (2006) suggested that, even though spider phobic individuals were able to detect more spider changes, in comparison with non spider changes, this may have been the result of prior screening with the spider phobia scale. This possibility is also true for the inattentional blindness task conducted by Lee and Telch (2008), as suggested earlier.

In relation to reducing harm to the participants, schematic spider images are considered less frightening than real images (a result confirmed by the pilot study of the thesis). Additionally, participants will be debriefed and given information on anxiety, including references to self-help material and, in the case of university-affiliated participants, information regarding access to the university counselling service. In the case of the general public referrals are made to organisations such as the Samaritans and the National Health Service, Primary Care services (see appendix E).

In the case of harm to the researcher, for experiments conducted in the university, the experimental laboratory is fitted with a panic alarm, which is connected to the technician's office. Experiments were only conducted while support was available. In the case of field research, the researcher will ensure contact with support can be made quickly.

Summary, Conclusions, and Decisions by RESC

The current study required participants to be deceived as to the experimental hypotheses, the presentation of the spider stimulus, and the use of a spider phobia scale. The participants were informed about all other aspects of the project. Furthermore, continuing consent for involvement is sought. Participants had the right to withdraw at any time. This means that they could leave as soon as they discover the experiments involved spiders. All other aspects of the project were revealed before participation began. The omissions in the informed consent stage are addressed in the debriefing stage of the experiment. The scientific need for the deception has been assessed and is necessary to maintain the integrity of the research. The physical and psychological risk to the participants has been assessed as low, due to the nature of the stimuli and additional information on anxiety and where people can seek help for this. The decision made by RESC is that the project should continue with the safeguards suggested above in place.

3.1.3.2 Procedure

The following procedure was used for all participants in the static experiments. The individual methods sections will highlight precisely where the specific experiment was conduced and any deviations from this procedure.

All individuals were approached and asked if they would be willing to participate in a study examining the link between emotion and perception. Individuals were informed that the experiment would take no longer than fifteen minutes. No information was given regarding the appearance of the critical image.

The participants were individually taken into a testing room. Firstly, they were asked to read and sign the consent form. Secondly, participants were asked if they would be prepared to complete the HADS

(Zigmoid & Snaith, 1983) after the experiment. The procedure did not continue to the next stage for participants refusing to complete the consent form and / or the questionnaire. Similarly, due to the rapid presentation of visual stimuli, participants were asked if they have epilepsy and the experiments did not continue for any participants reporting that they did. Consenting participants were then advised to read the standardised instructions shown on the computer screen and asked if they had any questions. The participants were then asked to place their chin on the rest and begin a single practice trial. The practice trial consisted of one line judgement presentation, which did not have the critical stimulus. Participants were asked to report which line was longest after the trial. This data was not recorded and no further questions were asked. After the practice trial the experimenter ensured understanding of the procedure and started the experiment.

Each trial block was conducted four times. Participants were required to judge which line was longest and report this verbally when the mask disappeared; the experimenter recorded the responses and started the next trial block. The longest line varied between horizontal and vertical pseudo-randomly for each presentation. On the fourth trial block, the critical stimulus appeared. After reporting which line was longest, participants were asked if they had noticed anything additional to the cross on the screen. The critical stimulus probe questions and the categorisation of noticing rates were in accordance with those outlined in section 3.1.2.2. All participants were then presented with the forced choice test at the same viewing distance. Participants who noticed the critical image were asked to choose which they thought they saw, whereas participants who did not notice were asked to chose an image at random. All responses were given verbally and recorded by the experimenter.

The second and third stages of the experiment were divided and full attention trials, respectively. On the divided attention stage, participants were asked to report the lines of the cross and be aware of anything else that might appear. On full attention stage, participants were instructed to ignore the cross and report if anything additional appears on the screen. The longest line on the critical trial was kept constant across stages. Responses for these stages were given verbally. After the experiment, participants were asked to complete the FSQ, and read and sign the debriefing form. The tasks were conducted in this order firstly, to ensure that the stimulus was perceptible under conditions of divided and full attention. The FSQ was administered after the experiment because providing it before would have possibly given an indication as to the appearance of the spider. That is to say, prior administration of the questionnaire would have primed participants and contaminated the results from the experiments.

3.1.4 Statistical methods used for comparisons in all experiments

The primary comparisons for the forthcoming series of experiments (and the dynamic and delayed disengagement experiments presented in chapters 4, 5 and 6, respectively) are the analysis of general noticing rates for the inattentional blindness tests, and the analysis of the association between spider fear§ and anxiety with levels of inattentional blindness. The choice of statistical tests of these analyses will now be outlined. Firstly, the analyses of the general noticing rates involves the allocation of participants depending upon their noticing status. *The question of interest for this analysis is the level of blindness the experiment has created, that is, how many people in each experiment showed no degree of attentional processing of the critical object*. Therefore, for this analysis, the detector and identifier groups, which will be used for the analysis of spider fear and anxiety, will be collapsed into one group as both groups have in common some awareness of the critical object, that is, they showed a degree of attentional processing. This procedure, therefore, creates two groups (inattentionally blind and attentional responders), which makes binomial tests the appropriate choice to examine whether the experiment caused a level of blindness beyond chance level.

Secondly, the purpose of the analysis of noticing rates and spider fear and anxiety status is to examine if the latter variables predict patterns no noticing for particular stimuli. This means that the nominal variable of noticing status returns to three categories as outlined in table 3.3. Spider fear and anxiety are measured by the use of psychometric tests. These psychometric tests produce ordinal level data, however, this data can be converted into nominal data for the particular scale. Again, as suggested in section 3.1.2.1, the Fear of Spiders Questionnaire (FSQ. Szymanski & O'Donohue, 1995) has no clearly defined cut-off points but previous literature indicates that there is a cut-off point at 30, where below this, people should be categorised as having low spider fear and above this, having increased spider fear. This, therefore, creates two nominal categories – moderate to high and low fear. Similarly, the Hospital Anxiety and Depression (HAD) scale (Zigmond & Snaith, 1983), has defined cut-off points with 0 – 7 indicating normal levels of anxiety, 8 – 10 indicating moderate anxiety, 11 – 14 indicating definite anxiety and 15 – 21 indicating severe anxiety. Due to the reasonably low numbers of participants for the experiments contained in this thesis and the purpose of the thesis being to examine how elevated, but not clinical, levels of anxiety affect noting rates and the limited presence of extreme anxiety in the general public, the latter two groups (moderate and high anxiety) will be collapsed. Therefore, the experiments investigating how spider fear affects noticing rates on the inattentional blindness paradigm yield two sets (noticing rates and fear of spiders status) of nominal data. This makes the choice of a 3 (inattentionally blind, detector, identifier) x 2 (low fear of spiders, elevated fear of spiders) multidimensional chi-square test an appropriate statistical tool. In the case of anxiety status this is also true (i.e., the three groups based on noticing status and the low and elevated anxiety groups).

The multidimensional chi-square test is a measure of association between two nominal variables (Rosenthal & Rosnow, 1991), which has a number of assumptions for its use. Additional to the variables being nominal, it is also a requirement that the expected frequencies for each of the cells in the matrix are higher than 5 (Brace et al., 2006). However, if there are cells with an expected frequency lower than 5, it is suggested (Rosenthal & Rosnow, 1991) that by using the Fisher's exact chi-square statistic, the expected frequency can be as low as 1. Therefore, in the current thesis, when the expected frequencies are below 5, the reported statistic will be a multidimensional chi-square test with exact significance option.

Additionally, issues surrounding statistical power require addressing. Primarily, as suggested above, the chi-square statistic is a measure of association. Therefore, correlation coefficients can be used to measure the strength of the association the test has yielded. Rosenthal and Rosnow (1991) suggest that the Phi (ϕ) statistic can be used as a correlation coefficient to measure the level of association between the two variables. The correlation coefficient, therefore, as with other measure of correlation (e.g., Spearman's and Pearson's statistics), can be used as a measure of the statistical power of the test. In line with other correlational tests and conventions in psychology, the correlation coefficient of 0.3 or below will be regarded as low, 0.5 – 0.7 will be regarded as medium and 0.8 or above will be regarded as high. Therefore, in all tests presented in this thesis, additionally to the standard alpha value (p value), the statistical power of the test will be described as the strength of the correlation, and indices of statistical power, between the two variables, as indicated by Phi (ϕ).

Finally, Cronbach's alpha will be used to examine the reliability of each of the measures used in the experiments. The results from this analysis will be included in the 'Materials' section for each experiment contained in chapters 4, 5 and 6. Additionally, the participants are being separated in to either low or moderate to high anxiety and / or fear of spiders. To ensure this procedure has been effective, a manipulation check conducted to ensure the groups differ significantly. This will be done using a Mann-Whitney. Similarly, the Mann-Whitney test will be used to examine whether any of the groups differ on age. This was considered necessary to ensure that the effects of age did not contaminate the results. For example, De Fockert (2005) suggests that cognitive aging reduces control of selective attention. In the present study may affect a person's ability to remain focussed on the cross judgement task during the inattentional blindness experiment.

Chapter 4. Static inattentional blindness experiments

4.1 Small Neutral Object Experiment

4.1.1 Introduction

The purpose of experiment 1 was to replicate the experiment conducted by Mack and Rock (1998), where the neutral object was placed in the parafovea and noticing rates were examined. However, due to the necessity for the critical stimulus to be placed outside the zone of attention and in order to compare the results from this experiment to future ones containing spider images, an exact replication of the Mack and Rock (1998) study was not possible. The second purpose was to examine whether levels of anxiety (as measured by the HAD scale) influence inattentional blindness when neutral geometric objects are presented. The hypervigilance theory (Eysenck, 1997) suggests that high anxiety causes an individual to notice additional objects in their environment, and that this is not associated with specific objects but rather generalises to all new objects in a person's visual field. If this is the case, it can be expected that the high scoring anxiety group will be more likely to notice the neutral object on the critical inattention trial.

4.1.2 Method

4.1.2.1 Design

The design remained the same as outlined in the General method section.

4.1.2.2 Participants

Participants were 12 males and 38 females, recruited from the student population of the University of Gloucestershire (mean age 30, SD = 13). All participants had normal or corrected to normal vision; no participants reported a history of neurological disease or trauma. None of the participants claimed to know of inattentional blindness or the experimental procedure being conducted.

4.1.2.3 Materials

In this experiment, the critical stimulus was a square measuring 0.5cm and subtended a visual angle of 0.7°. No forced choice test was used in this experiment. All other materials remained the same as outlined in the general method section. The anxiety subscale of the HAD scale had a Cronbach's alpha value of .79, whereas the depression subscale had a value of .69.

4.1.2.4 Procedure

During the first semester of 2007, participants were recruited from the Francis Close Hall campus of the University of Gloucestershire. The procedure remained the same as that described in the general method section.

4.1.3 Results

4.1.3.1 *General Noticing rates*

Binomial tests were included to compare the overall rates of inattentional blindness with the number of participants who showed a degree attentional processing. For the inattention trial, 21 of the participants were inattentionally blind and this was found to be non-significant, *p* = .32. Table 4.1 presents the number of participants who were inattentionally blind and the number who showed attentional processing.

Table 4.1. Percentage of participants for each response in each experiment phase for the small neutral object experiment

	Experiment Phase		
Response Type	inattention	divided attention	full attention
Inattentionally Blind	21 (42%)	1 (2%)	. 0
Attentional responders	29 (58%)	49 (98%)	50 (100%)

4.1.3.2 Association with Anxiety

Participants were divided into two groups depending upon their level of anxiety as measured by the HAD scaled. Participants were separated in to low anxiety (n = 30) and high anxiety (n = 20). The two groups did not differ in age (U = 257.000, N_1 = 20, N_2 =30, p = .00), but did differ on anxiety (U = .000, N_1 = 20, N_2 =30, p = .00) and depression (U = 159.000, N_1 = 20, N_2 =30, p = .01)[3].

A multidimensional chi-square test with exact significance option revealed no significant association between anxiety status and noticing (χ^2 = 2.931, df = 2, p =.21, ϕ = .26) on the inattention trial. The divided-attention and full-attention trials were not inferentially analysed. Table 4.2 presents the noticing rates for the high and low anxiety groups on the inattention trial. See figure 4.2 for group histogram for the low and moderate to high anxiety groups.

Table 4.2 Noticing rates for high and low anxiety groups on the inattention trial in the small neutral object experiment.

	Response Type		
Anxiety Group	Inattentionally blind	Detector	Identifier
Low Anxiety	14 (47%)	0	16 (53%)
Moderate to high anxiety	7 (35%)	2 (10%)	11 (55%)

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[3] While the high anxiety group had significantly higher depression than the low anxiety group, their mean score was still in the normal range, as defined by the HAD scale.

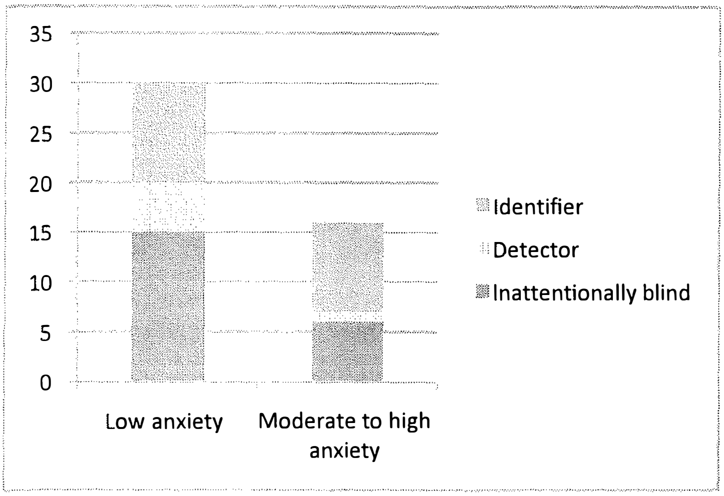

Figure 4.1 Group histogram displaying noticing rates for each category of noticing for the low and moderate to high anxiety groups in the small neutral object experiment.

4.1.4 Discussion

The purpose of experiment one was to replicate the findings of Mack and Rock (1998), with the intention of examining how anxiety affects noticing rates. Additionally, the results for this experiment will be compared against results from the following experiments using spider stimuli in order to assess whether phobic stimuli occupy a special place in visual processing generally or in relation to heightened levels of anxiety.

Firstly, the general noticing rates were analysed; participants were categorised into one of two groups – inattentionally blind, or attentional responders – based on their response to the experimental probe asking if they saw anything additional on the screen. The analysis revealed that there was no significant level of inattentional blindness. What does appear from the descriptive statistics is that the blindness levels in this experiment are lower than those reported by Mack and Rock (1998) (which were 75%), suggesting that when the critical stimulus is placed further away from the zone of attention inattentional blindness increases.

In regards to anxiety and awareness of the critical stimulus, the predicted association between increased anxiety and higher noticing was not observed. This analysis was a direct test of Eysenck's (1997) hypothesis that anxiety increases a general hypervigilance of the attentional system, which causes anxious people to notice new or novel stimuli appearing in their visual field. The hypervigilance theory of anxiety, therefore, has not been supported by the findings for experiment 1. Supporting this, the reliability analysis for the scale in this study fell in the same range as reported by Mykletun et al. (2001). The following experiments will assess whether there is a relationship between specific stimulus (a spider) and a specific anxiety type (spider fear).

4.2. Small Spider Experiment

4.2.1 Introduction

The purpose of experiment 2 was to examine whether a small schematic image of a spider is able to draw attention under conditions of inattention using the inattentional blindness paradigm. Based on the theoretical formulations (e.g., Williams et al., 1997) and findings from previous work (e.g., Mogg & Bradley, 2002) described in the introduction, it is possible to make a number of predictions. Firstly, if a fear of spiders is an evolutionary artefact from a time when spiders needed to be located and reacted to rapidly because of the threat they pose to other species, it can be expected that the majority of participants will notice the spider image when it is presented against expectation. Additionally, it can be hypothesised that if the spider image has been implicitly perceived (perceptually registered in the absence of conscious awareness), it will be chosen significantly more frequently on the forced choice test by the in attentionally blind participants than objects not appearing on the critical inattention trial. Next, if the saliency of the spider image is specific only to fearful individuals, it can be expected that people with greater degrees spider fear will be more likely to notice the spider. Finally, it can be predicted that if anxiety is characterised by a pattern of general hypervigilance, highly anxious participants will more frequently notice the spider image.

4.2.2 Method

4.2.2.1 Design

The design for experiment 2 is the same as outlined in the general method section.

4.2.2.2 Participants

Participants were 25 males and 25 females recruited from members of the public visiting 'At-Bristol' Science Museum (mean age 37, SD = 10.2). All participants had normal or corrected to normal vision; no participants reported a history of neurological trauma or disease; no participants reported having epilepsy. The data from one participant was excluded due to an indecipherable response. Therefore, the total participants for this experiment were 49.

4.2.2.3 Materials

A forced choice test was used to examine object recognition and implicit perception. A card contained five distinct images of equal size that were randomly positioned on the card. Three images were geometric objects (circle, triangle, square). The remaining two images were the spider appearing in the experiment and a reconfigured image of the spider (see figure 4.2.1). To reconfigure the spider image, the image was bisected on the vertical and horizontal planes and the quadrants were swapped over (for example, the top right quadrant became the bottom left, etc.). Participants were tested in a room joining the upstairs exhibit floor of the museum. The room was quiet with ambient lighting and contained the desk, chairs and experimental computer. All other materials remained the same as outlined in the general method section. The FSQ had a Chronbach's alpha value of .97. The anxiety subscale of the HAD scale had a Cronbach's alpha value of .21, whereas the depression subscale had a value of .49.

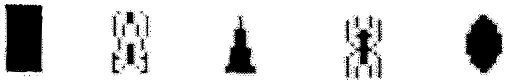

Figure 4.2.1 Stimuli used in the forced choice test. The spider (fourth image from left) is the one contained in the experiment. Not to scale.

4.2.1.4 Procedure

Between the 19th and 22nd of February, 2008 (inclusive), from 10am to 5pm, members of the public were approached on the exhibit floor of the museum and asked if they would be willing to participate in a study examining the link between emotion and perception. Other procedural factors remained the same.

4.2.3 Results

4.2.3.1 General Noticing rates

Binomial tests were included to compare the overall rates of inattentional blindness with the number of participants who showed a degree attentional processing. For the inattention trial, 28 of the participants were inattentionally blind and this was found to be non-significant, p = .39. Table 4.2.1 presents the number of participants who were inattentionally blind and the number who showed attentional processing.

Table 4.2.1. Percentage of participants for each response for the small spider experiment.

	Experiment Phase		
Response Type	inattention	divided attention	full attention
Inattentionally Blind	28 (57%)	4 (8%)	0
Attentional responders	21 (43%)	45 (92%)	49 (100%)

Object identification and implicit perception

Of the 28 participants who were inattentionally blind, 4 selected the box, 6 selected the distorted spider, 1 selected the triangle, 14 selected the spider and 3 selected the circle (χ^2 = 18.071, df = 4, p =.00, two-tailed).

4.2.3.2 Association with fear of spiders

When the participants were separated into low (n = 37) and moderate to high (n = 12) fear groups, a Mann-Whitney test revealed that the groups differed significantly on FSQ (U = .000, N_1 = 37, N_2 =12, p = .00) but not on age (U = 186, N_1 = 37, N_2 = 12, p = .40) or depression (U = 181.500, N_1 = 37, N_2 = 12, p = .34).

A multidimensional chi square test with an exact option found no significant association between the fear groups and noticing rates (χ^2 = .166, df = 2, p = 1.0 ϕ = .02) on the inattention trial. The divided and full attention trials were not inferentially analysed. Table 4.2.2 presents the noticing rates for the low and moderate to high fear of spiders groups on the inattention trial. Figure 4.2.2 displays a group histogram for the noticing rates for low and moderate to high fear of spiders groups on the inattention trial.

Table 4.2.2. Noticing rates for low and moderate to high fear of spiders groups on the inattention trial on the small spider experiment.

	Response Type		
Fear of spiders	Inattentionally blind	Detector	Identifier
Low fear of spiders	21 (57%)	6 (16%)	10 (27%)
Moderate to high fear of spiders	7 (41%)	7 (41%)	3 (18%)

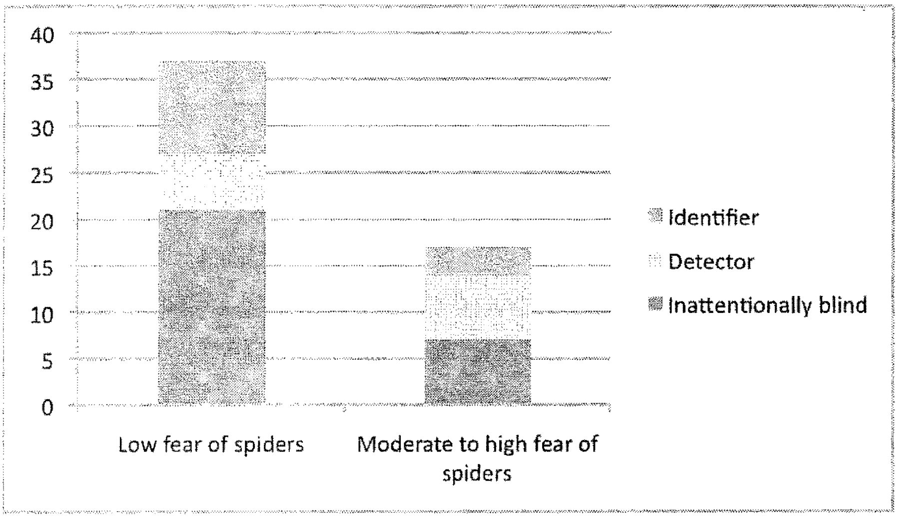

Figure 4.2.2. Group bar charts for noticing rates for the low and moderate to high fear of spiders groups on the inattention trial for the small spider experiment.

4.2.3.3 Association with Anxiety

When the participants were separated into low and moderate to high anxiety groups on the HAD scale, Mann-Whitney tests showed that they differed significantly on anxiety (U = .000, N_1 = 35, N_2 = 14, *p* = .00) and depression (U = 140.500, N_1 = 33, N_2 = 14, *p* = .02) but not on age (U = 212. 000, N_1 = 35, N_2 = 14, *p* = .46).

A multidimensional chi-square test with exact significance option revealed a significant omnibus effect (χ^2 = 7.936, df = 2, p = .02 ϕ = .4). Post-hoc analyses were conducted for noticing rates within each group and, for the low anxiety group revealed a significant effect (χ^2 = 20.692, df = 2, p = .00). Further to this, goodness-of-fit chi-square tests were used to compare the rates for each noticing category within the low anxiety group. The analysis, with the significance level corrected for multiple comparisons (i.e., 3) and set at .02) revealed a significant effect between the inattentionally blind and detector groups (χ^2 = 16.333, df = 1, p = .00) and the inattentionally blind and identifier groups (χ^2 = 8.000, df = 1, p = .01) but not between the identifiers and the detectors (χ^2 = 2.273, df = 1, p = .12). Comparisons between noticing rates were also conducted for the high anxiety group and revealed no significant effect between the three groups (χ^2 = .143, df = 2, p = .93). Further analyses were not conducted. Table 4.2.3 presents the noticing rates for the low and moderate to high anxiety groups on the inattention trial. Figure 4.2.3 displays a group histogram for the noticing rates for low and moderate to anxiety groups on the inattention trial.

Table 4.2.3 Noticing rates for the low and moderate to high anxiety groups on the inattention trial on the small spider experiment.

	Response Type		
Anxiety Group	Inattentionally blind	Detector	Identifier
Low Anxiety	24 (68%)	3 (9%)	8 (22%)
Moderate to high anxiety	4 (29%)	5 (35.5%)	5 (35.5%)

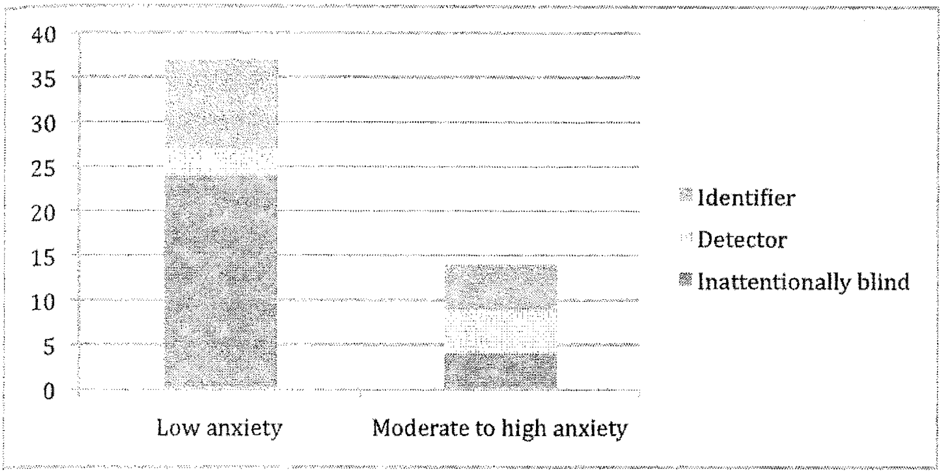

Figure 4.2.3 Group bar charts for noticing rates for the low and moderate to high anxiety groups on the inattention trial for the small spider experiment.

4.2.4 Discussion

Experiment 2 sought to examine whether a small schematic spider was able to attract attention under conditions of inattention. In relation to the three hypotheses outlined in the introduction, when the general noticing rates were compared, the analysis showed not significant association. The hypothesis that if spiders represent an evolutionary threat they will be noticed by the majority of the participants, was not confirmed. As expected on the divided and full attention trials, the majority of the participants saw the spider, and could accurately identify it. This ensured that the stimulus was clearly visible when participants expected something to be present (divided attention trial) and when attention was not engaged on a visual task (full attention trial). After the inattention trial, a forced choice test was used for the inattentionally blind participants; the results show that significantly more of the participants selected the spider, compared with neutral objects or the distorted spider image.

When the groups were separated into moderate to high and low fear of spiders, the analysis revealed that no significant association between this and noticing rates. More specifically, the hypothesised direction of increased noticing in the moderate to high group was not present. Rather, the pattern of results between the moderate to high and low groups was similar in that the majority of participants did not identify the spider. Additionally, when the groups were separated into moderate to high and low anxiety, the analysis revealed a significant overall association between noticing rates and anxiety status. To elucidate this effect, the moderate to high and low anxiety groups were analysed individually. With the low anxiety group the results showed that the majority of participants missed the spider image. The results from the analysis of the moderate to high anxiety group did not show the predicted elevation in noticing due to increased anxiety, although there were fewer inattentionally blind participants in the high anxiety group.

Firstly, relating the results back to the static inattentional blindness literature (Mack & Rock, 1998), it appears that a schematic spider image is less able to attract attention under conditions of inattention than other geometric shapes. When compared with the noticing rates for black square in experiment one, it appears that the spider image was less able to attract attention than this neutral object (rates of inattentional blindness were 57% and 42%, respectively). Regarding the object recognition test however, the finding is that significantly more of the inattentionally blind participants chose the spider image over neutral geometric objects suggests that, although not consciously recognised, the spider image was implicitly perceived. The perceptual registration of the spider with no conscious awareness in the majority of the participants supports the interpretation of the noticing rates that the spider is not a threatening object that can draw attention. In line with the suggestion made by Mack and Rock (1998) – that the perceptual system appears to draw attention to objects that are meaningful - it is reasonable to assume that attention would have been drawn to the spider if its importance (i.e., threat value) were high.

The results from experiment 2 may be interpreted in relation to the literature on the neural basis of fear, and models of anxiety disorders, both in relation to evolutionary threat and the association between noticing rates and fear of spiders. The neurobiological theories, and early stages of the cognitive psychopathology models (i.e., Bar-Haim et al., 2007; Beck & Clark, 1998; Mattews et al., 1997; Mathews & McIntosh, 1998; Mogg & Bradley, 1998; Williams et al., 1988, 1997) suggest that there exist early preattentive mechanisms, which operate below conscious awareness and mediate later cortical processing. The neurobiological theories (e.g., LeDoux, 1996) identify areas such as the amygdala and superior colliculus, the former being associated with fear response and the latter controlling involuntary eye saccades. All of these theories suggest that for certain stimuli and situations, neural circuitry will respond and affect physiological reaction (e.g., elevated heart rate) and cognitive response (e.g., the re-allocation of attention, as measured in this experiment). The results of the second experiment, therefore, suggest that small images of spiders do not attract the attention of people generally, or people with increased fear of spiders because it was not seen more frequently (in fact less so) than the neutral object experiment presented in section 4.1, and noticing was not associated with increased spider fear, respectively.

In relation to general anxiety, Eysenck (1997) suggests that anxiety is characterised by a pattern of general hypervigilance, where the perceptual and attentional system of anxious individuals scans the visual environment for new and novel stimuli. This theory would predict that anxious individuals will be more likely to notice new or novel stimuli in their environment, regardless of the specific properties of the stimulus. The results from separating the participants into moderate to high and low anxiety and spider fear do not support this suggestion. If anxiety were characterised by a general hypervigilance, it would be expected that the higher anxiety group would notice the spider image by virtue of it being an additional object in their visual field. However, comparisons between the two groups showed that the high anxiety group had significantly higher depression than did the low anxiety group. Mogg and Bradley (1998) suggest that depression can nullify the effects of anxiety on the attentional system, which may have affected noticing rates in the moderate to high fear group. However, this appears unlikely because the high anxiety group still scored within the normal range for depression (and the HAD depression scale had a low reliability value). Therefore, this experiment does not support the general hypervigilance model, however, in light of the reliability analysis for the HAD anxiety subscale, the cronbach's alpha value was low, so this result must be interpreted with caution.

The failure for the small spider experiment to find a difference in response between the moderate to high and low fear groups, and because of the generally high levels of inattentional blindness observed, it was hypothesised that the spider image might have been too small to elicit an effect. The cognitive psychopathology literature does not indicate that size has a specific effect on attentional response to spider images, however, a regular comment made by individuals who participated in this experiment was that their fear often depends upon the size of the spider, and larger spiders induced more fear. Secondly the small spider was employed in this experiment because it was the same size as the neutral geometric object, which was the same size as the stimulus used by Mack and Rock (1998). This procedure was used because it provided a better way of comparing the results of studies, however, the following experiment sought to examine whether a larger spider would elicit differences between the groups.

4.3 Large Spider Experiment

4.3.1 Introduction

In experiment 2, a small schematic spider was unable to attract the attention of the majority of participants across the whole sample, and noticing rates were not significantly associated with increased phobic status. Because the image was scaled to the same size as the geometric object in experiment 1, it is possible that the image was not of sufficient size to attract attention, or that the size affected the clarity of the image so that it was less identifiable as a spider. The purpose of experiment 3 was to examine whether a larger schematic spider will increase the noticing rates across the whole sample or produce an association between noticing and heightened fear status. The experimental hypotheses remain the same as experiment 2.

4.3.2. Method

4.3.2.1 Design

The design is the same as outlined in the general method section.

4.3.2.2 Participants

Participants were 21 males and 28 females (mean age 37, SD =13.6) and were recruited from the Cheltenham Science Festival. All participants had normal or corrected to normal vision; no participants reported a history of neurological trauma or disease and no participants reported having epilepsy. None of the participants reported knowing the static inattentional blindness paradigm.

4.3.2.3 Materials

A forced choice test was used to examine object recognition and implicit perception. A card contained five distinct images of equal size (1.5cm). Three images were geometric objects (circle, triangle, square). The remaining two images were the spider appearing in the experiment and a reconfigured image of the spider (see figure 6). To reconfigure the spider image, the image was bisected on the vertical and horizontal planes and the quadrants were swapped over (For example, the top right quadrant became the bottom left, etc.). The FSQ had a Chronbach's alpha value of .95. The anxiety subscale of the HAD scale had a Cronbach's alpha value of .74, whereas the depression subscale had a value of .49.

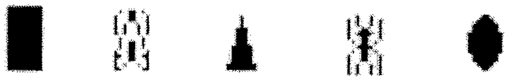

Figure 4.3.1. Stimuli used in the forced choice test. The spider (fourth image from left) is the one contained in the experiment. Not to scale.

4.3.2.4 Procedure

Between the 4th and 8th of June 2008 (inclusive) from 10am to 6pm, members of the public were approached and asked if they would be willing to participate in a experiment examining the link between emotion and perception. The procedure remained the same as the one described in the general method section.

4.3.3 Results

4.3.3.1 General Noticing Rates

Binomial tests were included to compare the overall rates of inattentional blindness with the number of participants who showed a degree attentional processing. For the inattention trial, 26 of the participants were inattentionally blind and this was found to be non-significant, p = .78. Table 4.3.1 presents the number of participants who were inattentionally blind and the number who showed attentional processing.

Table 4.3.1. Percentage of participants for each response for large spider experiment

	Experiment Phase		
Response Type	inattention	divided attention	full attention
Inattentionally Blind	26 (53%)	5 (10%)	0
Attentional responders	23 (47%)	44 (90%)	49 (100%)

Object Identification and implicit perception

Of the 26 participants who were inattentionally blind, 1 selected the box, 3 selected the distorted spider, 9 selected the triangle and 13 selected the spider (χ^2 = 14.000, df = 3, *p* = .00).

4.3.3.2 Association with fear of spiders

When the participants were separated into moderate to high (n = 13) and low (n = 36) fear groups using the FSQ, the groups differed significantly on the FSQ (U = .000, $N_1 = 36$, $N_2 = 13$, $p = .00$) and on age (U = 89.500, $N_1 = 36$, $N_2 = 13$, $p = .00$) but not on depression (U = 227.000 $N_1 = 36$, $N_2 = 13$, $p = .87$).

A multidimensional chi-square test with exact significance option revealed no significant association between fear status and noticing rates ($\chi^2 = 1.761$, df = 2, $p = .48$, $\phi = 19$) on the inattention trial. The divided and full attention trials were not subjected to inferential analyses. Table 4.3.2 presents the noticing rates for the low and moderate to high fear of spiders groups on the inattention trial. Figure 4.3.1 displays a group histogram for the noticing rates for low and moderate to high fear of spiders groups on the inattention trial.

Table 4.3.2 Noticing rates for low and moderate to high fear of spiders groups on the inattention trial for the large spider experiment.

Response Type			
Spider fear	Inattentionally blind	Detector	Identifier
Low fear of spiders	18 (50%)	9 (25%)	9 (25%)
Moderate to high fear of spiders	8 (62%)	1 (8%)	4 (30%)

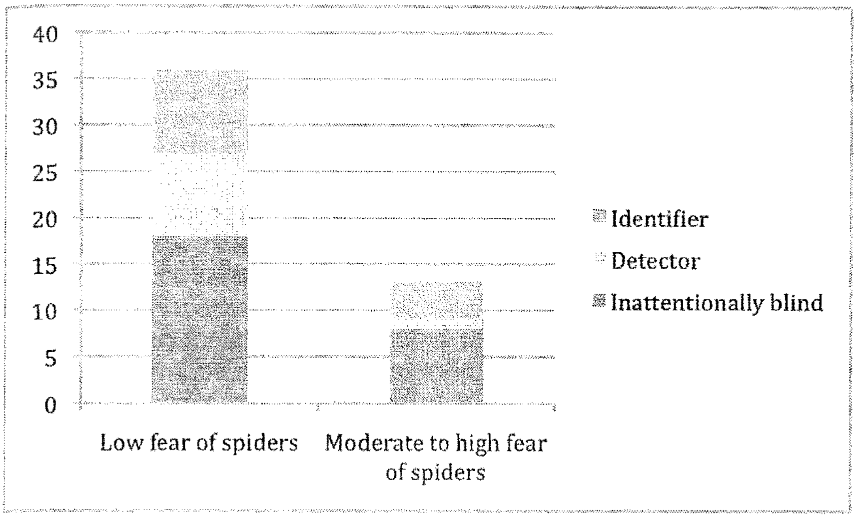

Figure 4.3.2 Group bar charts for noticing rates for the low and moderate to high fear of spiders groups on the inattention trial for the large experiment.

4.3.3.3 Association with Anxiety

When the participants were separated into moderate to high (n = 32) and low (n = 17) anxiety groups they differed significantly on anxiety (U = .000, N_1 = 32, N_2 =17, *p* = .00) and depression (U = 178.500, N_1 = 32, N_2 =17, *p* = .04) but not on age (U = 201.500, N_1 = 32, N_2 =17, *p* = .14).

A multidimensional chi-square test with exact significance option revealed a significant omnibus effect (χ^2 = 7.173, df = 2, *p* = .02). Post-hoc analyses were conducted for each of the groups and for the low anxiety group revealed a significant effect between noticing categories (χ^2 = 7.173, df = 2, *p* = .03). Follow-up analyses with the alpha value corrected for multiple testing and set at .02, revealed, for the low anxiety group, a significant effect between the inattentionally blind and detector groups (χ^2 = 7.200, df = 2, p = .01), but not between the detector and identifier groups (χ^2 = 4.000, df = 2, p = .04), or the inattentionally blind and identifier groups (χ^2 = .571, df = 2, p = .45). Table 4.3.3 presents the noticing rates for the low and moderate to high anxiety groups on the inattention trial. Figure 4.3.2 displays a group histogram for the noticing rates for low and moderate to high anxiety groups on the inattention trial.

A significant effect was found between noticing rates for the high anxiety group ($\chi^2 = 7.176$, df = 2, p = .03). Follow-up analyses with the alpha value corrected for multiple testing and set at .02 revealed significant differences between the inattentionally blind and identifiers groups ($\chi^2 = 7.364$, df = 1, p = .01) but not the detectors and identifiers ($\chi^2 = 3.571$, df = 1, p = .06 [Exact significance option used]) or the inattentionally blind and detector groups ($\chi^2 = 1.000$, df = 2, p = .32).

Table 4.3.3 Noticing rates for the low and moderate to high anxiety groups on the inattention trial on the large spider experiment.

Response Type Anxiety Group	Inattentionally blind	Detector	Identifier
Low Anxiety	16 (50%)	4 (13%)	12 (37%)
Moderate to high anxiety	10 (59%)	6 (35%)	1 (6%)

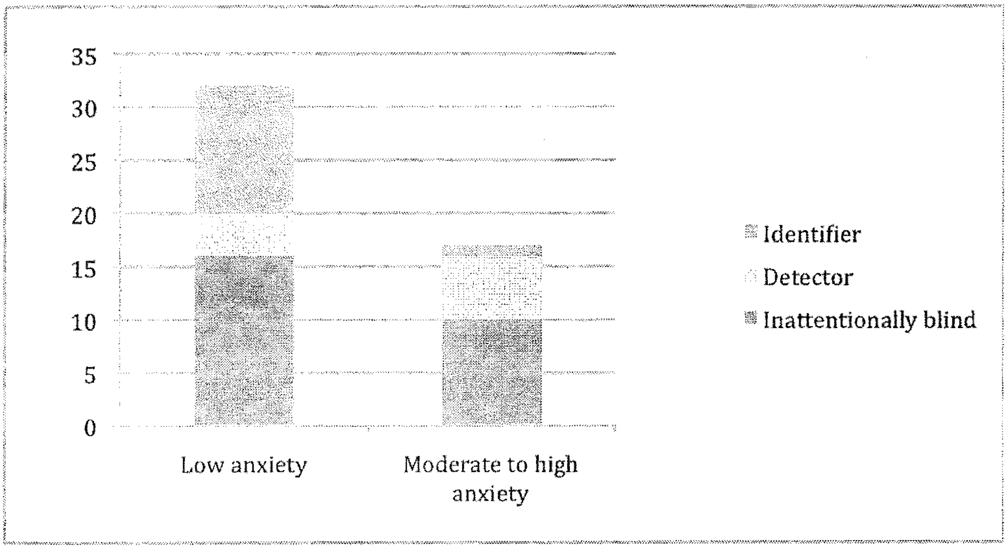

Figure 4.3.3 Group bar charts for noticing rates for the low and moderate to high anxiety groups on the inattention trial for the large spider experiment.

4.3.4 Discussion

In relation to the hypotheses outlined in the introduction, the general noticing rates indicate that the majority of participants had no specific awareness of the large spider image when it was presented on the critical inattention trial, suggesting again that spiders are not processed as if they represent an evolutionary threat. Nonetheless, the results from the forced choice test show that significantly more of the inattentionally blind participants chose the spider image over neutral geometric objects and a distorted spider that did not appear during the experiment, indicating that the image was implicitly perceived even though it was not consciously registered. The results from the divided and full attention trials indicate that the spider stimulus was perceptible when participants expected it and when attention was not engaged on a separate task, respectively.

When the groups were separated into moderate to high and low spider fear, the results indicated that there was no association between fear status and noticing rates. The noticing categories have similar frequencies for both groups. Specifically, the hypothesis that if spider fearful individuals display a perceptual and attentional bias towards spider images they will notice the spider on the critical inattention trial was not confirmed by the present investigation.

The participants were also separated into moderate to high and low anxiety in order to test the hypothesis that if anxiety causes a hypervigilance of the attentional system (Eysenck, 1997), whereby anxious individuals have increased awareness of novel objects appearing in their visual environment, they would see the spider image by virtue of it being an additional object. This hypothesis was not confirmed, despite the anxiety subscale having a Cronbach's alpha value in line with those reported by Mykletun et al. (2005).

The role of meaning as a predictor of the summoning of attention via perceptual processes, when attention is engaged on a concurrent task, also has implications for theories suggesting that spiders have a visual evolutionary threat value (e.g., Öhman, 2005). If the spider held a specific evolutionary property, which signified danger, the majority of participants would have noticed the image. *Because the majority of participants did not display any attentional processing of the spider*, two suggestions can be made. Firstly, the spider does not have sufficient threat value to attract attention. Secondly however, it might be the case that the spider was not of sufficient threat value for the perceptual system to pull attention away from the concurrent task. The following experiments will seek to address these questions.

Similarly to the analysis of anxiety, the results for the analysis of fear showed that the moderate to high fear group did not notice the spider image when it was presented against expectation and while attention was absorbed on the cross judgement task. Theories of threat detection generally and threat detection in anxiety suggest that pre-attentive perceptual processes analyse a stimulus and react by bring the stimulus within foveal vision and attentional processes. Theories such as LeDoux's (1996) suggest that it is the thalamo amygdala pathway (the 'low-road') that responds when a threatening object is perceived. Similarly the cognitive psychopathology models (e.g., Williams et al. 1988; 1997) suggest preattentive systems that operate below conscious awareness and judge the threat value of the incoming stimulus. If threat is judged to be high, feed into secondary components direct attentional resources towards the threatening object. These models are not supported by the current findings because neither the majority of participants nor the participants with increased spider fear noticed the image, despite the reliability of the scale achieving a high Cronbach's alpha value, suggesting spider fear was measured accurately.

It is possible that the results from this experiment are due to the location of the stimulus. The spider was placed in the right quadrant of the cross and therefore to the left hemisphere. Mogg and Bradley (2002) and Fox (2002) suggest that the bias is more pronounced when stimuli are presented in the left visual field and to the right hemisphere. The following experiment will therefore examine if inattentional blindness is affected by hemispheric specialisation when fearful stimuli are presented.

Secondly, the images used so far are schematic and not picture of actual spiders, unlike those used by other researchers. Forthcoming experiments will also seek to address this issue.

4.4 Left Visual Field Experiment

4.4.1 Introduction

The previous experiments using small and large schematic spider images have not demonstrated a specific attentional bias towards threat in people with heightened levels of spider fear. The purpose of experiment 4 was to examine whether the same large schematic spider is able to attract the attention of fearful individuals and anxious individuals if it is placed in the left visual field, and thus projected to the right hemisphere. Mogg and Bradley (2002) and Fox (2002) both found, when using a probe-detection experiment (in Fox's case, the subliminal version), that the attentional bias to threat displayed by socially phobic individuals was more pronounced when threatening stimuli were displayed to the right hemisphere. The hypotheses remain the same for this experiment. Namely, that if spiders possess an evolutionary threat value, the majority of participants will see the spider on the critical inattention trial. Related to this experiment, it is also hypothesised that if the spider is implicitly perceived in the absence of conscious awareness, it will be chosen to a greater degree by the inattentionally blind participants on a forced choice test. Relating to spider fear, it is predicted that if the moderate to high fear individuals show an attentional bias towards threatening objects, noticing rates will be higher for this group. In the case of anxiety, it is hypothesised that if anxious individuals display hypervigilant perceptual and attentional systems, the group with elevated anxiety will be more likely to notice the spider on the critical inattention trial.

4.4.2 Method

4.4.2.1 Design

The design was the same as outlined in the general method section.

4.4.2.2 Participants

The participants for the experiment were 21 males and 25 females (mean age 37, SD = 15.2), recruited from members of the public visiting the Glasgow Science Centre. All participants had normal or corrected to normal vision. No participants reported a history of neurological trauma or disease, and no participants reported having epilepsy. None of the participants reported knowing the static inattentional blindness paradigm.

4.4.2.3 Materials

In this experiment, the critical stimulus was a spider, which appeared in the bottom left quadrant 2.5cm (2.9° eccentricity) from fixation. The large spider measured 0.9cm and subtended a visual angle of 1°. This was chosen because it is just below the 1.1° retinal size threshold reported by Mack and Rock (1998). Thus, all parameters remained the same as experiments 2 and 3, apart from the location of he stimulus, which changed from the right to the left hemisphere. The same forced choice test as experiments 2 and 3 was used in experiment 4.

The experiments were conducted in an exhibit cubicle at the science centre. The cubical measured roughly 8ft square and had ambient lighting. The experimental computer and chin rest were place on a table, which had two chairs (one for the participant and one for the experimenter). Additionally, the consent form was placed on the desk in front of the participant's chair. The psychometric scales (the HADS, and the FSQ) were concealed under the desk until after completion of the computerised task. The FSQ had a Chronbach's alpha value of .96. The anxiety subscale of the HAD scale had a Cronbach's alpha value of .89, whereas the depression subscale had a value of .87.

4.4.2.4 Procedure

Between the 1st and the 10th of August 2008 (inclusive) from 11am to 4pm, members of the public visiting Glasgow Science Centre were approached and asked if they would be willing to participate in an experiment examining the link between emotion and perception. The procedure for approaching participants was the same used in experiment 1 and 3 (small spider and large spider [Right visual field], respectively). The participants were informed that the experiment would take no longer than 15 minutes. No information regarding the spider was given.

4.4.3 Results

4.4.3.1 General Noticing Rates

Binomial tests were included to compare the overall rates of inattentional blindness with the number of participants who showed a degree attentional processing. For the inattention trial, 21 of the participants were inattentionally blind and this was found to be non-significant, p = .66. Table 4.4.1 presents the number of participants who were inattentionally blind and the number who showed attentional processing.

Table 4.4.1. Percentage of participants for each response in the left visual field experiment

	Experiment Phase		
Response Type	inattention	divided attention	full attention
Inattentionally Blind	21 (46%)	3 (7%)	0
Attentional responders	25 (54%)	43 (93%)	46 (100%)

Object identification and implicit perception

Of the 21 participants who were inattentionally blind, 1 chose the distorted spider, 6 chose the triangle, 13 chose the spider and 1 chose the circle (χ^2 = 18.429, df = 3, *p* = .00)

4.4.3.2 Association with Fear of Spiders

When the participants were separated into high (n =19) and low (n = 27) phobia groups using the FSQ, the groups differed significantly on the FSQ (U = .000, N_1 = 27, N_2 =19, *p* = .00) and the HAD-Depression (U = 167.500, N_1 = 27, N_2 =19, *p* = .05) but not on age (U = .000, N_1 = 27, N_2 =19, *p* = .62).

A multidimensional chi-square test with exact significance option revealed a significant effect between noticing rates and phobia status (χ^2 = 9.916, df = 2, *p* = .01). Post-hoc comparisons were conducted for each of the groups and the low spider fear group revealed a significant effect (χ^2 = 8.222, df = 2, *p* = .02). Follow-up analyses between each category of noticing. The significance level, corrected for multiple (i.e., 3) comparisons, was set at 0.02 and revealed a significant effect between the inattentionally blind and detector groups (χ^2 = 5.762, df = 1, p = .02) but not between the inattentionally blind and identifier groups (χ^2 = 4.545, df = 1, p = .03) or between the detectors and identifiers (χ^2 = .091, df = 1, p = .76). Table 4.4.2 presents the noticing rates for the high and low phobic groups on the critical inattention trial. Figure 4.4.1 displays a group histogram for noticing rates for the low and moderate to high spider fear groups.

Table 4.4.2 Noticing rates for the phobia groups on the inattention trial for the LVF experiment.

		Response Type	
Spider fear	Inattentionally blind	Detector	Identifier
Low spider fear	16 (59%)	5 (19%)	6 (22%)
Moderate to high spider fear	5 (26%)	1 (5%)	13 (68%)

Comparisons were also conducted for the moderate to high spider fear group. A chi-square test revealed an overall significant effect (χ^2 = 11.789, df = 2, *p* = .00). *Follow-up analyses were conduced.* The significance level was corrected for multiple comparisons (i.e., 3)and set at 0.02. The comparisons revealed non-significant effects between the inattentionally blind and detector groups (χ^2 = 2.667, df = 1, p = .22 [exact significance option used]) and the inattentionally blind and identifier groups (χ^2 = 3.556, df = 1, p = .06) but significant effects were found between the detector and identifier groups (χ^2 = 10.286, df = 1, p = .00).

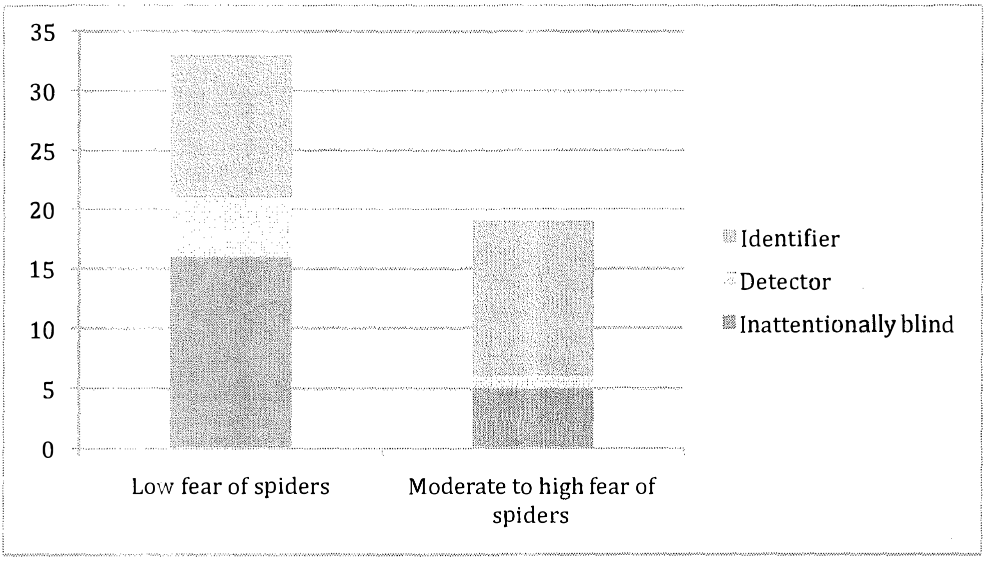

Figure 4.4.1 Group bar charts for noticing rates for the low and moderate to high fear of spiders groups on the inattention trial for the left visual field experiment.

4.4.3.3 Association with Anxiety

When the participants were separated into moderate to high (n = 16) and low (n = 30) anxiety groups using the HAD scale the groups differed significantly on Anxiety (U = .000, N_1 = 30, N_2 =16, ***p*** = .00) and depression (U = 132.000, N_1 = 30, N_2 =16, *p* = .01) but not on age (U = 182.500, N_1 = 30, N_2 =16, *p* = .18). A multidimensional chi-square test with exact significance option revealed a non-significant effect (χ^2 = 2.619, df = 2, *p* = .33, ϕ = .24). Follow-up analyses were not conducted. Table 4.4.3 presents the noticing rates for the low and moderate to high anxiety groups on the inattention trial. Figure 4.4.2 displays a group histogram for the noticing rates for low and moderate to high anxiety groups on the inattention trial.

Table 4.4.3 Noticing rates for the low and moderate to high anxiety groups on the inattention trial for the left visual field experiment.

Response Type Anxiety Group	Inattentionally blind	Detector	Identifier
Low Anxiety	15 (50%)	5 (17%)	10 (33%)
Moderate to High anxiety	6 (38%)	1 (6%)	9 (56%)

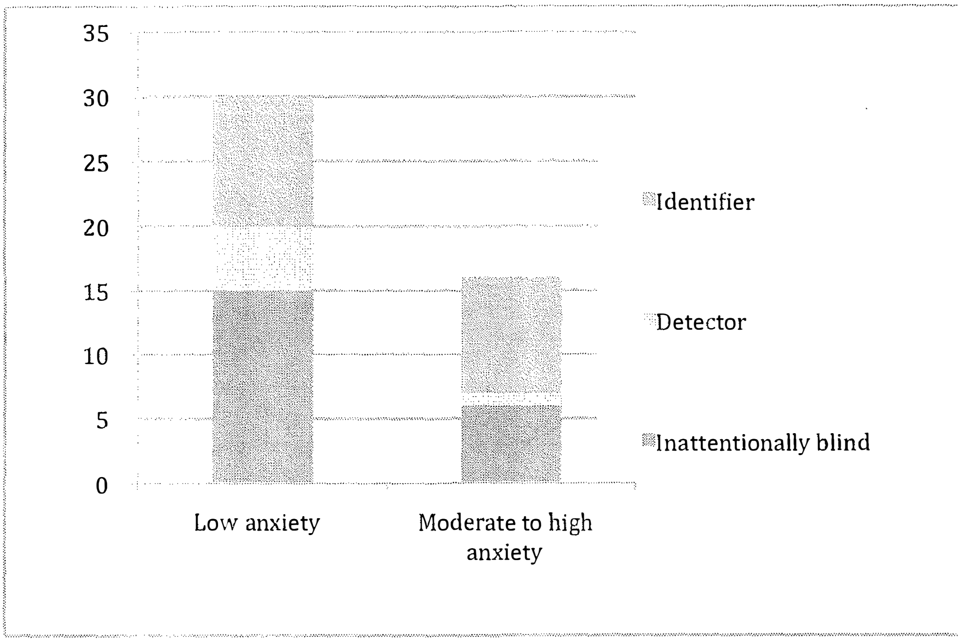

Figure 4.4.2. Group bar charts for noticing rates for the low and moderate to high anxiety groups on the inattention trial for the left visual field experiment.

4.4.4 Discussion

In relation to the hypotheses made in the introduction to this experiment, firstly, generally, spiders were not perceived by the majority of participants, suggesting that they may not have an evolutionary threat value. Supporting this assertion, the results from the object recognition test suggest that the spider was implicitly perceived. This finding is supportive because it indicates that the stimulus was perceptually analysed and registered. Unlike previous experiments, the analysis of spider fear revealed a significant association with noticing rates. The post-hoc analyses for the comparison of interest between the inattentionally blind and identifier participants in the moderate to high spider fear group revealed a non-significant effect. However, this effect approached significance. The analysis of anxiety revealed no significant association between increased anxiety and higher noticing rates. This suggests that anxious people are not generally hypervigilant for new or novel items in their visual environment, and is supported by a high Cronbach's alpha value for the anxiety subscale of the HAD scale.

In relation to the inattentional blindness literature, the current experiment shows that a schematic spider image is not more detectable than a neutral geometric object, and less detectable than other stimuli that may have evolutionary properties (i.e., certain face stimuli). The results, therefore, provide some support for the finding that a negative threatening stimulus does not attract attention. However, where the results from this experiment diverge with those found by Mack and Rock (1998) is that in their experiments, the negative (or more precisely, sad) face was noticed considerably less than geometric objects. In the case of the schematic spider in this experiment, the general rate of noticing is comparable to the geometric object in experiment 1 and neutral shapes in other literature. (e.g., Mack and Rock, 1998). This pattern might be explained by relative threat values. For example, while the sad face is negative, its threat value is low. The spider, on the other hand, might be perceived as more threatening but, because it is schematic, not sufficiently so to elevate noticing rates in the low fear group.

The findings from the current experiment, furthermore, do not support general theories of anxiety that predict that anxious individuals are hypervigilant to novel stimuli in their (visual) environment (e.g., Eysenck, 1997). If anxious individuals display a hypervigilant perceptual and attentional system, it would be predicted that more anxious individuals would have seen the spider image, regardless of its specific emotional value. However, Mogg and Bradley (1998) suggest that increased depression (which the results show that the highly anxious group had) nullifies hypervigilant states by causing the individual to be more internally focussed (e.g., they might have an elaborative memory retrieval bias, rather than an outward, stimulus driven, bias). This factor might explain the non-significant findings from the analysis of how anxiety affects noticing unexpected stimuli, although contesting this, it is noted that the group with increased anxiety did not have depression in the clinical range so this appears unlikely.

The models of cognitive psychopathology that predict threat detection in individuals with anxiety (e.g., Williams et al., 1988; 1997) are based on experimental evidence where particular anxiety disorders are tested in relation to their feared stimulus (e.g., socially phobic individuals being exposed to threatening faces). These models suggest that, at a perceptual level, stimuli are analysed on an affective basis for the threat they present. If they possess sufficient threat to an individual, the perceptual analysis feeds into a component that summons attention and directs it towards the stimulus for a conscious analysis and behavioural reaction (Bar-Haim et al., 2007; Mogg & Bradley, 1998; Williams et al., 1988, 1997). The results from the analysis of the moderate to high fear of spiders group provides marginal support for the suggestion that the perceptual system of these participants registered the spider image and drew attention to it. This was not the case with the low spider fear group, supporting the suggestion that attention was attracted due to increased fear and so the experiment is generally supportive of these models. However, due to the findings from the previous experiments (experiments 2 and 3), the lack of neural specificity requires addressing. For example, none of the models specify hemispheric differences in the processing of feared stimuli by individuals with heightened anxiety. The results from experiment 4 (the previous findings from Fox 2002 and Mogg and Bradley, 2002) suggest that, at least in the case of spider fear, the models need revising to account for the hemispheric asymmetry observed in the experiments. This issue is discussed further in the general discussion section. The following discussion concentrates on the more specific predictions made by the Cognitive Motivational Analysis by Mogg and Bradley (1998).

While the models have in common the preattentive and attentional components that are activated in response to fearful stimuli, that have been supported by the current findings generally, the Mogg and

Bradley (1998) model goes further to predict other factors that influence the valence evaluation system (VES). The marginally significant result lends partial support to the model and the predictions require further interpretation. The VES makes a number of further predictions, in regards to the state of the individual, their relationship to the feared object and the role of trait-anxiety. The role of biological preparedness, in the form of attentional allocation to evolutionarily salient objects, has been partially confirmed in the moderate to high fear group, but not the low fear group. This leaves the question open as to whether fear of spiders is due to a genetic predisposition or a learned response. Indeed, the Mogg and Bradley (1998) model treats each of these factors equally and does not separate their individual contributions. Relating to biological preparedness this appears likely in terms of the current results as the moderate to high fear group reacted to a relatively degraded image of a spider and the low fear group did not. The next experiment was designed to examine if a more realistic image of a spider is able to a) produce the same effect in the moderate to high fear group as found in this experiment and b) examine if an increase in saliency causes increased noticing in the low fear group. The findings from the next study will, therefore, contributed to the discussion as to whether spider fear is due to a biological predisposition or a learned response.

To summarise, the results from the left-visual field experiment lend partial support to the predictions made by biological and cognitive models of psychopathology the spider fearful individuals would be more likely to notice threat in their environment. However, to increase the ecological validity of the experiment, and to examine if a real image of a spider is able to draw the effect in low fear individuals also, the following experiment uses a more detailed image of a spider. This was conducted to examine if the lack of sensitivity that is possible with schematic images caused the bias only in individuals with increased fear. That is to say, it is possible, with a more visually rich stimulus, would attract the attention of all participants. This test was examined in the next experiment and, in combination with the findings from experiment 4, was a direct test of Öhman's (2005) hypothesis that fearful objects should be detected by all individuals (e.g., through their evolutionary saliency) and anxiety is a lowering of the fear threshold (i.e., making anxious individuals more sensitive to degraded images) and the predictions made by the Mogg and Bradley (1998) model.

4.5. Real Spider Experiment

4.5.1 Introduction

The LVF experiment provided partial support for the suggestion that when spiders are projected to the right hemisphere people with heightened fear are more likely to notice them under conditions of inattention than are people who self-report low levels of spider fear, supporting the models of Bar-Haim et al. (2007), Beck and Clarke (1998), Mathews et al. (1997), Mathews and McIntosh (1998) Mogg and Bradley (1998) and Williams et al (1988; 1997). Speaking from an evolutionary perspective, Öhman (2005) suggests that perceptual and attentional bias to threat found in anxiety disorders should be displayed in the general population if threat value is increased. Because previous experiments have used schematic spiders, it is possible to hypothesise that the use of a real spider image will increase the threat value and thus, if there is an evolutionary mechanism that detects spiders, individuals low in spider fear will notice the image.

In relation to the literature on inattentional blindness, Mack and Rock (1998) suggest a retinal size threshold effect, where stimuli subtending a visual angle greater than 1.1° will draw attention by virtue of their size. In the real spider experiment presented here, the spider subtends a visual angle of 1.9°. The combination of increasing saliency by using a real spider image and increasing the stimulus size may both have an effect and, therefore, it might be difficult to separate which factor is responsible. However, Williams et al. (1997) suggest that people have a perceptual defence mechanism, whereby stimuli that are (relatively speaking) mildly threatening are bypassed by the perceptual and attentional systems. They postulate that increased anxiety causes a lowering of this mechanism, which leads to a greater visual awareness of threat in the environment. Therefore, the real spider experiment will also examine whether people with lower levels of fear exhibit a perceptual defence mechanism, operationally defined as lower object detection and identification rates. As with previous experiments, it is hypothesised that if the spider is implicitly perceived by the inattentionally blind participants, it will be chosen on a forced choice test more frequently than other objects not appearing in the experiment. Additionally, the hypothesis that anxious individuals are hypervigilant for novel objects in their environment will be examined by looking at noticing rates and their association with increased anxiety.

4.5.2 Method

4.5.2.1 Design

The design was as described in the general method section.

4.5.2.2 Participants

Participants were 14 females and 16 males and were recruited from an Open University open day in Cardiff on 6.12.08 between 12:00 and 17:00 (mean age 33, SD = 11.6). All participants had normal or corrected to normal vision. No participants reported a history of neurological trauma or disease. No participants reported having epilepsy and, after the experiment was conducted, none of the participants claimed to have prior knowledge of the static inattentional blindness experiment.

4.5.2.3 Materials

The critical stimulus was a Redback spider image taken from a Google image search using the terms "Redback" and "Spider". The photograph was opened with Microsoft Paint and the red colour on the spider's abdomen was changed to black as it has been shown that differences in colour can affect noticing rates during inattentional blindness trials (Mack & Rock, 1998). The spider subtended a visual angle of 1.9° at a distance of 2.5 centimetres (2.9° eccentricity) from the centre of the cross, in the bottom left quadrant. This procedure was used again because of the findings from experiment 4, which suggest that, in the high fear group, spiders are engaged rapidly by the attentional system. A forced choice test, similar to the one used in previous experiments was used in this experiment. However, the spider and distorted spider images were matched to the one used in the computer task (see figure 2.4b in chapter 2). The FSQ had a Chronbach's alpha value of .96. The anxiety subscale of the HAD scale had a Cronbach's alpha value of .89, AND the depression subscale had a value of .87.

4.5.2.4 Procedure

On December 6th 2008 at the Open University open day, between 12 noon and 5pm, participants were approached and asked if they would be willing to participate in an experiment designed to examine the link between perception and emotion (the procedure for approaching participants was the same as that used in experiments 1 and 3). The participants were informed that the experiment would take no longer than 15 minutes. No information regarding the spider was given. Other procedural measures remained the same as outlined in the general method section.

4.5.3 Results

4.5.3.1 General Noticing Rates

Binomial tests were included to compare the overall rates of inattentional blindness with the number of participants who showed a degree attentional processing. For the inattention trial, 10 of the participants were inattentionally blind and this was found to be non-significant, p = .10. Table 4.5.1 presents the number of participants who were inattentionally blind and the number who showed attentional processing.

Table 4.5.1. General frequencies and percentages for noticing rates on the inattention, divided attention and full attention trials for the real spider experiment.

	Experiment Phase		
Response Type	inattention	divided attention	full attention
Inattentionally Blind	10 (33%)	1 (3%)	0
Attentional responders	20 (3%)	29 (3%)	30 (100%)

Object Identification and implicit perception

Of the 10 participants that were inattentionally blind, 1 selected the distorted spider, 6 selected the circle and 6 selected the spider (χ^2=3.800, df=2, *p* = .18).

4.5.3.2 Association with fear of spiders

Participants were separated into moderate to high and low spider fear groups based on the cut-off points used in previous research. Participants with a score equal to or less than 29 were allocated to the low fear group (n=20) and participants with a score of equal to or greater than 30 were allocated to the moderate to high fear group (N=10). The groups did not differ on age (U = 68.500, N_1 = 10, N_2 =20, *p* = .17) or depression (U = 74.500, N_1 = 10, N_2 =20, *p* = .27) but did differ on level of spider fear (U = .000, N_1 = 10, N_2 =20, *p* = .00).

A 2 (high and low fear) x 3 (inattentionally blind, detector, identifier) multidimensional chi square with an exact significance option was employed to examine the association between fear status and noticing rates (χ^2 = 5.108, df = 2, *p* = .04). Table 4.5.2 presents the noticing rates for the moderate to high and low fear groups on the inattention trial. Post-hoc analyses were conducted on the significant result for each group independently. Due to none of the participants being categorised as a detector in the low fear group the significance value remained at .05 and a single goodness-of-fit Chi-square test between the detectors and identifiers revealed no significant association (χ^2 = .200, df = 1, p =.66).

On the other hand, for the high phobia group, the post-hoc analysis revealed an overall significant effect (χ^2 = 9.800, df = 2, *p* =.01). Comparisons between the inattentionally blind (n = 1) and detectors (n = 1) were not conducted. Therefore, The significance level was corrected for multiple comparisons (i.e., 2) and set at 0.03. Follow-up analyses revealed the effect was present between the detector and identifier groups (χ^2 = 5.444, df = 1, p =.02) but not the inattentionally blind and identifier groups (χ^2 = .544, df = 1, p = .04).

Table 4.5.2 Noticing rates for low and moderate to high fear of spiders groups on the inattention trial for real spider experiment.

	Response Type		
Fear of spiders	Inattentionally blind	Detector	Identifier
Low fear of spiders	9 (45%)	0	11 (55%)
Moderate to high fear of spiders	1 (10%)	1 (10%)	8 (80%)

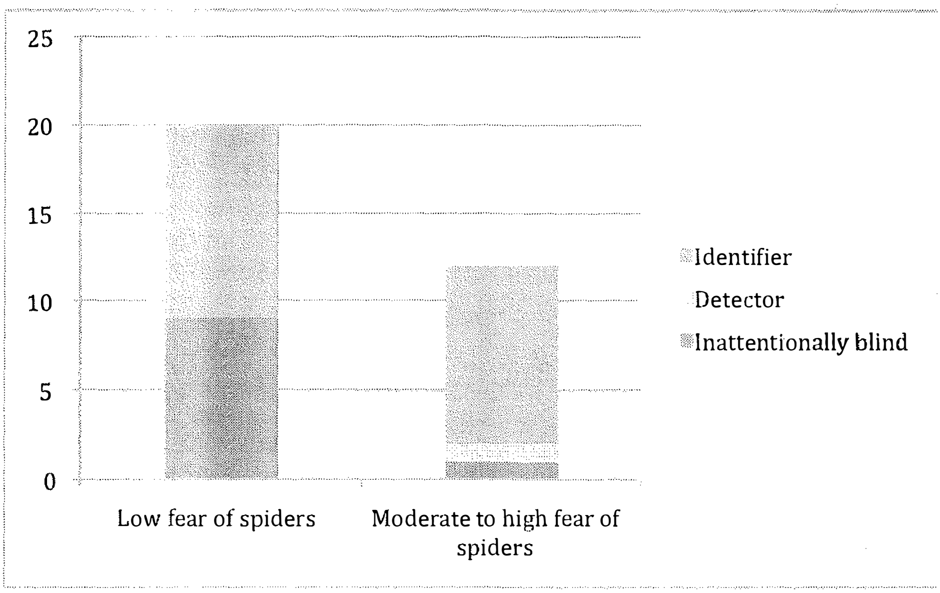

Figure 4.5.1 Group bar charts for noticing rates for the low and moderate to high fear of spiders groups on the inattention trial for the real spider experiment.

4.5.3.3 Association with Anxiety

When the participants were separated into moderate to moderate to high and low anxiety using the HAD scale (Zigmond & Snaith, 1986) they did not differ on age (U = 110.500, N_1 = 15, N_2 =15, *p* = .94) but did differ on depression (U = 60.000, N_1 = 15, N_2 = 15, *p* = .03) and anxiety (U = .000, N_1 = 15, N_2 = 15, *p* = .00). A multidimensional Chi-square test revealed no significant association (χ^2 = 1.874, df = 2, *p* = .45). Post-hoc analyses were not conducted. Table 4.5.3 presents the noticing rates for the low and moderate to high anxiety groups on the inattention trial. Figure 4.5.2 displays a group histogram for the noticing rates for low and moderate to high anxiety groups on the inattention trial.

Table 4.5.3 Noticing rates for the low and moderate to high anxiety groups on the inattention trial for the real spider experiment.

	Response Type		
Anxiety Group	Inattentionally blind	Detector	Identifier
Low Anxiety	6 (40%)	1 (7%)	8 (53%)
Moderate to high anxiety	4 (27%)	0	11 (73%)

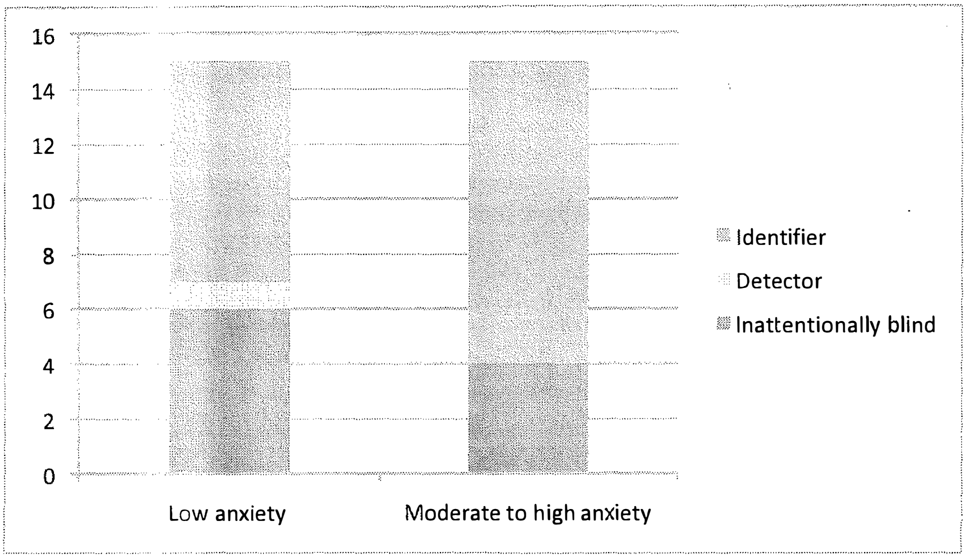

Figure 4.5.2 Group bar charts for noticing rates for the low and moderate to high anxiety groups on the inattention trial for the real spider experiment.

4.5.4 Discussion

In experiment 5 a number of hypotheses were made. Firstly, in relation to the high fear group, it was predicted that the noticing rates would present the same pattern as in experiment 4. Namely, that a significant majority of this group would identify the spider. In relation to the low fear group, two competing hypotheses were made. Firstly, in relation to the suggestion of Öhman (2005), it was predicted that if spiders represent an evolutionary threat value, the increase in saliency in this experiment would cause increased noticing rates. This finding would contribute to interactions between biological preparedness and prior learning as predicted by the Mogg and Bradley (1998) model. However, to take into account the suggestion of a perceptual defence mechanism (e.g., Minard, 1965), it was also suggested that if this were in operation, the low spider fearful group would not notice the object.

The general noticing rates in experiment five were higher than those found in other experiments. However, the analysis shows that there was not a significant degree of blindness and, more importantly, no significantly high level of noticing, which is discussed below in relation to the general noticing rates. As with previous experiments, and the work of others (e.g., Mack & Rock, 1998) identification rates on the divided and full attention trials were, as predicted, high, which ensures that the stimulus was perceptible when attention was not fully engaged on the cross judgement task. The results from the forced choice task revealed that no object in the array was chosen significantly more. However, as only ten of the participants were inattentionally blind, the participant numbers may have been too low.

When the participants were separated into moderate to high and low fear groups based on scores from the FSQ (Syzmanski & O'Donohue, 1995) the results indicate that there was an overall significant effect between noticing rates and fear status. Post-hoc analyses were conducted on both the moderate to high and low fear groups independently. For the low fear group, the three noticing categories were collapsed into two (inattentionally blind and identifier) due to no participants being categorised as detectors. The results show no significant difference between identification and inattentionally blind categories.

Post-hoc analyses for the moderate to high fear group indicated that significantly less of the participants were able to detect the spider. This result is not of particular interest and so an analysis was conducted between those participants who were inattentionally blind and those who were able to identify the spider. That is to say, the important analysis was between people who missed the spider (the inattentionally blind group) and the people who saw the spider and were correctly able to identify it (the identifier group). This approached significance, with the moderate to high fear group showing a tendency towards noticing the spider. Finally, when the low and moderate to high anxiety groups were compared, the group with higher levels of anxiety did not notice the spider more frequently.

The general noticing rates present a different picture compared with the previous experiments and literature on inattentional blindness. Firstly, the noticing rates were higher in this experiment compared with previous experiments and this is expected due to the increase in the size of the stimulus. However, it was predicted that the increase in size would have elevated the noticing rates to a higher degree than has been observed, due to Mack and Rock's (1998) suggestion of a retinal size threshold effect, where stimuli greater than 1.1° draws the attention of the majority of participants due to their size. Mack and Rock (1998) suggested that the retinal size threshold effect indicated that selection came early in the attentional bottleneck because basic stimulus features increased the noticing rates.

The results from the current experiment, however, could suggest that the perceptual system filters out certain stimuli at the perceptual level. This finding would suggest that late selection also occurs and filters out certain stimuli. Currently, the result here is reminiscent of the findings presented by Mack and Rock (1998) in regard to the face experiments. They found that a happy face was able to draws the attention of the majority of participants in their study, however, when the direction of the mouth was changed to signify a sad expression (but all other characteristics remained constant), noticing rates dropped significantly. While this is speculative because a direct comparison cannot be made, it is possible that a similar process was happening in the current experiment. That is, the participant's perceptual systems were filtering out the spider due to some higher-level properties (e.g., information beyond the psychophysical properties of the object) it possesses. However, this conclusion is tentative at the moment because of the difference in visual angles used in the current study. It is possible that, because the stimulus was placed further away from fixation in the experiment presented here, noticing rates generally were lower. The following experiment (experiment 6) addresses this issue, and further contributes to the discussion of whether stimulus selection is early or late in the attentional bottleneck (see section 4.6).

The hypervigilance model of anxiety proposed by Eysenck (1997) suggests that anxiety causes a hypervigilance of the attentional system. This suggests that anxious people will be distracted not only by their chosen fear, as is the case with specific phobias, but also if general anxiety is high, they will notice / be distracted by additional objects in their visual environment. The results from the current experiment do not confirm this suggestion. When the groups were separated into moderate to high and low anxiety using the HAD scale (Zigmond & Snaith, 1986), the finding that the high anxiety group were not more likely to notice the spider suggests that they are not hypervigilant for additional stimuli in their environment when attention is already engaged on a task. This suggestion is supported by the HAD scale anxiety subscale showing a reliability value in the same range as that reported by Mykletun (2005).

The various models of cognitive psychopathology regarding anxiety and phobias (Bar-Haim et al., 2007; Williams et al., 1988, 1997) have specified that certain stimulus properties and their meaning to the individual are critical in how attentional bias to threat manifests itself. That is to say, whereas the Eysenck (1997) hypervigilance model suggests an overall, stimulus independent, effect, these models propose that certain stimuli will elicit the effect and others will not. In terms of specific phobias, the models propose that preattentive mechanisms operate below conscious awareness and appraise the emotional valence of a stimulus. If threat value is high, attention will be withdrawn from a current task, and allocated to that object. If threat value is low, attention will bypass the additional object and remain on the current task. In the case of the experiment presented here the results provide only marginal support for this prediction.

In relation to the question of biological preparedness in the Mogg and Bradley (1998) model, and in relation to the suggestions of Öhman (2005), the results of this experiment show a similar pattern of noticing. The absence of a major increase in the low fear group suggests that humans are not biologically pre-programmed to detect spiders. Firstly, this finding does not support the views of Öhman (2005). Secondly, the findings suggest that greater emphasis should be placed on prior learning. However, in order to further verify this suggestion, the following experiment investigates whether a large neutral object elicits lower levels of inattentional blindness in the low fear group. That is to say, if the large neutral object is identified more frequently by the low fear group, it is possible to suggest that there is a biological preparedness but that anxiety is associated with a lowering of this perceptual defence. However, if noticing rates are similarly low in the low fear group, it could be suggested that these individuals are not demonstrating perceptual defence, and therefore spiders have no evolutionary basis.

To summarise, the results of this experiment lent only partial support to the hypothesis that spiders attract attention when they are not expected. That is to say, there was only a marginally significant effect observed in the moderate to high fear group. What is interesting is that, for the participants without or with minimal fear of spiders, the noticing rates remained similar, despite the increase in size and clarity of the image. As suggested above, this might be because these participants were exhibiting a perceptual defence against spider images. This possibility is plausible because spiders, particularly in northern Europe, do not represent a threat sufficient to endanger life. The following experiment is designed to examine this further by examining the attentional response of moderate to high and low fear groups to a neutral object that is the same size as the spider stimulus contained in this experiment. The introduction to the following experiment describes this hypothesis in more detail.

4.6. Large Neutral Object

4.6.1 Introduction

In Experiment 5, previously, the spider presented in the left visual field subtended a visual angle of 1.9°. This was much larger than in preceding experiments and it was predicted that the majority of participants would have noticed the object due to the size increase. The results lent partial support for the hypothesis that spider fearful individuals display an attentional bias towards spiders. Another finding was that, despite the increase in size, the participants with low levels of spider fear did not show any elevation in noticing rates. That is to say, for this group, rates of inattentional blindness remained the similar to those found in previous experiments. This finding led to the tentative suggestion that the low fear group might be exhibiting a form of perceptual defence, where their perceptual and attentional systems were bypassing the spider (and remaining on task) because it only represented minor or no threat. It was further suggested that is this was the case, it would indicate two factors: 1) that fear of spiders has an evolutionary basis and 2) that anxiety is a lowering of perceptual defence. To assess this interpretation, the current experiment placed a neutral black rectangle in the same position as the spider in experiment 5. Unlike the previous neutral object experiment, in this experiment, although the critical object is not related to spiders, the FSQ (Szymanski & O'Donohue, 1996) will be used to examine the attentional response of the moderate to high and low fear groups. In line with this procedure the following predictions are made. Firstly, if the trend observed for the moderate to high fear group in experiment 5 is not specific to spider image, noticing rates will be higher for this group, as compared with the low fear group for the neutral object. Secondly, if the low fear group demonstrated a perceptual defence that protected them from spider images, they will be more likely to notice a large neutral object, in comparison with the spider image. Finally, as with the small neutral object experiment, the hypervigilance model of anxiety will be examined. The hypothesis for this experiment is that if anxiety is characterised by a general pattern of hypervigilance, the highly anxious group will be more likely to notice the unexpected object.

4.6.2 Method

4.6.2.1 Design

The design did not deviate from that outlined in the general method section, apart from the divided attention trial was eliminated in this experiment as it the results from this trial were considered irrelevant to the hypotheses. This procedure was used by Cartwright-Finch and Lavie (2006). The full-attention trial remained, as this was necessary to ensure that the object was detectable when attention was not engaged on the cross-judgement task.

4.6.2.2 Participants

The participants for the experiment were 14 females and 17 males (mean age 41.42, SD = 15.28), recruited from visitors attending Cheltenham Science Festival between the 3rd and the 8th of June 2009. All participants had normal or corrected to normal vision. No participants reported a history of neurological trauma or disease. No participants reported having epilepsy and no participants reported having knowledge of the static inattentional blindness paradigm.

4.6.2.3 Materials

The critical stimulus was a black rectangle, which subtended a visual angle of 1.9° at a distance of 2.5 centimetres (2.9° eccentricity) from the centre of the cross, in the bottom left quadrant. The forced choice test was the same as experiment 5 (see section 4.5.2.3). The FSQ had a Chronbach's alpha value of .97. The anxiety subscale of the HAD scale had a Cronbach's alpha value of .77, whereas the depression subscale had a value of .32.

4.6.2.4 Procedure

Between the 3rd and the 8th of June 2009, visitors to the science festival were approached and asked if they would be willing to participate in an experiment designed to examine the link between perception and emotion (the procedure for approaching participants was the same as that used in experiments 1 and 3). The participants were informed that the experiment would take no longer than 15 minutes. No information regarding the spider was given. The procedure remained the same as the general method section.

4.6.3 Results

4.6.3.1 General noticing rates

Binomial tests were included to compare the overall rates of inattentional blindness with the number of participants who showed a degree attentional processing. For the inattention trial, 14 of the participants were inattentionally blind and this was found to be non-significant, *p* = .36. Table 4.6.1 presents the number of participants who were inattentionally blind and the number who showed attentional processing.

Table 4.6.1. General frequencies and percentages for noticing rates on the inattention, divided attention and full attention trials on the large neutral object experiment

	Experiment Phase	
Response Type	inattention	full attention
Inattentionally Blind	14 (45%)	0
Attentional responders	17 (55%)	31 (100%)

Object Recognition

Of the 14 participants who were inattentionally blind, 5 selected the rectangle, 4 selected the distorted spider, 4 selected the spider and 1 selected the circle (χ^2 = 2.571, df = 3, *p* = .46 Exact significance test used).

4.6.3.2 Association with fear of spiders

When the participants were separated into moderate to high (n = 5) and low (n = 26) fear of spiders using the FSQ, the participants did not differ on depression (U = 64.000, N_1 = 26, N_2 =5, *p* = .96) or age (U = 38.500, N_1 = 26, N_2 =5, *p* = .15) but did differ on spider fear (U = .000, N_1 = 26, N_2 =5, *p* = .00).

A multidimensional chi-square test with exact significance option revealed no significant association (χ^2 = 5.391, df = 2, *p* = .20). No further analyses were conducted. Table 4.6.2 presents the noticing rates for the low and moderate to high fear of spiders groups on the inattention trial. Figure 4.6.1 displays a group histogram for the noticing rates for low and moderate to high fear of spiders groups on the inattention trial.

Table 4.6.2 Noticing rates for the low and moderate to high fear of spiders groups on the inattention trial for the large neutral object experiment.

Response Type			
Fear of spiders	Inattentionally blind	Detector	Identifier
Low fear of spiders	12 (46%)	0	14 (54%)
Moderate to high fear of spiders	2 (40%)	1 (20%)	2 (40%)

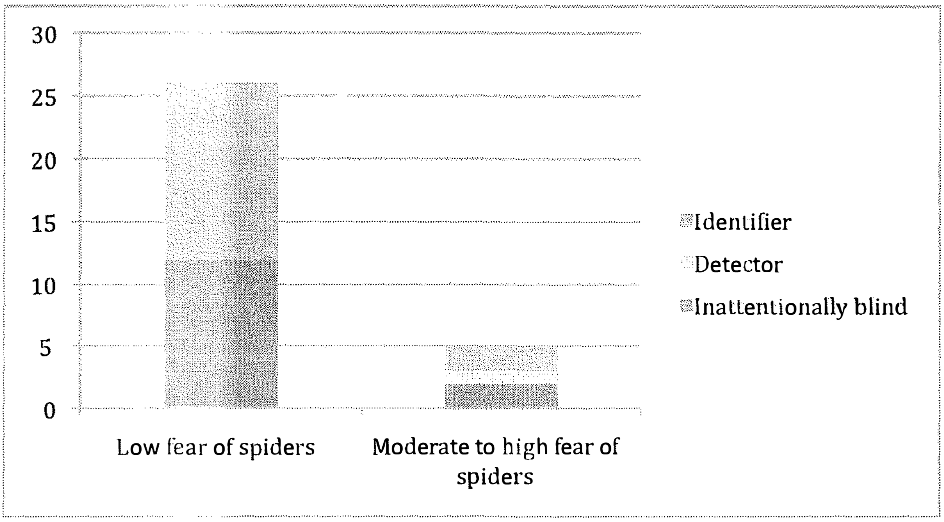

Figure 4.6.1 Group bar charts for noticing rates for the low and moderate to high fear of spiders groups on the inattention trial for the large neutral object experiment.

4.6.3.3 Association with Anxiety

When the groups were separated into moderate to high (n = 8) and low (n = 23) the groups did not differ on age (U = 71.000, N_1 = 23, N_2 =8, *p* = .362), but did differ on depression (U = .000, N_1 = 23, N_2 =8, *p* = .01) and anxiety (U = .000, N_1 = 23, N_2 =8, *p* = .615). A multidimensional chi-square test with exact significance option revealed a no significant association (χ^2 = .409, df = 2, *p* = 1.0). Follow-up analyses were not conducted. Table 4.6.3 presents the noticing rates for the low and moderate to high anxiety groups on the inattention trial. Figure 4.6.2 displays a group histogram for the noticing rates for low and moderate to high anxiety groups on the inattention trial.

Table 4.6.3 Noticing rates for the low and moderate to high anxiety groups on the inattention trial for the large neutral object experiment.

Response Type Anxiety Group	Inattentionally blind	Detector	Identifier
Low Anxiety	10 (44%)	1 (4%)	12 (52%)
Moderate to high anxiety	4 (50%)	0	4 (50%)

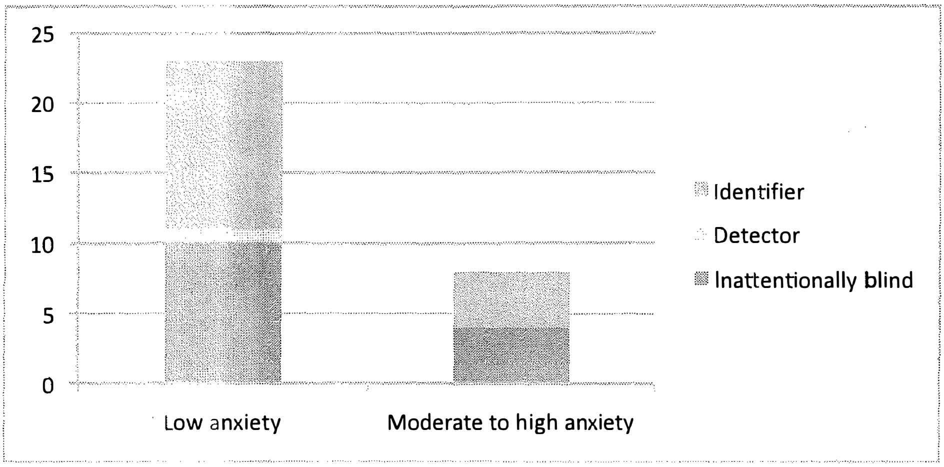

Figure 4.6.2 Group bar charts for noticing rates for the low and moderate to high anxiety groups on the inattention trial for the large neutral object experiment.

4.6.4 Discussion

The purpose of experiment 6 was to examine if the large spider effect observed in experiment 5 was simply due to size, or whether it was due to a specific effect of the stimulus. The results showed that, in the case of the low and moderate to high fear groups, the participants did not show a bias towards the geometric object. This suggests that spider fearful individuals are responsive only to spider images. Moreover, the low fear group did not show higher noticing rates for the larger neutral object relative to the large spider suggesting that their inattentional blindness in experiment 5 for the spider image was not due to a perceptual defence against threat.

The analysis of the general noticing rates shows that the large neutral object did not elicit significantly lower levels of inattentional blindness, despite the increase in size. This finding is discussed in more detail in the general discussion section, in relation to general theories of perception and attention. The results of the analysis of the moderate to high and low anxiety groups show that the high anxiety group did not detect the object to any greater level than did the low anxiety group. They therefore do not confirm the predictions made by Eysenck (1997) that anxiety is associated with a general hypervigilance for new or novel stimuli in the visual environment.

In relation to the suggestions of cognitive models of attentional bias to threat (e.g., Bar-Haim et al., 2007; Williams et al., 1988; 1997), while the results from this experiment are not immediately compatible with the theories due to the neutrality of the critical stimulus, they nevertheless add to the findings from experiment 5 (real spider experiment). For example, the spider stimulus is experiment 5, although only marginally significant, did attract the attention of more of the spider fearful participants than was the case in the experiment presented here although the stimuli did not differ in size. Therefore, the results from both experiments lend only partial support for models of cognitive psychopathology.

The results have implications for the neurobiological model proposed by Öhman (2005) and the model proposed by Mogg and Bradley (1998). Both models suggest that anxiety causes an oversensitivity to threat, which manifests as anxious individuals being more sensitive to potential danger, but that all individuals should be sensitive to evolutionarily based threat if danger is higher. This hypothesis was not supported by experiment 5, where, despite the increased clarity of the spider image, it still failed to draw the attention of the low fear group. It was suggested in that experiment that the effect could have been due to the low fear group displaying a perceptual defence against mildly threatening objects, which would confirm the suggestions of Mogg and Bradley (1998) and Öhman (2005), in particular that spider fear is an evolutionary artefact. The findings from this experiment suggest that perceptual defence had not occurred because the low fear group did not recognise the large neutral object. The experiment presented in chapter 5 further increases the saliency of the image by creating a moving spider stimulus.

Chapter 5 – The dynamic experiment

5.1 Introduction

The previous experiments presented in this thesis used the static inattentional blindness task to assess whether phobic individuals noticed spiders when they were presented against expectation. The findings lent partial support to the hypothesis that spiders presented in the left visual field will be localised by people with an increased fear of spiders. The purpose of the dynamic experiment is to examine whether the same bias occurs for moving images.

The experiment described here is designed to assess if phobic individuals display the same bias for moving spider images. Additionally, the results from experiments 4, 5 and 6 suggest that individuals with low levels of spider fear will not localise spider images. This was found despite a systematic increase in saliency across the experiments. Due to the noticing rates being almost equal for the low spider fearful groups in experiments 5 (real spider experiment) and 6 (large neutral object experiment), which were 45% and 46% respectively, it was suggested that this group are not exhibiting a perceptual defence against spiders. The results therefore do not support the suggestion that spider phobia has an evolutionary basis. However, as this suggestion is contrary to the theories proposed by Mogg and Bradley (1998) and Öhman (2005) and might be due to the relatively innocuous level of the stimulus (for example, the stimuli so far have been static computer generated images), it was decided that this suggestion should be further tested with a an increase in saliency to a moving spider image.

5.1.1 Previous work on Dynamic Inattentional Blindness

The work on dynamic inattentional blindness has been discussed in the introduction (see section 1.4.3) so only a short description will be provided here. Simons and Chabris (1999) developed the work of Nessier (1979) and presented participants with a scene where six people are divided into two teams of three people (the "white team" and the "black team"). Each team has a basketball and the players are passing it to one another. During this brief scene, and unexpected event occurs. A person, dressed in a Gorilla suit, walks in from the right, stops in the middle and beats their chest, and then continues walking left until they leave the screen. The findings indicated that 46% of the participants in the study missed the gorilla, despite it passing directly through their visual field. A further finding from the study was that participants attending to the "black team" were more likely to notice the gorilla than were the participants attending to the white team, suggesting that attentional set affects noticing rates.

The work by Simons and Chabris (1999) was followed up in two ways. Firstly, Memmert (2007) presented the same scenario to basketball experts and non-experts and found that the experts were more likely to detect the gorilla than were non-experts. It was suggested from these findings that, due to their expert status, the demands of the task were lower on for the expert group. Secondly, Wayand et al. (2005) used the same basketball attentional task but replaced the gorilla with a girl who scratches her nails down a blackboard halfway through the scene. The sound of the nails scratching down the board was included in the scene. The results showed that inattentional blindness remained at a similar level of that of the Simons and Chabris (1999) study, despite the change of stimuli and additional sound, suggesting that when attention is engaged on a demanding task, additional stimuli presented in a different modality are still unable to break through from perception to attentional processing. As suggested in the introduction, this research has an important implication; it demonstrates that stimuli that are noxious can be filtered out by the perceptual system before they reach attentional processing. This suggestion is supported by Mack and Rock's (1998) claim that conscious perception only occurs with attention. Thus, the absence of any conscious awareness of the object suggests it did not reach the attentional system. This, as suggested in the introduction, has important implications for the study of anxiety and inattentional blindness.

5.1.2 Dynamic experiments in cognitive psychopathology

During the production of this thesis, one peer-reviewed paper had been published that investigates anxiety through the inattentional blindness experiment. A dynamic experiment was conducted by Lee and Telch (2008). In their dynamic task, participants were instructed to count how many times a particular type of shape that moving around the display touched the side. During this task an additional object appears, which entered the screen from the right and moved to the left. It was found that individuals with increased social phobia were more likely to notice the stimulus when it was a schematic face with a frowning (i.e., angry) facial expression, suggesting that increased levels of fear reduce inattentional blindness for threatening faces.

While the Lee and Telch (2008) task was dynamic in as far as the distracter stimuli and critical stimulus were moving (and so attention was required to shift to a number of areas), the critical stimulus does not resemble an actual moving face. It is schematic, and has no moving features (for example, the facial expression does not go from neutral to angry). While some researchers argue that schematic faces have a more powerful effect on cognitive-perceptual biases (Juth et al., 2005), these comments have been made in relation to typically static experimental designs and realistic dynamic stimuli might have a different effect. Therefore, while the Lee and Telch (2008) study indicates biases are present for moving images, the effect of realistic stimuli was not fully addressed by the study.

With regard to attentional bias to spiders, the cognitive psychopathology literature is dominated by experiments using static images of spiders. Only recently did Vrijsen, Fleurkens, Nieuwboer and Rinck (2009) conduct an experiment with moving images of spiders. There experiment was based on the probe-detection task, and the procedure was as follows. Participants were presented with a central fixation cross, after which a spider and a wheel were presented. The images moved in either straight lines or in pseudo-random ways across the left or right of the visual display for 250ms. During the display, a probe appeared on the side that either the spider or the wheel appeared. The participants were required to locate the probe as quickly as possible. The results showed that the spider phobic participants were faster than the control participants at detecting the probe when it appeared on the side of the spider, suggesting an attentional bias to moving spiders in spider phobic individuals.

The Vrijsen et al. (2009) experiment is unique in so far as it is the first study to contain a moving image of a spider. However, an argument similar to the one made for static experiments – that informing participants prior to the task that a spider will appear shows little about how (moving) spiders are detected when they are not expected. Therefore, the current experiment builds on this work by providing an attentional task and a moving spider image, however, crucially, in the experiment described here, the spider was unexpected.

5.1.3 Current Dynamic Experiment

Based on the previous research using dynamic inattentional blindness tasks (e.g., Simons and Chabris, 1999), it was assumed that in order to elicit inattentional blindness for spiders, the participant's attention would need to be absorbed on a concurrent, but unrelated, task that was attentionally demanding. For this purpose, a task was created where eight cards were presented in two horizontal rows of four that were separated by a width of one card, measured vertically (see figure 5.1.).

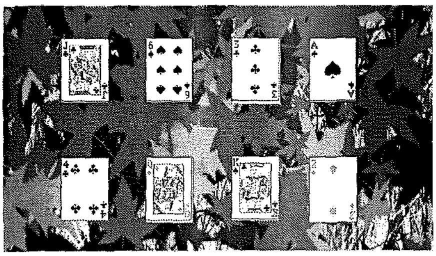

Figure 5.1 Card vigilance task on the dynamic experiment

During the task the cards refresh sequentially from left to right on the top row and then in the same sequence for the bottom row, before repeating the top row. This sequence continues for 75 seconds. The participant's task during this time is to count how many times they see two or more cards that are presented contain the same number or picture (i.e., Jack, Queen or King). The task was programmed so that the participant would be required to shift their attention across the whole display continually. For example, a number 2 card appears in the position of card 3 and remains there while another number 2 card appears in the position of card 6, beginning at 8 seconds. It was hypothesised that this process would require the participant to shift their attention from the second card to the first card in order to check their matching. This process was continued throughout the experiment, which lasted for 75 seconds. The total number of matching cards was 35.

Due to the nature of the experiment and the stimuli being used, it was further assumed that the experiment would require a background that was sufficiently visually complex. Since no prior research was available from the inattentional blindness literature, the decision was made that the background should be coloured. This decision was, in part, governed by the need to make the spider image transparent in the first instance (see below). Therefore, it was impossible to have a white background. The decision was made to make the background appear as a series of fallen leaves. This was because it was predicted by the experimenter that this might represent a naturalistic environment for the spider. Following the same logic as Mack and Rock (1998) in regards to the use of schematic facial stimuli, if this was insufficient to create the desired effect, the background would have been changed in future versions of the experiment.

The spider image, as can be seen in figure 5.2 was a diagrammatic image of a spider. This image was not based on a particular species of spider but contained the body parts outlined in chapter 2. The spider was positioned in a canonical view along with the cards, which gives the viewer the impression that they are looking at the scene from above. The spider was considerably larger than the ones presented in the static trials, measuring 3cm at the widest point and representing a visual angle of 3.4°, when viewed from a distance of 50cm. Due to the finding by Simons and Chabris (1999) that colour consistency between the distracter task and the critical stimulus affects noticing rates, it was decided that the spider could not be black. As such, it was decided in the first instance to make the spider translucent. Following the same logic as Mack and Rock (1998), when they conducted the face trials, if this proved insufficient to draw an effect, the spider image would have been changed.

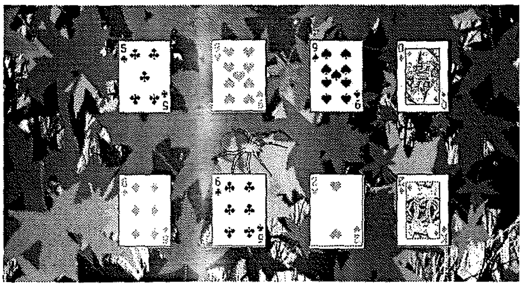

Figure 5.2 Image of dynamic **experiment with the translucent spider in a central position.**

5.2 Method

5.2.1 Design

1. General Noticing Rates

As with the static inattentional blindness experiments, participants were allocated to groups depending upon whether they noticed the stimulus during the presentation. However, unlike the static trials, no participants claimed to have seen something but were unaware of what it was.

Therefore, participants were categorised as either 1) inattentionally blind; or 2) attentional responders. After the inattention trial, all participants were presented with the scene again, but were not asked to count the cards. This was called the full attention trial. Data from this trial was not inferentially analysed and the divided attention trial was not included in this experiment, for reasons outlined in the procedure.

2. Association with Fear of Spiders

A quasi-experimental between-participants design was employed. The independent variable represented the participant's fear status (moderate to high vs. low) as measured by the Fear of Spiders Questionnaire (FSQ. Szymanski & O'Donohue, 1995). The dependent variable represented the noticing status of the participants, as defined above. The effect general anxiety has on noticing rates was not examined in this experiment, as the preceding six experiments did not yield particularly strong associations.

5.2.2 Participants

Participants were 10 males and 20 females recruited from undergraduate courses in psychology at the University of Gloucestershire and the general public in Cheltenham (mean age 30, SD = 12.8). All participants had normal or corrected to normal vision; no participants reported a history of neurological trauma or disease. After the experiment was conducted, no participants claimed to have expected that this was an inattentional blindness task.

5.2.3 Materials

Psychometrics

Similarly to the static experiments, the FSQ (Szymanski & O'Donohue, 1995) was used to measure the participant's level of spider fear (Cronbach's alpha value of .97). This cut-off points for high and low fear remained the same as outlined in section 8.1.2.1 of the thesis. The Hospital Anxiety and Depression Scale was not used in the current study. As stated earlier, anxiety did not appear to have a consistent effect on the noticing rates during the previous 6 experiments and so the decision was made not to further measure anxiety. The depression subscale was not included because the Mogg and Bradley (1998) model, which suggests that depression can nullify attentional bias in anxiety, does not make the same prediction specifically for fear of spiders.

The dynamic experiment

The dynamic experiment has been described in the introduction to this chapter. However, further technical details of how the experiment was created will be included here. An undergraduate media student from the University of Gloucestershire was employed to create the experiment. The experiment was created in Adobe Flash CS4® on an Apple Macintosh iMac G5® personal computer. The experiment was conducted on an Apple Macintosh MacBook Pro® with a 13 inch monitor and NVIDIA GeForce 9400m Graphics Card®.

Additional Materials

Before the experiment was conducted, a consent form indicated the partial purpose of the study (see appendix F) and the participant's right to withdraw. No indication was given about the appearance of the spider. A chin rest was used to control the viewing distance at 50cm. A debriefing form, which included a full description of the study and the participants right to withdraw, was provided (see appendix D). Finally, an information sheet on anxiety and depression and where to find help was offered to participants (see appendix E).

5.2.4 Procedure

Participants were approached and asked if they would like to participate in an experiment designed to examine the link between perception and emotion. They were informed that the experiment would take no longer than 15 minutes. If they agreed they, they were asked to read and sign the consent form. The experimenter then initiated the experiment. After the experiment had finished, the participants were asked the flowing questions, described in figure 5.2.1.

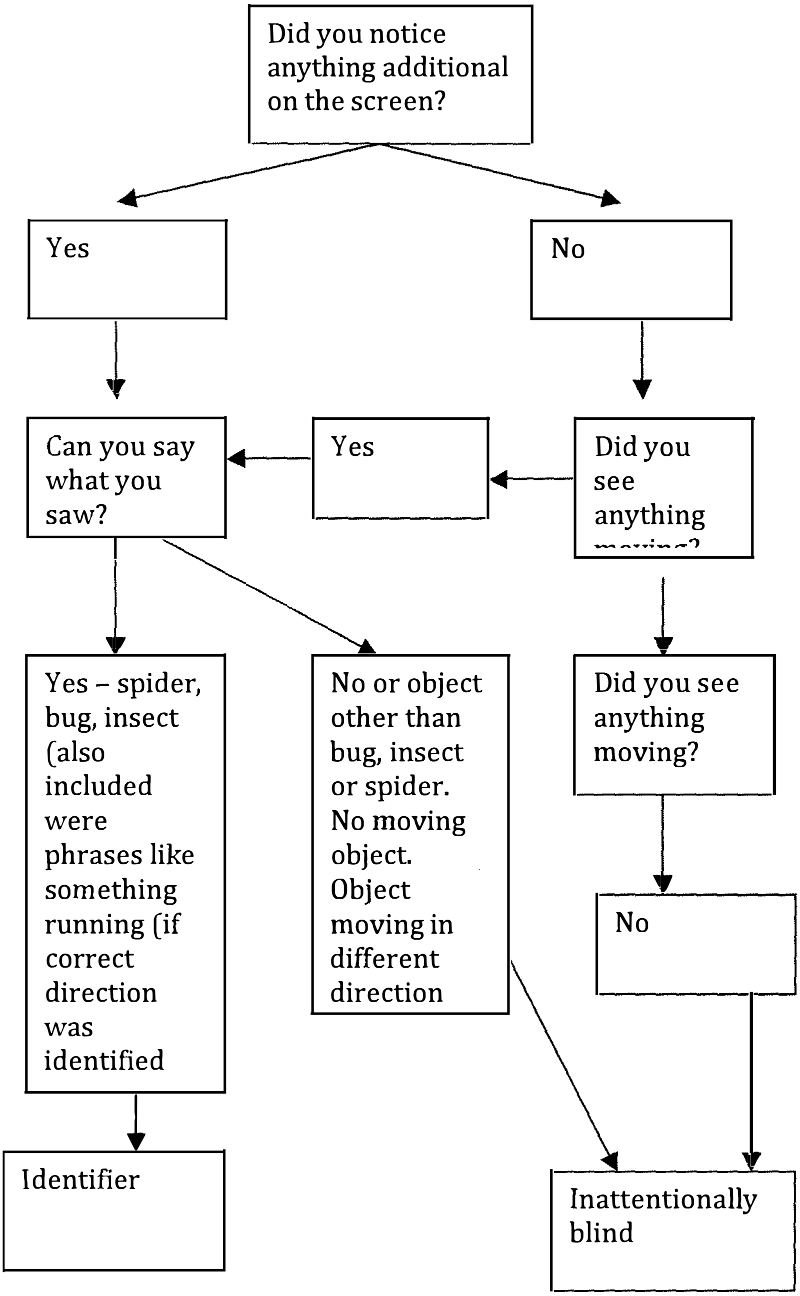

Figure 5.2.1. Post computerised task question algorithm for the dynamic experiment.

5.3 Results

5.3.1 General Noticing Rates

Binomial tests were included to compare the overall rates of inattentional blindness with the number of participants who showed a degree attentional processing. For the inattention trial, 15 of the participants were inattentionally blind and this was found to be non-significant, *p* = . 57. Table presents the number of participants who were inattentionally blind and the number who showed attentional processing.

Table 5.3.1 Inattentional blindness rates for the dynamic experiment

	Experiment Phase	
Response Type	inattention	full attention
Inattentionally Blind	15 (50%)	0
Attentional responders	15 (50%)	30 (100%)

5.3.2 Association with fear of spiders

When the participants were separated into moderate to high (n=17) and low (n=13) spider fear groups, Mann-Whitney tests showed that the groups differed significantly on the FSQ (U = .000, N_1 = 17, N_2 = 13, *p* = .00) but not on age (U = 101.500, N_1 = 17, N_2 = 13, *p* = .71) or depression (U = 109.500, N_1 = 17, N_2 = 13, *p* = .97). A multidimensional chi-square test revealed a non-significant effect between the groups and noticing status on the inattention trial (χ^2 = 3,394, df = 1, *p* = .07). The full-attention trial was not inferentially analysed. Table 5.3.2 presents the noticing rates for the high and low fear of spiders groups on the inattention trial. Figure 5.3.1 presents group histograms for the high and low fear of spiders groups on the inattention trial.

Table 5.3.2 Noticing rates for the low and moderate to high fear of spiders groups on the inattention trial on the dynamic experiment.

	Response Type	
Fear of spiders	Inattentionally blind	Identifier
Low fear of spiders	4 (31%)	9 (69%)
Moderate to high fear of spiders	11 (65%)	6 (35%)

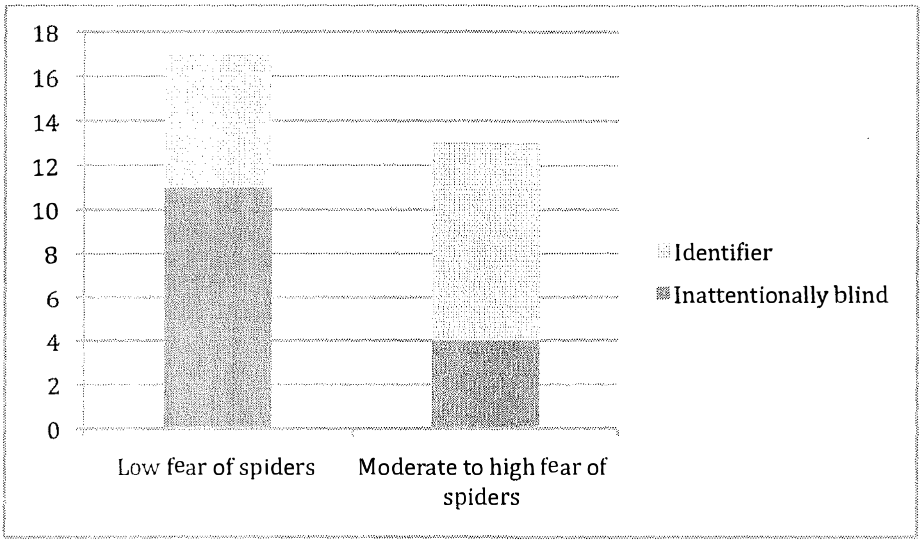

Figure 5.3.1 Group bar charts for noticing rates for the low and moderate to high fear of spiders groups on the inattention trial for the dynamic experiment.

Discussion

In the introduction it was hypothesised that if increased levels of spider fear cause an attentional bias towards spiders, the high fear group would notice the spider on the dynamic inattentional blindness task. Furthermore, based on the findings from experiments 4, 5 and 6 in chapter 4, that an increase in saliency does not elicit attentional response to spiders in the low fear group, it was hypothesised that if spiders represent an evolutionary threat the use of a larger moving spider would cause the low fear group to notice the image.

The analysis of the general noticing rates show no particular association between noticing but that the experiment elicited inattentional blindness in half of the participants. This suggests that the increase in saliency was not sufficient to draw a general effect. The comparison between the moderate to high and low fear groups also showed a non-significant result, suggesting that spider fear does not cause a attentional bias to moving spider images when they are not expected.

In relation to the neurobiological and cognitive models of attentional bias to threat in anxiety and phobia that predict the involuntary allocation of attentional resources to threatening objects (e.g., Mogg & Bradley, 1888; Beck & Clark 1997), the current results do not support these theories, suggesting that individuals with heightened fear of spiders do not exhibit sensitivity to unexpected moving spider images. Nevertheless, the pattern of results shows a trend in the hypothesised direction, which warrants future research with larger participant samples.

Inspection of the noticing rates for the low fear group present an interesting pattern. Firstly, in relation to the previous static tasks, it was suggested that the low fear groups were not exhibiting a bias towards spider images or a perceptual defence towards them. This experiment sought to investigate this finding further by using a dynamic image and suggests, again, that individuals with a low, or no, fear of spiders do not notice spider images. The finding from this experiment, therefore lend support for the suggestions that spider fear is not an evolutionarily based phenomenon.

Further discussion of this experiment will be provided in the general discussion section. However, firstly, more recent accounts of attentional bias to threat in anxiety suggest that anxiety is characterised by difficulties disengaging from emotionally negative or threatening stimuli. The final experiment in this thesis is designed to test this hypothesis.

Chapter 6 – Delayed Disengagement Experiment

6.1 Introduction

The left visual field, real spider and dynamic experiments have provided only limited support to the suggestion that individuals with a fear of spiders demonstrate an attentional bias towards spider images. However, Fox et al. (2001) have suggested that one of the primary categories of assessment (the visual probe-detection task) indicates that anxious individuals have difficulty disengaging their attention from a negative stimulus once it has been detected, and this leads to quicker probe detection times found in many studies. They have supported this suggestion with an experiment new to the cognitive psychopathological literature, which suggests that the disengage component of attention was biased in anxious individuals and furthermore, that the inhibition of return process (where attention normally displays an inability to return to already attended stimuli), was reduced in anxious individuals when threatening stimuli were presented (Fox et al., 2002). The purpose of this experiment, therefore, is to examine whether this disengagement bias is also found in other types of anxiety disorder (i.e., spider phobia) and whether a modification to the inattentional blindness paradigm is a suitable method to assess this.

The delayed disengagement hypothesis follows distinctions made by Posner and Petersen (1990) that attention is comprised of three discrete mechanisms. Firstly, there is the engage component. This reflects the attentional system, via perceptual processes, picking up the target stimulus in order for conscious processing. Next is the disengage component, which reflects the attentional system's ability to remove itself from the stimulus that has been attended. Finally, the shift component refers to the attentional systems ability to move from object to object in visual space.

The inattentional blindness paradigm may be able to lend itself to examining whether people with a fear of spiders have difficulty disengaging from negative stimuli. During previous experiments in this thesis, the object of attention has been the cross judgement task, where participants must judge whether the horizontal or vertical line is longest. On the fourth trial an object (for example, a spider) was placed in one of the quadrants of the cross and noticing rates between moderate to high and low groups were examined. In order to examine whether the disengage component of attention is disrupted by anxiety or spider fear, the cross judgement task requires replacing with a task involving fear (e.g., a spider) and the unexpected critical stimulus must be either neutrally or positively valenced, rather than having threat value. Therefore, in the current experiment, the cross judgement task was replaced with a schematic image of a spider. On this task, one of the spider's two top legs was longer than the other. The participant's task was to decide (and subsequently report) whether this leg was on the left or the right of the spider (from their viewpoint).

To explore the ability of the inattentional blindness task to detect delayed disengagement in anxious individuals it was assumed that the unexpected critical object needed to be one with a high frequency of being noticed. Mack and Rock (1998) found that, of all the objects they presented against expectation, a schematic smiling face and a persons name were the most likely to draws attention. Therefore, in the current experiment, a schematic smiling face was used as the critical unexpected object on the fourth inattention trial. For the current experiment, therefore, it was hypothesised that if anxiety is characterised by an inability to disengage attention from fearful stimuli, individuals with heightened spider phobia would not notice the schematic smiling face, whereas, because of its high identification rate individuals low in spider phobia would notice the unexpected (face) stimulus.

6.2 Method

6.2.1 Design

1. Noticing rates

An experimental design was employed; participants were allocated to groups depending upon their category of noticing on the critical inattention trial. Based on their response, participants were characterised as; 1) inattentionally blind and 2) attentional responders. Object recognition was examined for the inattentionally blind participants.

2. Association with Fear of Spiders

A quasi-experimental between-participants design was employed. Participants were separated into moderate to high and low fear of spiders groups using the FSQ (Szymanski & O'Donohue, 1996) and these groups represented the independent variable. The dependent variable represented the noticing category for the participant and had three levels (inattentionally blind, detector and identifier).

6.2.2 Participants

Participants were 12 male and 19 females (mean age = 34, SD = 17.70) and were recruited from a local Further Education (FE) college and Cheltenham Science Festival between May and June 2009. All participants had normal or corrected to normal vision. No participants reported a history of neurological trauma or disease. No participants reported having epilepsy and no participants reported having knowledge of the static inattentional blindness paradigm.

6.2.3 Materials

The spider used for the length judgement task consisted of two ellipse circles with eight lines protruding off the upper circle. Attached to the eight lines were an addition eight lines at perpendicular angles. These were used to simulate the spider's legs. The two upper legs were of markedly different lengths. The longest leg subtended a visual angle of 4.6° (4cm) and the shortest leg subtended a visual angle of 2.3° (2.4cm). The longest leg varied pseudo-randomly on each trial, however, the longest leg was always the left when the critical object appeared. The critical object was a schematic smiling face, consisting of a circle with two dots to represent they eyes and a curved line placed under the eyes to simulate a smiling mouth. The smiling face was placed in the left half of the screen 2.5° from the centre of the circle. The smiling face subtended a visual angle of 0.6°. This position was chosen over the usual position (towards the left bottom quadrant, had the cross task been used) for a number of reasons. Firstly, because it was hypothesised that the participant's attentional zone would be located at the upper part of the spider image, where the leg length judgement task was presented. Secondly, previous experiments (experiments 4 and 5) found a bias for spiders presented on this side and considering there might be a general emotionality effect for faces in anxiety disorders (particularly in, but not restricted to, social phobia. See Gilboa-Schechtman et al., 1999), this was considered to be the most likely presentation area to draw attention, and thus be the most stringent test of whether attention disengages from spider images.

A forced choice test was used to examine object recognition and implicit perception. A card contained five distinct images of equal size was used. Three images were geometric objects (circle, triangle, square). The remaining two images were the spider image and a smiling face. To measure participants' levels of phobia, the FSQ (Symanski & O'Donohue, 1995) was used (with a Cronbach's alpha value of .97). The HADS depression scale (Zigmoid & Snaith, 1983) was used to measure depression (with a Cronbach's alpha value of .57). A standardised debriefing form was used to inform participants of the full purpose of the study and the experimental hypotheses (see appendix D). An information sheet about anxiety and how the participants can seek health care and self-help material was provided (see appendix E).

The experiments were conducted in two places. At the FE College they were conducted on a desk with two chairs in an empty classroom. At the science festival, they were conducted in small, portioned off area of the University of Gloucestershire Science Exhibit, which contained the experimental equipment, a desk and two chairs. All other materials remained the same as the previous static inattentional blindness experiments (see general method section).

6.2.4 Procedure

At both locations people were asked if they would be willing to take part in some research examining the link between perception and emotion. The procedure for approaching participants was the same as in previous experiments conducted in public venues for individuals recruited at the science festival. For participants at the FE College, the class tutor informed their students that a Psychologist from the local university would be visiting the college, and they were asked if they would be willing to participate. All participants were informed that the task would take no longer than 15 minutes. Participants were informed that they would be exposed to drawings of spiders, as the spider was not the unexpected object in this experiment.

Participants were taken individually into the testing area and asked to read and sign a consent form (see appendix C). The procedure did not continue for participants not wishing to sign the consent form. The participants were asked to place their chin on the rest and begin a single practice trial. The practice trial consisted of one leg judgement presentation, which did not have the critical stimulus. Participants were asked to report which leg was longest after the trial. This data was not recorded and no further questions were asked. After the practice trial the experimenter ensured understanding of the procedure and started the experiment.

Each trial was conducted four times. Participants were required to judge which leg was longest and report this verbally when the mask disappeared; the experimenter recorded the responses and started the next trial. The longest leg varied between the left and right randomly for each presentation. On the fourth trial, the critical stimulus appeared. After reporting which line was longest, participants were asked if they had noticed anything additional to the spider on the screen. The critical stimulus probe questions and the categorisation of noticing rates were in accordance with those outlined in chapter 2. Unlike previous experiments, the inattention trial was not followed by the divided and then full attention trials. In accordance with the procedure used by Carthwright-Finch and Lavie (2007), the divided attention trial was eliminated and the full attention trial followed the inattention trial. This modification was used to reduce the testing time for each participant while still allowing for an assessment of whether the critical stimulus would be perceived if attention was not engaged.

All participants were then presented with the forced choice test, at the same viewing distance. Like previous experiments, the inattentionally blind participants were asked to choose an image at random. The detector participants (those who saw something, but could not identify it) were asked to guess. The identifier participants were asked to confirm what they saw.

6.3 Results

6.3.1. General noticing rates

Binomial tests were included to compare the overall rates of inattentional blindness with the number of participants who showed a degree attentional processing. For the inattention trial, 14 of the participants were inattentionally blind and this was found to be non-significant, *p* = .36. Table 6.3.1 presents the number of participants who were inattentionally blind and the number who showed attentional processing.

Table 6.3.1. General frequencies and percentages for noticing rates on the inattention and full attention trials for the delayed disengagement experiment

	Experiment Phase	
Response Type	inattention	full attention
Inattentionally Blind	14 (45%)	0
Attentional responders	17 (5%)	31 (100%)

Object Recognition

Of the 14 participants who were inattentionally blind, 5 selected the square, 4 selected the spider, 4 selected the triangle and 1 selected the circle. A Fisher's exact test revealed no significant effect (χ^2 = 2.571, df = 3, *p* =.46).

6.3.2 Association with Fear of spiders

When the participants were separated into moderate to high (n=12) and low (n=19) fear groups using the FSQ (Syzmanski & O'Donohue, 1996), the groups did not differ significantly on depression (U = 101.000, N_1 = 19, N_2 =12, *p* = .62) as measured by the HAD scale and age (U = 94.000, N_1 = 19, N_2 =12, *p* = .44), but did differ significantly on the spider phobia FSQ (U = .000, N_1 = 19, N_2 =12, *p* = .00). A multidimensional chi-square test with exact significance option revealed no significant association between noticing rates and phobia status (χ^2 = .183, df = 2, *p* = 1.0). Due to the non-significant result, follow-up analyses were not conducted. Table 6.3.2 presents the noticing rates for the low and moderate to high fear of spiders groups on the inattention trial. Figure 6.3.1 presents a group histogram for the noticing rates for low and moderate to high fear of spiders groups on the inattention trial.

Table 6.3.2 Noticing rates for low and moderate to high fear of spiders groups on the inattention trial for the delayed disengagement experiment.

Response Type Fear of spiders	Inattentionally blind	Detector	Identifier
Low fear of spiders	9 (48%)	5 (26%)	5 (26%)
High fear of spiders	5 (42%)	4 (33%)	3 (26%)

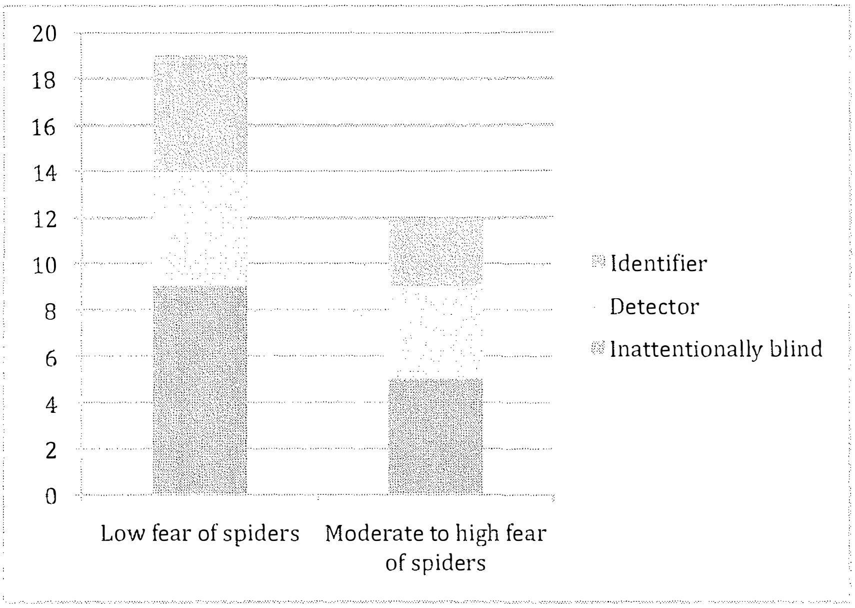

Figure 6.3.1 Group histogram for noticing rates for the low and moderate to high fear of spiders groups on the inattention trial for the delayed disengagement experiment.

6.4 Discussion

The purpose of experiment 8 was to examine whether a modified version of the static inattentional blindness task is able to assess delayed disengagement in fear of spiders. Specifically, the first purpose of the experiment was to assess whether the use of a spider distraction task would create inattentional blindness. If this was the case, following on the general analysis, the hypotheses for the experiment were that if elevated fear contributed to difficulties in the disengagement component of attention, this would be reflected in lower noticing rates for the unexpected critical stimulus on the inattention trial in the moderate to high fear group.

The results show that the new method was able to elicit higher levels of inattentional blindness. In relation to this, considering that a smiling schematic face was used, the levels of blindness observed in this study are considerably lower than those found by Mack and Rock (1998) for their inattentional blindness task. This suggests that either the task was more difficult or that spiders generally are more difficult to disengage from. However, considering the results of the analysis between the high and low phobia groups, the latter suggestion seems unlikely.

Fox et al. (2001) suggest that anxiety is characterised by a bias in the disengage component of visual attention that results in individuals being "locked on to" a fearful stimulus. This hypothesis was not conformed by the current experiment. Specifically, fearful individuals did not show an increased tendency to miss the critical stimulus. There are a number of reasons why this might have been the case. Firstly, this is the first study to examine delayed disengagement from spider images. It might be possible that spider fear is qualitatively different from other anxiety disorders and does not cause attention to dwell on the image. Although the previous experiments have found little evidence for the evolutionary basis of spider fear, it is possible that if spider fear is an evolutionary artefact, the dwell of attention on the image is likely to cause a subsequent delay in escape from the object. If this is the case, it is not particularly evolutionarily adaptive. However, further evaluation of this hypothesis is required.

It is also possible, however, that methodological reasons are causing the lack of evidence for delayed disengagement in the group with heightened spider fear. Firstly, the choice of the critical unexpected stimulus might be responsible. This choice was based on the findings from Mack and Rock (1998) that a schematic smiling face could robustly draws attention in the majority of their participants. As such, this was considered the most appropriate stimulus to use. However, Gilboa-schetchmann et al. (1999) suggest that anxiety may cause difficulties in processing facial expressions, despite their valence. While this suggestion was made in regards to social phobia, it would need to be eliminated in the case of anxiety generally and spider fear before this possibility can be entirely ruled out. Secondly due to the difficulties in recruiting participants with severe or clinical levels of spider phobia, it might be possible that delayed disengagement only occurs in severe cases of the disorders, and not in general levels found in the population used in this experiment.

Overall, while the delayed disengagement experiment has not yielded an association with spider fear and delayed disengagement, it does provide the basis for future work investigating delayed disengagement in spider fear, and the use of the delayed disengagement inattentional blindness paradigm to investigate attentional disengagement processes in anxiety disorders. Further work in this area is beyond the scope of the current thesis, however, recommendation for future research in this area can be found in the general discussion chapter. The following chapter provides experimental comparisons between the large and small neutral object experiments and the large neutral object and real spider experiments.

Chapter 7 – Experimental Comparisons

7.1 Introduction

In order to assess the findings in terms of general inattentional blindness, two experimental comparisons were conducted on the general noticing rates for the stimuli in each experiment. This procedure of combining results across two experiments that have used different groups of participants has been used in inattentional blindness experiments (Mack & Rock, 1998). However, such a procedure has not been used when the participant groups vary on personality factors, such as in this case with fear of spiders and therefore this analysis will not be conducted. Firstly, a comparison was made between the small (experiment 1) and large (experiment 6) neutral objects. This comparison was conducted in order to test the suggestions of Mack and Rock (1998) that an increase in retinal size reduces levels of inattentional blindness. Secondly, a comparison between levels of inattentional blindness was made between the large neutral object (experiment 6) and the real spider (experiment 5). This analysis was conducted for two reasons. Firstly, to further examine if spiders have an evolutionary threat values and, secondly, because Downing, Bray, Rogers and Childs (2004) suggest that biologically based stimuli reduce inattentional blindness to a greater degree than either distorted biologically based stimuli or non-biologically based objects.

7.2 Method

The general set-up of each experiment can be found in the general method section (chapter 3). Here the experimental procedure and the general inattentional blindness task used for each experiment are described. Specific details about the participants and the stimulus can be found in the method sections for each experiment.

Results

7.3.1 Comparison between the small neutral object and large neutral object experiments

The data from the small and large neutral objects were analysed using a multidimensional 2 (large neutral object, small neutral object) x (inattentionally blind, attentional responder) Chi-square test with exact significance option. The results showed a non-significant effect of stimulus type on noticing (χ^2 = .78, df = 2, p = .03, ϕ = .07). Table 7.1 presents the noticing rates for each of the static inattentional blindness experiments contained in the thesis.

7.3.2 Comparison between the large neutral object and the real spider experiment

The data from the real spider experiment and the large neutral object experiment were analysed using a multidimensional 2 (large neutral object, real spider) x 3 (inattentionally blind, attentional responder) Chi-square test with exact significance option. The results showed a non-significant overall effect of stimulus type on noticing (χ^2 = .894, df = 2, p = .34, ϕ = .12). Table 7.1 presents the noticing rates for each of the static inattentional blindness experiments contained in the thesis.

		Inattention trial	
		Inattentionally Blind	Attentional Responders
Neutral object experiments	Small Neutral Object	21 (42%)	29 (58%)
	Large neutral object	14 (45%)	17 (55%)
Spider image experiments	Small spider	28 (57%)	21 (40%)
	Large spider	26 (53%)	26 (47%)
	Left Visual field spider	21 (46%)	25 (55%)
	Real spider	10 (33%)	20 (67%)

Table 7.3.1 Descriptive statistics for each inattentional blindness experiment contained in chapter 4.

7.4 Summary of Results

Firstly, the results from the comparison between the small and large neutral object experiments showed no association between object size and noticing rates. As can be seen in table 7.3.1, the rates of inattentional blindness for each object differ by only 3%, suggesting that retinal size does not influence levels of inattentional blindness. Secondly, in relation to the comparison between the real spider stimulus and the large neutral object, no significant association between object type and levels of inattentional blindness were found. Again, inspection of the descriptive statistics shows that the inattentional blindness rates differ by only 12%. The implications of these results are discussed in relation to inattentional blindness in the general discussion.

Chapter 8 – General Discussion

8.1. Aims of thesis

This thesis had a number of aims, which will now be re-outlined.

1.) to assess whether there is attentional bias to threatening images within the context of the IB paradigm

2.) to assess key psychological factors that may affect any such bias or IB, namely fear of spiders, anxiety, depression

3.) to address and resolve methodological issues regarding the investigation of these issues

4.) to appraise dominant models of attentional bias to threat, especially regarding the issues of whether any such bias

- (a.) occurs at an early or late stage of processing
- (b.) yields engagement or disengagement with the threatening stimulus
- (c.) is linked to specific or more generic hypervigilance in anxiety
- (d.) is located in the left or right cerebral hemisphere

The following sections of the general discussion will focus on how each of these aims have been addressed by the experiments, the respective findings and how these contribute to the established knowledge base on attentional bias to threat in anxiety. The methodological difficulties associated with experiments will be discussed and directions for future research will be provided.

8.2 Review of rationale for series of experiments

The broad aim of this thesis was to examine attentional bias to spider images in individuals with moderate to high and low levels of spider fear. The second aim was to examine if anxiety is characterised by a pattern of general hypervigilance for new or novel stimuli appearing in a person's visual field. As such the pilot study sought to establish a reliable image of a spider to be used during the experiments. The previous literature using schematic spider images was small and without a standardised image. Taking into consideration the parameters set by the experimental procedure being used (e.g., that the image needed to be relatively small in the first instance) and the level of visual processing being tested (i.e., while the image was supra-threshold it would still receive low level [perceptual] analysis before being brought to higher level [attentional] vision), it was decided that a basic spider image, comprising of the major constituent parts (i.e., eight legs and two small body parts) would be tested and used in the experiments.

The static inattentional blindness experiments presented in chapter 4 (experiments 1 to 6) attempted to follow the parameters outlined by Mack and Rock (1998). However, two modifications were made before hand. Firstly, while the visual angles of the circle size, cross lines, and stimulus sizes were kept as close as possible to the original series of experiments, the viewing distance was changed from 76cm (as used by Mack and Rock) to 50cm. This was done because the experiments were going to be conducted in various locations and a shorter distance between the chin rest and computer screen meant that the experiment could be conducted more easily in locations with varying and often limited resources.

The second modification was the location of the stimulus. In the Mack and Rock (1998) studies, the critical stimulus was presented within the hypothesised zone of attention that was determined by the longer arm of the cross. In the present study, the stimulus was placed just outside this zone. This change was made because of the suggestion made by Miltner et al (2004) that anxious or phobic individuals may have biases that lay in the parafovea. Thus, the current experimental method may be more sensitive to anxiety states. A further and related benefit for using this procedure is that noticing rates in the Mack and Rock studies for neutral objects were at c. 75%, when objects were placed within the zone of attention. This high level of noticing means that the task might not be sensitive enough to uncover differences between the moderate to high and low fear groups. Therefore, the current experimental procedure was designed to be practical and modified to be sensitive to anxiety.

The experimental format led to three analyses the first was an examination of the general noticing rates caused by the experiment and the stimuli. This procedure was designed to examine levels of inattentional blindness and to detect any general effect the stimulus might have. This would make the results more applicable to the current general work on inattentional blindness. Related to this, all of the experiments, with the exception of the small neutral object experiment, presented the participants with a forced choice test in order to examine if the critical stimulus had been implicitly (that is unconsciously) perceived. Additionally, the assessment of general noticing rates would reveal whether spiders have a biological basis for rapid recognition across the general population, due to an evolutionary threat value. For the spider experiments, the spider placed on the critical trial was included on the forced choice test with a distorted spider and an array of geometric objects that did not appear during the trials. The exceptions to this were the delayed disengagement experiment, where a smiling face and a spider were included as objects and the large neutral object experiment, which included a spider that did not appear on the critical object trial.

After the general noticing rates were analysed, the association with spider fear and general anxiety were examined. Before beginning the trials with spider images and measuring spider fear, it was considered important to examine whether anxiety affected inattentional blindness more generally. That is to say, due to anxiety theoretically causing a hypervigilance of the visual system (e.g., Eysenck, 1997), it would be expected that anxious individuals would be more likely to notice new or novel stimuli in the visual environment, regardless of the emotional valence of the stimulus. The initial neutral object experiment, therefore, sought to address this question and to act as control measure on which to compare results from experiments using spider images.

After the neutral object experiments, a series of experiments were conducted to examine the effect spiders have on inattentional blindness and the effect of the participant's fear status in this regard. The first experiment matched the former neutral object experiment, with the exception that the black square was replaced by a spider image that was the same size. This experiment was conducted to examine what effect the spider had on inattentional blindness and whether there was an association between fear status and inattentional blindness. In the next experiment, the spider was enlarged to examine whether the size of the stimulus had an effect on noticing rates. Due to the current experiments yielding no significant associations between noticing rates and fear status, the stimulus was switched to the lower left quadrant of the cross and thus projected to the right hemisphere. This modification was based on the findings from Fox (2002) and Mogg and Bradley (2002) and who found, using a probe-detection task, that biases towards threatening images were more pronounced to stimuli presented in the left visual field, and Compton et al. (2000) who found similar evidence using a Stroop task.

Two more experiments were conducted to examine the rapid engagement of threatening stimuli by fearful individuals. The first experiment examined the effect of presenting a more realistic and larger spider in the lower left quadrant of the cross. This experiment was conducted for two reasons. Firstly, an increase in size is noted to increase noticing rates generally on inattentional blindness tasks. Secondly and related to this, presenting a large realistic spider image would also allow for an assessment of whether the low fear group possessed a perceptual defence against images that are threatening and, thus, whether anxiety and spider fear involve a lowering of perceptual defence. This is because, when stimuli are over a certain size (i.e., the retinal size threshold effect), they normally draws attention by virtue of their size. The second experiment attempted to increase the saliency of the stimulus and the ecological validity of the experiment by presenting the spider as part of a dynamic scene that resembled the dynamic inattentional blindness experiment conducted by Simons and Chabris (1999).

Two further experiments were conducted. The first was an additional neutral object experiment to examine the specificity of the effect found for the real spider experiment (thus all experimental parameters were kept constant, but the spider was swapped for a rectangle of the same size). This experiment was conducted to examine whether the high noticing rates of the moderate to high fear group were due to the size of the image and secondly to examine whether the lack of noticing in the low fear group was due to a perceptual defence mechanism, which operates to protect people from mildly threatening stimuli in the visual environment. The next experiment was designed to assess whether the inattentional blindness paradigm, with modifications, was able to test the delayed disengagement hypothesis. Effectively this required replacing the cross-judgement task with an image of a spider, where the participant's task was judge whether the longest leg was on the right or the left of the spider. This experiment was conducted in order to allow for an assessment of the proposals made by Fox et al. (2001) and Fox et al. (2002). Across all of the static inattentional blindness experiments (with the exception of the delayed disengagement experiment), how noticing rates were associated with anxiety was also assessed by separating groups into moderate to high and low anxiety using the HAD scale This analysis was conducted in order to establish whether generally anxiety has an effect on the attentional system, and whether increased anxiety leads to hypervigilance. Finally, across all of the static inattentional blindness experiments (with the exception of the delayed disengagement experiment) assessing attentional bias in spider fear and anxiety, depression was measured and the moderate to high and low groups compared. This analysis was conducted in accordance with Mogg and Bradley's (1998) suggestion that heightened depression can have a nullifying effect on anxiety driven attentional bias.

8.3. Review of results from experiments

Firstly, the results of the general noticing on the static inattentional blindness experiments require discussion. In each of the experiments in chapter 4 and the experiments contained in chapters 5 and 6, the first analysis was to examine the general noticing rates between the two categories of response (inattentionally blind and attentional responders). The results showed that the small spider experiment caused the greatest level of inattentional blindness, with the large spider experiment following this. The left visual field experiment fell centrally out of the experiments conducted in terms of level of inattentional blindness and was followed by the large neutral object and delayed disengagement experiment, the small neutral object and finally the real spider experiment caused the lowest level of inattentional blindness.

In the inattentional blindness experiments contained in chapters 4, 5 and 6, the following pattern of results regarding spider fear and anxiety emerged. Firstly the neutral object experiment yielded no significant association with anxiety. That is to say, the anxious group were no more likely to notice the critical stimulus than were the low anxious group. As such, the original experimental hypothesis – that anxiety causes a hypervigilance of the attentional system, which results in anxious individuals locating new or novel items in their visual environment – was not supported. Similarly, when the neutral object was replaced by a spider image in the small spider experiment, no association was found between heightened fear of spiders and noticing rates.

Nonetheless, it was hypothesised that this lack of impact for anxiety and spider fear may have been due to the placement of the critical stimulus in the right visual field. This hypothesis was generated on the suggestions of Fox (2002) and Mogg et al. (2002) who found a stronger bias towards threatening images presented in the left visual field using the probe detection task. Therefore, to further assess the effect of using a spider as the critical stimulus, the spider was placed in the left visual field and thus exposed to the right hemisphere. In this experiment a significant association was found. Further analysis of the moderate to high fear group revealed that in comparison with the inattentionally blind and identifier groups, significantly fewer of the participants detected something on the screen but were unable to inform the experimenter what it was (either verbally or by the forced choice test). This latter result was an artefact of the categorisation of noticing rates into three groups (inattentionally blind, detectors and identifiers) and was not of special interest. However, the comparison between the inattentionally blind group and the identifier group, which was of interest, approached statistical significance. That is to say, while the results do not fully support the suggestion that spider fearful individuals allocate attention to spiders they did not expect to see, the results do lend marginal support to this idea. Similarly, the real spider experiment (see section 4.5) showed a similar pattern of results. The overall chi-square test showed a significant association, however, when the significance level was corrected for multiple comparisons for the post-hoc analyses, there was a marginally significant association between the moderate to high fear group and identifying the unexpected spider. The results of the dynamic experiment did not show statistical significance, however, the descriptive statistics and consideration of the effect size (see section 8.12) suggest that this experiment should be conduced with a larger sample of participants. Additionally to the primary purpose of examining the association with fear of spiders, a secondary analysis of the association between anxiety and noticing rates was conducted. None of these analyses revealed that the moderate to high anxiety was associated with increased vigilance for the critical (spider or neutral object) image.

The delayed disengagement experiment did not show the hypothesised reduction in noticing rates in the moderate to high spider fearful group, with the participants being able to disengage their attention from the spider. This would suggest that the spider image did not cause the moderate to high fearful group to be unable to disengage their attention from the spider image. Furthermore, this result was found despite previous work by others (e.g., Mack et al. 2002) suggesting that smiling schematic faces can break through the attentional blink and robustly draws attention in inattentional blindness experiments (Mack & Rock, 1998).

Finally, with the exception of the small neutral object experiment and the delayed disengagement experiment, each of the static inattentional blindness experiments containing spider images used a forced choice test to examine whether the spider had been implicitly perceived by the inattentionally blind participants. The analysis of each of these tests showed that the spider was chosen more frequently (in the majority of experiments significantly so) than the other objects in the array of stimuli presented in the forced choice test. Overall this indicates that the spider was implicitly perceived by the inattentionally blind participants. Supporting this suggestion, in the large neutral object experiment, the spider was included in the forced choice test, but was not selected as frequently. Therefore, there is evidence that the spider was not selected by virtue of being the most visually complex item on the forced choice test.

Summary

To summarise, the results from the series of static experiments contained in chapter 4 overall showed that individuals with low levels of spider fear are unlikely to notice spiders when they are presented in the inattentional blindness paradigm. In the case of the moderate to high fear groups, the pattern of results is less clear. In terms of the small spider and large spider experiments, where the stimulus was projected to the left cerebral hemisphere, there was no evidence of an attentional bias towards spiders. In the case of the left visual field and real spider experiments, where the image was presented to the right cerebral hemisphere, none of the experiments showed a clearly significant association between identification rates and increased fear of spiders. As such, the results do not support the hypothesis that spider fearful individuals display attentional biases towards spiders during the inattentional blindness paradigm. Nevertheless, in the left visual field and real spider experiments, the comparisons of interest – between the inattentionally blind and identifier groups – for these experiments did show a marginally significant association. That is to say, there is marginal support from the experiments that spider fearful individuals display attentional bias towards spider images. In the case of the dynamic experiment, no association was found between increased identification rates and heightened fear of spiders, thus suggesting that spider fearful individuals do not show a bias towards moving spiders when they are presented against expectation. Finally, in the case of the delayed disengagement experiment, the results did not show that people with increased fear of spiders are unable to disengage their attention from spider images.

8. 4. Comparison with work on inattentional blindness

Before consideration of these results and how they correspond with previous reports on inattentional blindness can begin, it is important to note a specific consideration. Due to the necessity to remove the stimulus from the hypothesised zone of attention (see general method section), which would lead to lower rates of noticing, it makes the current experiments more difficult to compare with the work of others (e.g., Mack and Rock, 1998; Cartwright-Finch & Lavie, 2007). Nevertheless, the experimental procedures are internally consistent and, therefore, what the current findings suggest in terms of inattentional blindness will now be considered, however, firstly some general implications will be discussed.

The rates of inattentional blindness for the series of experiments presented in this thesis were compared to examine whether size and biological relevancy reduce rates of inattentional blindness (see chapter 8). The results indicate that there was no association between increased size of stimulus and lower rates of inattentional blindness. In terms of biological significance, the results showed that spider stimuli did not reduce inattentional blindness to any greater level than did neutral geometric objects. The finding that size did not reduce inattentional blindness does not correspond with the suggestions of Mack and Rock (1998) who found that a circle subtending a visual angle .6° was noticed significantly less than a circle presented at almost twice the size. This finding is most comparable with the comparison between the small (0.7°) and the large neutral object (1.9°), but no such difference in noticing rates can be seen in the descriptive statistics.

It was suggested earlier in this thesis that retinal size might be an important factor because it may signal danger (e.g., the larger an object is, the potentially closer it is and thus is more likely to require response). Additionally, Mack and Rock (1998) suggest that an increase in size reducing inattentional blindness supports an early bottleneck model of attention because size is a low level stimulus property. The results from the experiments comparing size do not indicate that size is an important factor in the drawing of attention and therefore refuting the general threat hypothesis, and the early selection suggestions by Mack and Rock (1998). However, the discrepancy between the two studies is that Mack and Rock presented the stimulus centrally, with the cross distraction task placed in the parafovea. The current experiments used the reverse of this method (i.e., the foveal task). Therefore, it is possible that size has a greater effect when stimulus is placed at fixation, rather than in the parafovea. As highlighted in the general method section discussing the procedure to be used in the current thesis, it is possible (due to a lack of confirmatory eye-tracking evidence) that the foveal and parafoveal tasks measure different components of attention. For example, the parafoveal task involves a shift of attention towards the cross (which although hypothesised to be covert, may not be). In this case, the larger stimulus might break through the IOR response. On the other hand, however, in the foveal task, a larger neutral object might not cause the engagement or shift components of visual attention to engage the object. Therefore, size might have a specific effect only on the disengage component of visual attention.

When considering the relevancy of biological stimuli, Downing, Bray, Rogers and Childs (2004) found that, when they compared biological stimuli to either distorted versions of the same stimuli or non-biological stimuli, biologically based stimuli reduced inattentional blindness. The finding that rates of inattentional blindness where no different for the real spider stimulus and the large neutral object (see chapter 7), although they were matched for size, suggests that biologically based stimuli have no greater power to draw attention than do geometric objects. This suggestion is supported by the finding that there was no perceptual defence mechanism in operation in the low fear group. This latter finding is discussed in relation to the models of threat detection suggested by LeDoux (1996) and Öhman (2005). However, a possible discrepancy between this study and the one conducted by Downing et al. (2004) is the location of the critical stimulus. Downing et al. (2004) used the precise procedure described by Mack and Rock (1998), whereas in the studies presented in this thesis, it was necessary to place the stimulus outside of the hypothesised zone of attention. This may account for the effect, i.e., biological stimuli may have greater power to draw attention, but only when they are in foveal focus and when they are outside foveal focus, their ability to attract attention is reduced.

The delayed disengagement experiment used the smiling face as the critical stimulus against a spider distraction task, because, as suggested above, it has been found to robustly attract attention under conditions of inattention. In relation to general levels of inattentional blindness, the rates were considerably lower than those found for the happy face in the Mack and Rock (1998) studies. This might be due to the greater complexity of the spider image. However, this task was designed to be similar to the line judgement task, i.e., discrimination was required between the lengths of two lines. Due to the nature of the spider image, it was difficult to place the face within the hypothetical zone of attention, so instead the face occupied a position in the left hemisphere of the circle at a distance from the target leg that was equal to the distance from the centre of the cross in the Mack and Rock (1998) experiments. This distance was chosen to make the experiment more comparable with previous studies. While the results showed that there was no particular association between a lowering of detection rates in the moderate to high fear of spiders group, the results of this experiment demonstrate that spider leg length judgement is an effective way of inducing inattentional blindness.

The series of static experiments presented here also examined whether implicit perception had occurred. Implicit perception refers to having a cognitive trace of the object presented although the participant was not consciously aware that the object appeared in the experiment. For the experiments that contained a spider image, the small spider, large spider and left visual field experiment showed a pattern where the inattentionally blind participants selected the spider significantly more than the other objects on the forced choice test. This suggests that, overall, the spider was implicitly perceived by the inattentionally blind participants. However, it is possible to suggest that the spider was chosen because it was, in comparison to the other stimuli, more visually interesting or a concrete object (that is, the spider is a biologically relevant stimulus, or animal, when the other objects were geometric shapes). Therefore, in the large neutral object experiment, the spider was included in the forced choice test despite it not appearing in the inattentional blindness task. In this experiment, the spider was not chosen significantly more than the other stimuli. As such, the previous inference that the spider was chosen because it was implicitly perceived is supported. This supports the equivalent findings reported by Mack and Rock (1998) and is discussed in greater depth in relation to general models of attention (section 8.11) and cognitive psychopathology (8.5).

8.5 Neurobiological and cognitive models of perception and attention in anxiety disorders

Both neurobiological theories of perception and attention in anxiety (e.g., LeDoux, 1996; Öhman, 2005) and models of cognitive psychopathology (e.g., Bar-Haim et al., 2007; Beck & Clark, 1997; Mathews et al., 1997; Mathews & Fulcher, 1998; Mogg & Bradley, 1998; Williams et al., 1988, 1997) have in common early preattentive mechanisms, mediated by the thalamo-amygdala pathway. These preattentive mechanisms perceptually, that is pre-consciously, analyse a stimulus for its threat value. Both categories of theory suggest that mechanisms controlling the direction of attention act on the basis of this output. If threat is appraised as being high, attention shifts towards the stimulus; if the threat appraisal is low, current goals are pursued and the stimulus is bypassed. The models suggest that anxiety causes an increased sensitivity to threat; anxious individuals will therefore appraise mildly threatening stimuli as dangerous and will be more distractible. In terms of spider fear, the models predict that spiders will be appraised as threatening and attention will be drawn to them. Eysenck (1997) proposes a similar model in terms of anxious reactions to stimuli considered particularly threatening (e.g., spiders to a spider phobic individual) but also suggests that anxiety causes a general hypervigilance of the attentional system that causes anxious people to be distracted by new or novel stimuli in their visual environment. Experimental evidence taken from the Stroop task, the probe-detection task, and variations of the visual search task has provided evidence supporting these models.

The results from the experiments conducted in this thesis provide varying levels of support for the different models. Firstly, the neutral object experiments failed to confirm Eysenck's (1997) theory of a general hypervigilance of the attentional system. There was no association between increased anxiety and noticing rates on the inattention trials in either of the experiments. These findings suggest that, although a novel object appeared in the experiment, this object did not distract the anxious participants in the experiment more than the low anxious individuals. This suggests that when anxious individuals are instructed to stay focussed on a visual task, they are not necessarily distractible by additional stimuli in their visual environment. Additionally, throughout the experiments no association was found for increased noticing in the group with increased anxiety. This again suggests that anxious individuals are not generally hypervigilant for new or novel items in their visual field.

The neurobiological theories presented by LeDoux (1996) and Öhman (2005) will be considered along with the cognitive psychopathology models (e.g., Williams et al., 1988) because they are commensurate in their predictions of threat appraisal by preattentive mechanisms, which subsequently predict attentional response in individuals with increased anxiety or spider fear. The more elaborate predictions of the models, which include personality dimensions such as state and trait anxiety and the roles of prior learning, will be considered after the predictions of rapid threat detection in elevated anxiety states that are commensurate across the models. However, before discussing the implications for the moderate to high fear groups, the models proposed by Mogg and Bradley (1998) and Öhman (2005) suggest that anxiety causes a heightened sensitivity to images, but some images, spiders in particular, might have an evolutionary threat value, which will cause attentional response in all individuals regardless of their level of anxiety.

The findings from the current series of experiments do not suggest that all individuals have a bias towards spiders, and question the suggestion that spiders have an evolutionary threat value. This is confirmed by both the analyses of general noticing rates in on each of the experiments, which, if this had have been the case, spiders would have elicited much lower levels of inattentional blindness, and by the analyses that separated low and moderate to high fear of spiders. Treating the experiments in order, while it might have been possible that the low fear group missed the small spider image because it did not represent significant threat by virtue of its size, the same cannot be said for the large spider experiment. In the large spider experiment, the results showed no particular association between increased fear of spiders and increased detection rates for that group, which could have been due to the lack of sensitivity to threat of the left cerebral hemisphere. This suggestion is partially supported by the analysis of the left visual field experiment. In this experiment, there was marginal support for the hypothesis that spider fearful individuals, but not people low in or without, spider fear, notice spiders when they are not expected. While this might have been due to the low level of threat that schematic spider images illicit, similarly low noticing rates were found for the low fear group in the real spider experiment, while, again, the analysis of the moderate to high fear group again provided marginal support for the hypothesis that spider fearful individuals selectively attend to spiders when they are not expecting them.

This suggestion is further supported by two other findings. Firstly, the findings from the large neutral object experiment showed that the low fear group did not display heightened noticing of this object. This could be interpreted as general lack of vigilance for items falling outside foveal vision in this group, however, this seems unreasonable because it is more likely that the participants were focussing on the explicit line judgement task. However, what these findings also point to is that the effect of missing the spider was not due to a perceptual defence of these individuals. If the findings from the large neutral object experiment had shown increased noticing in the low fear group, it would have been reasonable to assume that in the previous experiment, the low fear participants were exhibiting perceptual defence, which would have supported the evolutionary argument that the human species are genetically programmed to view spiders as dangerous.

Secondly, the general findings from the forced choice tests for the experiments that included spiders showed that the inattentionally blind participants (of which the majority would have been from the low fear group) selected the spider image, but this was not the case for the large neutral object experiment, where the spider was not chosen more frequently. These findings suggest that the spider image was perceptually registered, but was not prioritised for attentional processing. Therefore, overall, there is reasonable evidence presented in this thesis to suggest that spider phobia does not have an evolutionary basis. However, a contrasting explanation is provided in the relation to the prediction of situational context by the Mogg and Bradley (1998) model below.

There are a number of points of interest for the findings for the high fear group, in relation to the suggestion that people with elevated fear of spiders selectively attend to spider images, the findings of interest in the current thesis come from the right and left visual field experiments and the real spider experiment. Before any discussion can begin, it is important to note that, in the case of the left visual field and real spider experiments, the analyses of noticing rates for the moderate to high spider fear groups did not reach statistical significance. Rather the analysis showed a marginal result that approached significance. With this caveat in mind, the following discussion will focus on the difference between the two groups and what the results are partially indicating. The experiment that placed the spider in the right visual field and thus presented the image to the left cerebral hemisphere did not show any particular association between noticing rates and increased spider fear. That is to say, the hypothesised direction where the increased fear group would show a bias towards identifying the spider was not confirmed. Nevertheless, in the left visual field experiment, when the spider was projected to the right cerebral hemisphere, the moderate to high fear group showed a pattern where they were more likely to identify the spider image. This pattern, although not significant, was also observed in the real spider experiment. Furthermore, the lack of association between identification and heightened spider fear in the large neutral object experiment suggests that this pattern of results found for spider images was specific to spiders. Thus, the results point to a right cerebral hemisphere bias in heightened fear of spiders.

To understand why the increased sensitivity of the right cerebral hemisphere has not been more fully elucidated and accounted for by the models of attentional bias to threat, it is important to consider the experimental tasks that have been used to inform the models. The findings from each of the methods are discussed in more detail later in the general discussion section, however, for the purposes here the major methodological difficulties will be outlined. Firstly, the emotional Stroop task will not be considered because of the prior criticisms of its lack of specificity to attentional tasks (e.g., Williams et al., 1997). The visual search task, as suggested is unable to fully account for hemispheric specialisation, particularly without the use of eye tracking. The most dominant paradigm in the literature is the probe-detection task (e.g., as used by Mogg & Bradley, 2002). Firstly, as suggested in the introduction to this thesis, most of the results come from experiments with presentation times with exposure durations of 500ms, although the argument here is also applicable to lower exposure rates of the subliminal versions of the task. While it has been established (e.g., Fox et al., 2001) that the task only provides an indication of where visual attention is located when the probe appears and so rapid engagement cannot be assessed, this too leads to further difficulties in assessing hemispheric specialisation.

In the probe-detection task, both images are presented sequentially and, as Fox et al. (2001) point out, both are relevant to the experimental task. In the majority of experiments the picture stimuli are presented side by side, with one image on the left and one image on the right. It is possible that when the threatening image is presented on the left, it is rapidly engaged by the right cerebral hemisphere. However, when the threatening image is presented on the right, it is engaged but not as rapidly by the left cerebral hemisphere. The detection of the subsequent probe would not allow for an assessment of this process. Thus, the probe-detection paradigm is unable to fully assess the contributions made by the left and right cerebral hemispheres.

In relation to the theories and the argument for the increase in right cerebral hemisphere sensitivity to emotional stimuli, it is also important to point out that, in terms of the current findings, it could also be the case that, in the right visual field experiment, the spider would have been implicitly perceived by the fearful participants but not prioritised by the attentional system for conscious processing because of the concurrent task. As Williams et al. (1988; 1997) explicitly suggest in their model (and an assumption held by all models), threatening stimuli have the power to interrupt current cognitive tasks and cause a subsequent reallocation of attention to the feared object. This interruption of concurrent tasks is not assessable by the probe-detection paradigm because, as Fox et al. (2001) suggest, the emotionally valenced stimuli are both relevant to the task. Therefore, the observed effect of the right hemisphere, firstly indicates that spiders do interrupt current concurrent tasks and further suggests that this is more likely to happen when threat is presented in the left visual field. Overall, therefore, the current findings have elucidated further the respective roles of the left and right cerebral hemispheres in the processing of threatening stimuli, and have extended current findings to suggest this also occurs in spider fear. The role of the right cerebral hemisphere in the processing of threatening stimuli is discussed further in section 8.11 in relation to the general literature on perception and attention.

This thesis was the first to attempt to create an experiment with a moving and unexpected spider image. The results from the dynamic experiment did not support the hypothesis that spider fearful participants will notice the image. This result does not confirm the findings of Lee and Telch (2008) for their dynamic study, who found a bias for moving threatening faces in social phobia. Similarly, the findings for Vrijsen et al. (2009) who found a bias in spider fearful individuals using a dynamic probe detection task. In relation to the Lee and Telch (2008) study, it may be the case that spider fear is qualitatively different to social phobia and this requires further investigation. However, as suggested earlier, in their study Lee and Telch (2008) advertised for socially phobic participants and indicated the nature of the task, which might have contaminated the findings by increasing expectation or dividing attention on the critical inattention trial. In relation to the Vrijsen et al. (2009) study, while the image was a moving spider, the same analyses as provided for the static probe-detection task applies here. Firstly, that it is difficult to assess whether it is the engage or disengage component of visual attention that is responsible for the effect, as suggested by Fox et al. (2001). Secondly, as suggested in this thesis, the spider image is expected and so the paradigm tells us little about how spiders are detected when they are not expected. It is, therefore, possible to suggest that further work is required to establish whether people with elevated forms of anxiety (e.g., spider phobia and social phobia) rapidly engage dynamic images of fearful stimuli, and particularly when they are not expecting them.

In relation to the more elaborate predictions of the models provided by Beck and Clark (1997), Mogg and Bradley (1998) and Williams et al. (1988; 1997), it is important to note what the current thesis does not contribute to. Firstly, state and trait anxiety were not measured because this thesis focussed on spider fear, as such the relative contributions of these two factors cannot be assessed. Similarly, in relation to Beck and Clark (1997), further activity throughout the cognitive system (e.g., memory activation) cannot be addressed because again this was not the purpose of the thesis. As such, the current findings contribute to the suggestions of Mogg and Bradley's (1998) model that biological preparedness, prior learning, situational context and depression affect attentional response to threat in anxiety states.

Firstly, the role of biological preparedness in the Mogg and Bradley (1998) model is similar to the predictions made by Öhman (2005) – that such biases might have an evolutionary basis and so can be found in all individuals if saliency is increased. The evolutionary basis of spider fear was questioned in relation to the finding that, even with an increase in saliency, the low fear group did not exhibit an attentional allocation to the object. This lack of support for the evolutionary basis of spider fear logically promotes the suggestion that spider phobia is a learned response. Partial support for this idea is suggested by Fulcher, Mathews, Emler, Catherwood and Hammeri (in review), who found, using a probe-detection task, that the children of anxious mothers display the same pattern of attentional allocation to threat as their mothers although in the absence of elevated anxiety. The findings from this study, with the research described by Fulcher et al. (in review) suggests that the role of prior learning inattentional bias to threat requires further investigation. This is particularly the case because Fulcher et al. found biases in children despite the lack of anxiety in this group. This suggests that attentional bias to threat may precede development of measureable anxiety states.

Further work in this area could make a significant contribution to our understanding of the aetiology of anxiety disorders.

Regarding both situational context and depression the model makes a number of predictions. In relation to situational context, the model suggest that appraisal of threat by the preattentive VES is dependent on situational context. This prediction may offer a plausible explanation of why the low fear group did not recognise the spider in the rapid engagement experiments described in this thesis. While it was suggested earlier that there is reasonable evidence to suggest that spider fear does not have an evolutionary basis, it might also be the case that the situational context (i.e., that it was an experiment, run in laboratory settings on a computer) caused the lack of response in the low fear group. It stands to reason that if this is the case, the situational context was still sufficient to induce a marginal effect in the moderate to high fear group. If this is the case, then the findings presented in this thesis offer partial support the suggestion that fear of spiders causes an increase in sensitivity to spider images, which will be displayed in situational contexts where the threat is observably low. Finally, it was difficult to assess the contribution of depression, and the spider fearful groups did not have markedly high depression in any of the experiments. It is therefore clearly necessary for future research to investigate the roles of situational context, biological preparedness and depression in the Mogg and Bradley (1998) model.

8.6 Comparison with the emotional stroop task

The theories discussed above were considered in relation to the probe-detection task because that task was used to overcome the methodological difficulties associated with the emotional stroop task. The major difficulty with the emotional Stroop task is that the response measure (the colour naming latency) may not be due to attentional processes. For example, Williams et al. (1997) suggest that post-attentive processes such as memory activation and self-referent activity may be responsible for the observed lag in anxious participants. A further difficulty with the Stroop task is that it does not provide an indices of which stimulus enters conscious awareness first, which does not allow that task to fully elucidate the theoretical prediction that threatening stimuli rapidly summon attention. As such, while the results of the inattentional blindness task are not readily interpretable with the Stroop task, they might contribute to uncovering the responses made by anxious individuals during the task. The following analysis will, therefore, concentrate on interpreting the process leading up to the output of the colour name in previous Stroop findings.

The emotional Stroop has been used with two forms of stimulus – either pictoral or word – which are embedded in a colour, which has to be named verbally as quickly as possible by the participant. Additionally, the task has been used at both subliminal and supraliminal presentation speeds. It is important to note that, across all versions of the task, stimuli presented in during the emotional Stroop task are presented centrally, and therefore there is no ability to assess hemispheric asymmetry. However, for the purposes of the present discussion, the marginal findings from the LVF experiments will be used to explain the findings. Due to the number of Stroop tasks conducted and that, since the addition of the probe-detection task, it largely been discredited, individual studies will not be concentrated on here and only a brief description will be provided.

In the case of pictoral stimuli, the findings from the inattentional blindness experiments presented in this thesis suggests that, while the Stoop task is unable to show precisely which stimulus entered conscious awareness first, it is likely that in anxious participants the threatening stimuli were prioritised by the attentional system. The findings from previous Stroop tasks that have found biases for word stimuli (e.g., Pishyar et al. 2004) remain elusive. As suggested (e.g., Mogg and Bradley 1998), word stimuli are not likely to have a superior threat advantage and so are unlikely to be rapidly engaged. Therefore, overall, the current investigation suggests that, firstly, the inattentional blindness experiment is more suited to studying attentional bias in anxious individuals and secondly, that the limitations of the Stroop mean that is should be disregarded as a measure of the rapid engagement of threat in anxious individuals.

8.7 Comparison with probe-detection task

The results from the current experiments are compatible with those finding an attentional bias to threat using the probe-detection task (e.g., Mogg & Bradley, 2002). In the probe-detection task, participants with various types of anxiety are compared with non-anxious controls. The groups are compared on the speed at which they detect a probe replacing one of two emotionally diverging pictures. Evidence of an attentional bias to threat is assumed when participants detect the probe faster when it replaces the negatively valenced stimulus. Different studies have used either pictoral or word stimuli that are relevant to the particular anxiety sub-disorder (for example, in spider phobia, the word 'web', or snake phobia and using a picture of a snake). Due to the similarity of findings across sub-disorders, the specific anxiety disorder will not be outlined in the discussion unless specifically relating to spider fear (but the studies are outlined in more detail in the introductory chapters); rather an analysis of the similarity of findings more generally will be provided. Similarly, a detailed analysis of how the findings related to specific studies will not be provided. Due to the inattentional blindness paradigm using pictorial stimuli the compatibility with probe-detection tasks using word stimuli is limited and these studies will not be considered further here.

The studies finding biases towards threatening images in the probe-detection task (see table 1.1 for a description of these) are compatible with the findings from the current series of experiments with certain limitations. These studies found (with the exception of Cooper and Langton, who found a non-significant trend) that, in comparison to low anxious controls, anxious participants were quicker to detect the probe when it replaced the negatively valenced stimulus. These findings are taken as evidence that the threaten object enters conscious awareness first. However, a 500ms exposure time will allow for both covert and overt shifts of attention, and movement of the eyes. Therefore, to be able to say precisely which stimulus entered conscious awareness first is difficult, however, this appears more probable for stimulus presentation times that are lower (i.e., Mogg and Bradley (2001) who used a 200ms exposure condition). Therefore, although the results for the left visual field and real spider experiments only approached significance (that is, there was a trend in the data) the current experiments suggest that in the case of probe-detection tasks, when stimuli are placed in the left visual field, they will enter conscious awareness more rapidly (i.e., within 200ms) and, furthermore, that attention will be shifted from a current goal and towards the image, which was not observed in the low fear groups.

While the findings from the current thesis are marginal, they do lend support the argument that people fearful of spiders will engage spider images when they are not expected and that this is mediated by the right cerebral hemisphere. The findings also suggest that the equivocal results across the studies described in table 1.1 might be due to the lack of precision as to which cerebral hemisphere the stimuli are presented to. It is possible, therefore, to suggest that modifications to the probe-detection task so that exposure times are reduced to 200ms or below would be important for future research. Similarly, experimental procedures that eliminate the participant's expectation can also be considered as important methodological advancements in the study of attentional biases in anxiety states.

8.8 Comparison with Visual Search tasks

Working from the suggestion from Mack and Rock (1998) that visual search tasks do not fully illuminate perceptual processes because attention is not engaged, it was proposed that the findings of perceptual processing biases found in anxious individuals might be due to enhanced attentional abilities rather than preattentive processes. Furthermore, the visual search tasks were criticised on two methodological grounds. Firstly, because task instructions inform participants that they must locate a fearful stimulus, the procedure shows only, for example, that phobic individuals detect spiders more rapidly than people who are not fearful of spiders (which, as suggested above, leads to inaccurate conclusions). The experimental method does not demonstrate how, for example, phobic individuals visually react to spiders when they are not expecting them. Secondly, and related, it was suggested that prior attentional engagement would enhance the ecological validity of the findings in so far as it is reasonable to assume that if spider fearful individuals preferentially process spiders, attention will be removed from a task and be reallocated to the spider. Finally, using the visual search task does not allow for an assessment of cerebral asymmetry.

The visual search task was separated into two different types: the target detection task and the odd-one-out task (Rinck et al., 2005). In the target detection task, participants are instructed either verbally or with pictures to localise the target. Odd-one-out tasks, on the other hand, verbally instruct participants to find the incongruent stimulus (e.g., a frowning face in an array of smiling faces). When combined with the inattentional blindness experiment not informing participants about the appearance of the spider, the tasks can be treated in order of reduced expectation. To demonstrate with the example of spider fear, at the highest level of expectation creating, the target search task will present a picture of a spider. Next down, the odd-one-out task will inform participants to detect an incongruent picture (which will be a spider). So participants are informed there is a target to locate. Finally the inattentional blindness experiment does not indicate that any additional object will appear, so participants are unaware of anything appearing or the nature of the task.

The odd-one-out task was used to discover rapid engagement biases for threatening faces by Hansen and Hansen (1988), which was refined by Eysenck and Byrne (1995). Both studies showed that threatening faces have a general threat superiority effect, whereby participants detected them more quickly than neutral or positively valenced faces. However, anxious participants demonstrated a more rapid detection speed than the low anxious participants. This finding was contested, however, by Gilboa-Schechtman et al. (1999), who found that anxious participants were only faster to detect threatening faces when compared with positively valenced faces (i.e., a within groups comparison). Furthermore, they expanded the research to show that when a positively valenced face was included in an array of angry distracters, generalised social anxiety disordered patients showed a detection latency. Gilboa-Schechtman et al. suggested from these findings that threatening faces are not detected more rapidly, but rather that anxious individuals have difficulty processing positive faces.

Similarly questionable findings were reported by Juth et al. (2005) using an odd-one-out task. They found that across controls, high-trait social phobia and clinical social phobia, natural happy faces were detected faster and more accurately than angry faces across all groups. The results only reversed in the socially phobic groups when schematic faces were presented. The authors concluded similar to Gilboa-Schechtman et al. (1999) that, while angry faces appeared to be processed more efficiently than happy faces, this was due to a inefficiency in processing happy faces in the anxiety group, rather than a marked increase in detecting negative faces.

There is difficulty reconciling these findings. However, the the results from the left visual field and real spider experiments, while not statistically significant, do so marginally significant results and suggests that anxiety disorders do lead to rapid preattentive detection when stimuli are presented to the right cerebral hemisphere. The Eysenck and Byrne (1995), Gilboa-Schechtman et al. (1999) and Hansen and Hansen (1988), studies did not control for this factor and it is therefore possible to suggest that, based on the findings from the current series of experiments, hemispheric asymmetries may be responsible for the effect. However, this is speculative due it being impossible (without the use of eye tracking equipment) to assess where the stimuli was picked-up.

Visual search studies specifically investigating fear of spiders have used traditional tasks (both target detection and the odd-one-out paradigms) and modified versions of these, and newly designed experiments. Firstly, Rinck et al. (2005) used both the target search task and the odd-one-out paradigms. The results from the target search task yielded no significant differences between spider phobic individuals and non-phobic controls. However, in the odd-one-out task, spider phobic individuals showed facilitated detection, compared with the control group. In relation to these findings it can be suggested that the there was a systematic reduction in expectancy. As highlighted by Rinck et al. (2005), this is likely to have reduced the advantage target search tasks give to individuals low in spider fear. They also suggested that parafoveal processing (i.e., away from fixation) might be enhanced in anxiety states. This suggestion finds support in the results presented by Miltner et al. (2004). In their modified version of the target search task, when the target was a mushroom, and participants were instructed to locate the target, phobic, but not non-phobic participants showed a reaction time lag when a "distracter" spider was presented additional to the target. From these results, they suggested that covertly presented stimuli are better able to attract attention. The results of the current study, while providing only partial support due to the lack of statistical significance, support this suggestion and better elucidate the effect for a number of reasons. In terms of covert presentation, the Miltner et al. study was not entirely covert – participants were recruited for their fear status and the spider that appeared as a distracter also appeared as a target. It might be the case that the anxious individuals became confused as to which the target was in that trial; a problem perhaps exacerbated by increased fear. It is also possible, as was the case with target search tasks, that prior exposure caused this in the anxious group, but not the phobic group (e.g., perhaps by elevating state anxiety due to prior exposure).

When assessing how the inattentional blindness experiment and the results presented in this thesis contribute to visual search tasks two general advantages can be highlighted. Firstly, as suggested, the role of perceptual processes has been better elucidated due to the absorption of attention on the cross judgement task. Secondly, as suggested in relation to the probe-detection task, the inattentional blindness experiment better elucidates the specific roles of the two cerebral hemispheres. However, in specific relation to the findings and interpretations described above by Rinck et al. (2005) and Miltner et al. (2004) a number of points can be made. Firstly, while the results from the left visual field and real spider experiment only approached significance, if it is considered that the role of expectation is reduced systematically by the target search and odd-one-out tasks, and by the inclusion of a spider image when participants were not instructed to locate it caused a further reduction in expectation, the inattentional blindness experiment goes further to completely eliminate expectation and demonstrates that covertly presented spiders are detected by individuals with increased spider fear. Secondly, Miltner et al. (2004) suggest that parafoveal processing might be enhanced in spider fearful participants. The results from the small spider and right visual field experiments do not confirm this suggestion. That is, although the spider image was presented in the parafovea, the groups with increased fear of spiders did not notice them. In the case of the left visual field and real spider experiments, where the spider images were again presented in the parafovea, there was marginal support for this suggestion. It appears, therefore, that establishing the possibility of enhanced parafoveal processing in spider fear requires further investigation.

8. 9 Comparison with alternative methods

Despite the dominance of the emotional Stroop, probe-detection, and visual search paradigms, alternative methods have been used to assess perceptual and attentional biases in anxiety disorders. Firstly, the results from Merckelbach et al. (1993) contribute further to the parafoveal debate above. They found that anxious individuals displayed reaction time lag to naming the direction of lines presented either horizontally or vertically when they were flanked by either pictures of flowers or spiders. That is, the effect was not specific to spiders. A number of explanations for this finding have been suggested. Firstly, Eysenck (1997) suggests that the spatial proximity (i.e., the spiders being placed parafoveally) led to a reduced effect, which as suggested, was similar to the suggestions of Fox et al. (2001; 2002), who noted that Stroop effects are not present for non-centrally presented emotional stimuli. A similar argument was put forward by Lavy et al (1993) in relation to their findings of no response lag when spider images were presented away from fixation. Similarly, the results from the current series of experiments lent only partial support for the suggestion that parafoveal processing is enhanced, i.e. the stimuli were presented in the parafovea, but two of the experiments (in the right visual field) failed to confirm a parafoveal bias and the left visual field experiments only showed marginal significance. Therefore, again, it appears that further investigation of parafoveal processing in various anxiety sub-disorders is required.

More recently, two experiments have been borrowed from the perceptual and cognitive psychology literature – the change blindness and inattentional blindness paradigms. Firstly, Mayer et al. (2006) presented two groups of participants (spider phobic and non-spider phobic) with rapid and repeated visual scenes. Across the presentations, additional objects appeared (spiders or neutral objects), which signifies the 'change' in the name of the experiment. The results showed that spider phobic individuals were able to detect spiders faster than were non-phobic controls. Lee and Telch (2008), on the other hand, used an inattentional blindness paradigm similar to the one used in the current thesis, but they presented the critical stimulus (e.g., a frowning face) centrally and the cross in the parafovea (see introduction for outline of this method) and found that anxious people were more likely to detect frowning faces than non-frowning faces and more likely to detect frowning faces than were low socially anxious controls.

Although the results from the left visual field and real spider experiments only approached significance, they do offer partial support for the studies outlined above. However, there are a number of discrepancies between the research procedures. Firstly, in relation to the Mayer et al. (2006) study, participants were screened before hand for levels of spider fear. While this was several weeks beforehand, as the authors themselves note, this may have contaminated the findings, and contributed to enhanced detection in the high phobic group. In relation to the Lee and Telch's (2008) study (specifically their static experiments, the dynamic experiment has been considered earlier), there are a number of difficulties, which mean the full validity of the inattentional blindness experiment was not addressed. Firstly, as with the Mayer study, participants were screened for social anxiety before the computer based inattentional blindness experiment began. This would possibly contribute to the effect observed and the enhanced detection rates displayed by the socially phobic group. Additionally, the authors produced a web based participant recruitment advertisement, which explained the study and the inattentional blindness experiment. It is reasonable to further suggest that this procedure may have informed participants of the nature of the study sufficiently to disturb the results, which may account for why they observed a stronger effect.

8.10 Comparison with the delayed disengagement hypothesis

The alternative model to the rapid detection theories (e.g., Williams et al., 1988) is the delayed disengagement hypothesis (Eysenck et al., 2007; Fox, Russo, Bowles & Dutton, 2001), which suggests that anxiety causes difficulties with the disengage component of visual attention outlined by Posner and Petersen (1990). This hypothesis stems from the observation that the probe-detection task does not measure rapid engagement and better demonstrates that the anxious individuals display a delay in removing their attention from a negative stimulus once it has been detected, i.e., the failed to disengage from it. Additionally, the effects observed in the emotional Stroop task (i.e., the colour naming response latency) may be attributable to delayed disengagement, but this is only speculative and is open to other interpretations. Fox et al. (2001) and Fox et al. (2002) successfully demonstrated a delayed disengagement bias in a series of experiments designed to illuminate the processes suspected to be present during the probe detection task. The results from the delayed disengagement inattentional blindness experiment failed to corroborate these findings, yielding no association between anxiety and failure to detected the critical smiling face.

While no association was observed between the group with increased spider fear and decreased detection of the smiling face on the delayed disengagement experiment, there are a number of possibilities of why this occurred. From a methodological perspective, it is possible that the face in the inattentional blindness experiment did not attracted the attention of the moderate to high fear group and elicited disengagement due to its emotional value. For example, Fox et al. (2002) found a general emotional effect in their experiments so that positively valenced faces caused similar disengagement difficulties as negatively emotionally valenced faces. Similarly Mack and Rock (1998) suggest that a positive facial expression is reliably able to attract attention during inattentional blindness tasks. However, this suggestion is limited when the findings from the Lee and Telch (2008) study are considered. They found that a positive face did not attract attention in socially anxious individuals. Therefore, in terms of the stimulus used to elicit disengagement, why delayed disengagement did not occur remains unclear and requires further testing.

From the perspective of phobia, it is possible that simple animal phobias do not elicit the same delayed disengagement response as faces found by Fox et al. (2002). Compared with the an image of a spider, facial expressions are transient and able to change in their emotional valence very quickly (e.g., from being threatening to becoming neutral) and therefore, the disengagement process may be adaptive in assessing a whether the emotional valence changes. Similarly, faces can display the intentions a person has towards the perceiver and, therefore, the disengagement process may serve to anticipate the intention of others. However, these interpretations do not account for the findings reported from experiment 1 in Fox et al.'s (2001) paper, where word stimuli were used. It is possible, however, to suggest that words might elicit a different response, which causes the anxious individual to momentarily ruminate on the word, while leaving attention fixed on the visual space where the word appeared (an effect similar to that found in emotional stroop tasks). Thus, words may elicit self-referent activity that causes a more rapid detection of validly cued stimuli (i.e., where the probe appeared on the same side as the negative cue) but slowed detection of invalidly presented cues (i.e., when the probe appeared on the opposite side to the cue).

There are further difficulties with the findings suggesting delayed disengagement in anxiety (e.g., Fox et al. 2002). While they were able to demonstrate a disengagement bias, it is difficult to reconcile these findings with the established evolutionary framework of anxiety. Anxiety has been interpreted as a heightened state of threat detection. The evolutionarily adaptive function of threat detection involves the individual rapidly detecting threat in their environment in order to facilitate escape from danger (Edelman, 1995) Difficulties disengaging attention from a feared object is unlikely to facilitate escape from harm. Returning to the argument that spider phobia does not elicit an effect when socially valenced human signals do, it is possible that animals present a more clearly defined threat, whereas human faces require a more thorough assessment of intention and potential threat so a more detailed assessment is required. Therefore, there may be an evolutionary distinction between the attentional response towards human and non-human threat.

To summarise, it is possible to suggest that further work investigating delayed disengagement is required. In terms of the current results from the delayed disengagement experiment, while no evidence was found that individuals with increase spider fear have difficulty disengaging their attention from the object, it is possible that other factors were responsible for the effect. A face stimulus was chosen because it appeared to be the most likely stimulus to break through any difficulty disengaging attention. Thus, it was possible that this stimulus would produce the most stringent test of the delayed disengagement hypothesis. However, further research should examine more clearly the degree of sensitivity components of visual attention have a range of stimuli and anxiety types. Similarly, as suggested, it might be the case that different anxiety types have different effects on visual attention and spider phobia may not cause the same disengagement response. Overall, therefore, future work is needed to fully understand delayed disengagement across the anxiety spectrum.

8.11 Implications for theories of perception, attention and working memory

How the findings related to the literature on perception, attention and working memory requires discussion. Firstly, in relation to the neurophysiology of the visual system and the suggestions made by LeDoux (1996) and Öhman (2005), it appears that, in the groups with increased spider fear in the left visual field and real spider experiments, the marginally significant effect may have been due to the low level thalamo-amygdala pathway, which reacts early in the visual processing chain when threatening stimuli are presented. Subsequently, cells in the superior colliculus would have assigned attention to the spider, which would have allowed for better identification by the right ventral visual processing stream, which is specialised for the processing of the global aspects of an object, rather than the constituent parts, which is controlled by the left cerebral hemisphere (Banich, 2004).

The suggestion of right hemisphere processing receives further support when the findings presented by Koivisto and Revonsuo (2004) are considered. They found that bird and car experts were faster to process images of birds and cars, respectively, when they were presented in the left visual field (i.e., to the right hemisphere). In relation to the suggestion of right-hemisphere dominance in the processing of spider images made by Fox (2002) and Mogg and Bradley (2002) and the marginally significant findings for the left visual field and real spider experiments in this study, the suggestions made by Koivisto and Revonsuo (2004) of expert bias, open up the possibility that the spiders were detected by the high fear group due to this group being more "expert" on spiders. This possibility seems possible when the models of attentional bias to threat are considered. For example, if an attentional bias to threat causes individuals with increased spider fear to notice more spiders in their visual environment, it is logical to assume that they are going to be more familiar with them (i.e., more expert) than people with low spider fear. As such, the evidence from the models of attentional bias to threat, combined with the suggestions made by Koivisto and Revonsuo (2004) suggest that the biases displayed by individuals with spider fear are likely to be the result of a self-perpetuating process, which causes increased exposure to spiders in individuals fearful of them. The suggestion, in turn, lends further support to the model provided by Mogg and Bradley (1998), which suggests that prior learning may be responsible for attentional bias to threat in anxiety disorders.

The findings from the current study also need to be interpreted in reference to general psychological theories of attention. These theories fall broadly into two categories. Firstly, there are models that attempt to account for why certain information is selected for conscious attentional processing and why other information is not, and the level to which the unselected information is processed (e.g., Lavie, 1995). Secondly, there are theories relating to attentional systems including whether there are object and spatially based attention systems (e.g., Soto & Blanco, 2004) and the processes by which attention is allocated and removed from spaces or objects (e.g., Posner and Petersen, 1990).

In relation to the early (Broadbent, 1958), late (Deutsch & Deutsch, 1963) and variable (Triesman, 1964, Lavie 1995) bottleneck debate a number of points can be made. Firstly, Mack and Rock (1998) suggested that the finding that a large object could more reliably draw attention than a small object support early bottleneck models of attention because the object was selected on a low-level stimulus feature (i.e., size). The results of the object comparison analysis do not confirm this finding and suggest that early selection on the basis of size does not occur. The current experiments, however, do offer support for late bottleneck models of attention. The results from the forced choice tests, with the exception of the real spider experiments, suggest that the spider images in particular received a high level of perceptual analysis because they were chosen more frequently than objects not appearing in the critical inattention trial. Therefore, the current findings lend greater support for the late bottleneck models of attention.

In relation to the components of visual attention outlined by Posner and Petersen (1990) the findings firstly suggest, in accordance with the general argument contained in this thesis, that in the left visual field and real spider experiments, although not significantly so the spider attracted attention rapidly and this was related to the engage component of visual attention. Due to the lack of available eye tracking equipment during the majority of the production of this thesis, it was impossible to assess whether the allocation of visual attention was covert (endogenous) or overt (exogenous). However, based on the suggestion by Banich (2004) – that involuntary saccades operate within 120ms and voluntary saccades operate in 200ms to 300ms – it is possible, but not directly assessable, that the shifts in attention to the spider image were covert.

In relation to whether attention is object based or spatially based, the suggestion provided by Soto and Blanco (2004) that there is a dynamic interaction between the spatially based and object based attention is supported. These authors suggest that object based attention might be dominant and that the spatially based attention system operates, at least in the first instance as a secondary system, that follows the object based system to enhance processing of that particular object. However, spatially based attention can be reallocated with the appearance of a new or novel stimulus in the visual field. The evidence from the current series of experiments did not fully test this hypothesis but the marginally significant results from the left visual field and real spider experiments suggest that object based attention would have been allocated to the cross judgement task and then, in the case of participants who detected or identified the critical stimulus, spatial attention would have been allocated to the critical stimulus. A more direct test of this hypothesis could have been provided by examining the accuracy of the judgements made about which line was longest when the critical object appeared on the inattention trial. However, while the accuracy of these judgements were recorded during the experiments, there was a general ceiling effect, with the majority of participants being fully accurate across trials. Therefore the current inattentional blindness experiment was not able to assess this, and generally modifications to the paradigm to allow for such an assessment may have contaminated the finding in relation to the primary objective of the thesis to examine attentional allocation to threat in individuals with heightened spider fear.

Finally, in relation to the link between visual attention and working memory, DeFockert et al. (2001) suggest that if working memory load is high, individuals will be more distractible and show less efficiency on sustained attention tasks. The results of the experiments contained in this thesis do not impact directly on this finding, however, it appears that the dynamic experiment did not place a sufficiently high load on the participants in the study, as there were no general distraction effects observed (i.e., the general level of inattentional blindness in this study was low). However, what the current findings do point to is that dynamic inattentional blindness studies may be able to assess this hypothesis further.

8.12 Limitations of current study

There are a number of limitations to the current study. Beginning with the static inattentional blindness method, these relate to procedural methods, statistical analyses, effect size and statistical power. Regarding the procedural methods and the stimuli used, unlike, for example, the Stroop and the probe-detection experiments where stimulus sizes can be reasonably large, the stimuli used in the inattentional blindness experiment are required to be relatively small. On the one hand, it is useful to use small stimuli because it can provide an index of sensitivity to images (e.g., in the current study a relatively degraded image of a spider that was of sufficient size was noticed by the fear group, but a smaller size spider was not). However, on the other hand, there are a number of problems. Firstly, because of the small size of the image, but with the exception of the real spider experiment, it is possible that the image was not clear enough to allow a fully accurate percept of the spider. This would have led to an increase in the detector group (i.e., people who saw something but were unsure what it was). The problem of correct identification is perhaps supported by the finding that more of the low fear group were able to identify the spider correctly in the real spider experiment. However, it is also possible to suggest that the quick and dirty pathway identified by LeDoux (1995) will have picked up a degraded image of a spider and responded by allocating attention to it in the high fear group.

Related to the difficulty with the spider image is the categorisation of noticing rates. The procedure allowed for two options. Firstly, it was possible to collapse the detector and identifier groups into one group of noticing the object. This procedure is possible to justify on the suggestions of LeDoux (1995) of the thalamo-amygdala pathway responding to a degraded image that represents a feared object. However, this was not considered to be sufficient considering that exposure times were sufficient to allow for a fully conscious perception of the critical object.

The second was to use three groups (inattentionally blind, detector and identifier), an option chosen for the present study for two reasons. Firstly, the reports by participants could be separated into three non-overlapping categories based on the responses they made. Based on the suggestions made by Mack and Rock (1998) – that there is no conscious perception without attention – and the suggestions made by LeDoux – that the thalamo-amygdala pathway picks up degraded images of stimuli and reacts by allocating attention in their direction – the decision was taken to separate the participants into three groups. This procedure is supported by the 200ms presentation time of the critical stimulus, which permits a conscious representation of the image. This procedure also corresponds to the ones used by Mack and Rock (1998) and Lee and Telch (2008).

The next limitation of using the inattentional blindness paradigm is the method of recruiting participants. There are a number of factors of consideration on this topic. Firstly, as suggested, to make full use of the experiment, participants cannot be given an indication before hand that a spider will appear. As Mack and Rock (1998) suggest, an indication that the critical stimulus will appear causes attention to be divided, which will increase the likelihood of noticing the object. This makes recruiting participants because of their fear status difficult because it relies on the prevalence of the phobia within society. For example, less common phobias would be difficult to test in such, but spider phobia has a prevalence rate of 7% to 13% (Sue, Sue & Sue, 2003), which makes it sufficiently common enough to expect a sufficient amount of individuals to fall into the category of heightened spider fear.

Related to this matter, as suggested in chapter 3 (general method section), defining cut-off points for spider fear is difficult because the scale used in the current study did not suggest any significant distinguishers between low, medium and high phobia. The current research followed the procedures used by Huijding and De Jong (2006) and Cochrane et al. (2008), which was subsequently supported by statistical analyses. The data obtained from the FSQ (Szymanski & O'Donohue, 1996) across the whole cohort of participants demonstrated a binomial split where the participants were divided with a majority spread between 18 and 25 and the remainder distributed from 30 to 126. At the lower end of the scale, this data supports the use of a low fear category, which supports the statistical procedure used (i.e., a 2x3 chi-square test). However, the scores of the high fear group are distributed across a larger dimension (of 96 points). This difficulty with treating these participants as one group is that there may be differences in the extreme ends of the defined scale, which may mask differences between, for example, people with a medium level of phobia and those with a high level of the disorder. However, because of the reasonably low sample sizes for each experiment this procedure was unavoidable.

Another point for discussion is the separation of participants at a specific cut off point (i.e., those scoring below 30 being placed in the low fear group, and those scoring 30 or greater being placed in the high fear group. In their meta-analysis, Bar-Haim et al. (2007) suggest that within the cognitive psychopathology literature, two procedures for comparing high and low anxious people have been used. One procedure is to measure participants' scores on a scale, say for example, the STAI (Speilberger et al., 1983), and take the highest and lowest scoring participants. This procedure excludes participants scoring towards the central point of the scale and is useful for examining the extreme differences between, continuing with the example, high and low anxiety, and is useful for examining differences in neural processing between the two groups. This method is often used to increase the statistical power of studies (Fox, 2002).

The second method, as used in this thesis, is to use a defined cut-off point and includes all participants below or above that point and separate them into two groups. This method is useful for examining subtle differences between the two groups in the study, and gives a better example of, for example, spider fear across the spectrum defined by the scale. Bar-Haim et al. (2007) suggest that this method is less likely to achieve statistically significant results, but effectively shows how disordered groups differ from the general population (as apposed to, for example, how people with extremely elevated anxiety compare with individuals will abnormally low anxiety). This method was chosen for this particular study for this reason and because, while recruiting individuals with no fear of spiders is particularly easy, finding individuals at the other end of the scale is more difficult, particularly when it was impossible to place advertisements asking for spider phobic people to participate (of course, this would have given sufficient information, or primed the participants adequately, to contaminate the results and possibly increase noticing rates).

An additional problem with using the inattentional blindness paradigm in the way it has been used here is the covert nature of the research. Effectively, participants were deceived as to the nature of the research. To exemplify, participants could not be informed of the experimental hypothesis until after the procedure was conducted. This did not allow them to give fully informed consent before beginning their participation. This problem is exacerbated by the nature of the study because spider phobic people were being recruited and exposure to the stimulus may cause adverse reactions in these individuals. However, the research passed ethics committee approval with certain measures taken. These included, as standard for all research, information about the participants right to withdraw at any time, and a consent form explaining the partial nature of the study. Additionally, between completing the experiment and beginning the questionnaires, participants were verbally informed about the nature of the study. After the questionnaires were completed a full debriefing was given including the experimental hypotheses and a reminder of the participants right to withdraw. Additionally, and information sheet about anxiety and where to find support (for both students and non-students) was provided.

Such research procedures would be difficult to utilise in other anxiety disorders for a number of reasons. Firstly, many anxiety disorders (e.g., obsessive compulsive disorder, generalised anxiety disorder) are not sufficiently represented in the general population (Sue et al. 2003), so recruiting participants will rely on access to either in-patient or out-patient clinical settings. The complicated experimental and ethical considerations are then exacerbated. For example, it would be difficult because participants are then being recruited specifically for the disorder (which in this study they were not). Secondly, recruiting the participant but not providing them with the knowledge becomes more difficult in a clinical setting.

A final difficulty with the present study, and the use of the inattentional blindness paradigm in assessing anxiety states generally, is that participants only yield one data point each. That is to say, a person can only be tested once. Once a person has completed the experiment, their knowledge of the procedure means that if they were tested again they would expect to see the critical stimulus on the inattention trial. Therefore, because subsequent trials are not possible a large number of naive participants are required for a series of experiments. This factor is discussed later in relation to the statistical analysis conducted. Overall, therefore, while the inattentional blindness paradigm is theoretically valid and is able to assess perceptual and attentional biases in anxiety states, procedural and practical restrictions may limit the usefulness of the paradigm.

A further limitation of the present study relates to effect size and power. In order to address this issue a brief discussion of the type of data and tests used to analyse it need to be provided. The data from the current experiments is nominal. Specifically, the noticing rates from the inattentional blindness experiments represent three categorical variables (inattentionally blind, detector and identifier). The ordinal FSQ (Syzmanski & O'Donohue, 1995) was converted into a two group nominal variable (fear: high and low). Due to having two categorical variables, the appropriate test was a 2x3 Chi-Square test to examine the main hypothesis in this thesis (that increased levels of spider fear cause attentional biases to spiders). Multidimensional Chi-Square tests have a number of assumptions that need to be met before the test can be used. Firstly, they require the data to be nominal in nature; an assumption satisfied with the current data set. Secondly, the data for each variable must fall into only one distinct group. This assumption has also been satisfied by the current research. Thirdly, within the Chi-square matrix, the expected frequencies for each cell cannot be below 5. When this final assumption has not been met, another version of the Chi-Square statistic, Fisher's exact test of significance, must be used (Brace, Kemp and Snelgar, 2006; Rosenthal and Rosnow, 1991). This statistic allows for expected frequencies as low as 1. In the current research project, Fisher's exact significance test was used when the assumption had been violated

In relation to effect size, determining the size of the effect predicted for the experiments is important because this can be used to indicate the number of participants needed in the study. For example, if there is a predicted small effect size a researcher can increase the sample size in order to be able to detect the significant effect if there is one present (i.e., controlling for a type-2 error). However, in the current study, there were two difficulties that made this procedure difficult to use. Firstly, there was no indication of the possible effect size because there was no guiding research indicating the effect size that was likely. That is, there was no research that had measured spider fear and inattentional blindness. Thus, it was difficult to predict what effect might have been present and to select the number of participants to used in the study.

The second issue is that the chi-square statistic works on the number of observations in a particular category expresses this as a percentage. The use of percentages means that the number of participants in the study does not influence the sensitivity of the test to detect statistically significant differences if they are present. To exemplify this point, the small spider experiment showed a non-significant association. If the sample size were increased from 49 to 490 participants the test would not have shown a different result. Thus, the chi-square statistic and effect sizes generally are not influenced by the number of participants. Therefore, the following discussion will concentrate on the effect sizes found for each of the experiments without further consideration of the sample sizes.

As suggested above, it was difficult to conduct an a priori power analysis for the experiments in this thesis. However, interpretation of the results will be aided by post-hoc power analyses. Rosenthal and Rosnow (1991) suggest that, because the chi-square statistic is primarily a measure of association, a correlation co-efficient can be used as an indication of the effect size obtained in the experiment. The correlation co-efficient used to measure effect sizes in Chi-Square analyses in the Phi statistic. This has been reported in results section of each of the static inattentional blindness experiments, but is also provided below in table 8.1.

Table 8.1. The correlation co-efficient to measure effect size and the p-values.

Experiment	*Phi*	*P* value
Small Spider	.02	1.0
Large Spider	.19	.52
Left visual field Spider	.46	.01
Real Spider	.41	.04
Small neutral object	.26	.20
Large neutral object	.42	.19
Delayed disengagement	.08	1.0
Dynamic experiment	.23	.07

As can be seen in the table, the two significant results found for left visual field experiment and the real spider experiment have Phi correlation co-efficients of .46 and .41 respectively. The significant results obtained for the test suggest that the experiments had sufficient power to detect a significant result. This therefore impacts on the other experiments. For example, the large neutral object experiment has a phi value of .42 but does not detect a statistically significant result. As such, it is possible to suggest that, in the case of this experiment, there was no effect present and therefore a type-2 error has not been made. In the case of the small and large spider experiments, and the small neutral object and delayed disengagement experiments, it is possible that a type-2 error has been made. It should also be noted that this is particularly the case for the dynamic experiment. The dynamic experiment has a p value of .07, which is close to significance with a small effect size. Therefore, these results should be considered with caution.

To summarise, the inattentional blindness experiment has a number of difficulties associated with its use when assessing attentional bias to threat in anxiety disorders. These include restricted stimulus size, difficulty with participant recruitment and ethical clearance, and problematic estimates of participant samples needed. These factors affect how feasible a study using the inattentional blindness experiment is to conduct and limits the group of anxiety disorders that can be assessed. It is also important to note that, particularly in the case of the Bar-Haim et al. (2007) and Beck and Clark (1997) model (but not the Mogg and Bradley, 1998, or Williams et al, 1988, 1997 model), the inattentional blindness experiment cannot assess further theoretical predictions (for example, the potential behavioural avoidance strategies used by phobic individual when the see spiders or memory activation).

8.13 Directions for future research

Despite the limitations with the inattentional blindness paradigm outlined above, there was partial evidence that spider phobia is associated with an attentional bias to spiders when they are not expected and when attention is already engaged on a concurrent task. Related to this, it was also found that this bias is detectable most prominently in the right cerebral hemisphere. Finally, it was also found that individuals low in spider phobia do not exhibit such biases despite a systematic increase in image saliency. Based on these findings there are a number of directions for future research. Firstly, with the exception of different distracter stimuli (e.g., Cartwright-Finch & Lavie 2007), the static inattentional blindness experiment has remained in its typical form since the Mack and Rock studies (1998). The example provided by Pflugshaupt et al. (2005) demonstrates that in change blindness studies an array of backgrounds can be displayed. It would be worthwhile examining whether it is possible to change the static inattentional blindness paradigm so that more natural scenes can be used. For example, research investigating whether people can detect additional and new visual objects while studying natural distracter scenes that are more visually rich than the single cross judgement task that is displayed in current experiments.

While Cartwright-Finch and Lavie (2007) were able to demonstrate that the level of information in the distracter task affected levels of inattentional blindness, it would also be worthwhile examining how different stimuli compete for attentional registration when they are presented simultaneously. That is to say, if the level of perceptual / attentional load can be set at a certain level, and two critical unexpected objects were displayed in apposing quadrants of the cross which, if not both, would be consciously perceived. An examination of different research questions using this procedure may help to increase understanding of how the attentional bottleneck filters out and lets in certain information. Further relating to the inattentional blindness task, as suggested earlier, the suggestion of meaning might be confounded by the possibility that it is familiarity. While it is of course very likely that objects meaningful to a person are also familiar to them inn terms of the perceptual system, it would be interesting to dissociate these two factors in order to further elucidate the role of meaning.

While this study has concentrated on whether anxiety states affect inattentional blindness, it might also be worth examining whether other factors affect the phenomenon. The array of factors available is wide and covers not only emotional correlates but also other factors. For example, it might be important to examine whether factors such as Intelligence Quotient, and in particular different subtests from, for example, the Wechsler Adult Intelligence Scale predict a predisposition for people experiencing inattentional blindness, and the specific factors that affect this. Likewise, correlating inattentional blindness with neuropsychological factors may help increase understanding of the brain regions involved in perception and attention and may aid understanding of exactly where the blindness is caused. Similarly, research into these areas may also contribute to resolving the debate between inattentional blindness and inattentional amnesia (Wolfe, 1999).

In addition to examining inattentional blindness in the context of neuropsychological functioning as a means to uncover the cognitive processes and brain regions involved in the phenomenon, it would also be worthwhile using neurophysiological measures with the paradigm. For example, dense array Electroencephalography (EEG) equipment shows what brain regions become active during cognitive tasks. Studying Event Related Potentials (ERPs) and how they differ between people who notice, detect and identify the critical stimulus may help to illuminate how far along the visual chain stimuli pass before they become "lost" in those participants who are inattentionally blind. A similar argument can be proposed for the use of functional Magnetic Resonance Imagining (fMRI) studies.

In addition to taking neurophysiological measurements, eye-tracking equipment would be useful for a number of reasons. While it has been successfully demonstrated that eye tracking can be used with the dynamic inattentional blindness paradigm (Memmert, 2006), use of such equipment with the static inattentional blindness experiment offers a number of possibilities. For example, while it has been assumed (in this and other studies, e.g., Mack and Rock, 1998) that participants maintain their focus on the central fixation cue (and subsequently the cross or the critical stimulus) throughout the experiment, it is impossible to objectively verify this. This is of importance with the type of inattentional blindness experiment used in the current thesis, but more so perhaps when the cross is placed in the parafovea and the critical stimulus is placed at fixation. As Fox et al. (2002) suggest, 'although foveal vision and attention are not the same thing, there is a general consensus that it is impossible not to attend to information within 1° radius from fixation ' (P .682). While Mack and Rock (1998) have successfully demonstrated that is belief may be incorrect, it will take the use of eye tracking equipment before this finding can be fully substantiated. Addressing this issue would allow for clearer distinctions between what is perception and what is attention, and support the claims made by Mack and Rock that there is 'no conscious perception without attention' (1998. P.ix). Further use of eye-tracking will be suggested in relation to suggestions for advancements in the field of cognitive psychopathology.

There are a number of advancements that could be made in the field of attentional bias to threat in the cognitive psychopathology literature. These advancements fall into the categories of advancement in the use of the inattentional blindness paradigm and the development of new experimental methods; further verification of the theories proposed to account for the phenomenon of attentional bias to threat; and integration of different theories. Firstly, as suggested above, there are several of practical issues that make the inattentional blindness experiment difficult to use in relation to anxiety disorders; these problems are likely to be exacerbated with the use of clinical populations. Nevertheless, with appropriate disorder related stimuli, this appears to be one avenue for future research. Such research may uncover qualitative differences between, for example, different types of phobia. Similarly, due to the time constraints placed on the research presented here, and because the focus of the research was on spider phobia, it was difficult to include a more detailed psychometric inventory of anxiety. Research shows (Fox et al., 2002) that attentional processes are mediated differently by state and trait anxiety. Further research investigating whether state or trait anxiety affect inattentional blindness is required, both in relation to threatening stimuli and neutral objects. Such research would allow for a more thorough assessment of the hypervigilance model proposed by Eysenck (1997).

The Mogg and Bradley (1998) and Williams et al. (1988; 1997) models of cognitive psychopathology make predictions as to how depression affects perception and how depression mediates the link between anxiety and hypervigilance of the attentional system. In common, both theories suggest that depression is an affective state that renders the depressed individual as internally focussed. It is suggested, therefore, that people who are depressed will miss things in their visual environment. If this is the case, it is possible to predict that inattentional blindness will increase for individuals with markedly high depression. Therefore, it would be possible to experimentally verify such predictions with the inattentional blindness experiment.

A number of theoretical verifications, integrations and syntheses are also required in the cognitive psychopathology literature on attentional mechanisms and anxiety. Firstly, future research would benefit from advancements in assessing the Bar-Haim et al. (2007) model of attentional bias to threat in anxiety disorders. While the model is functionally similar to the models of Mogg and Bradley (1998) and Williams et al. (1988; 1997) for the first two stages after stimulus input (see figure 1.3.), it also goes further to suggest that after preattentive processes have reallocated attention towards the stimulus an array of cognitive functions occur that match the stimulus to representations stored in memory, and assess the situational context and available coping resources. There is an additional mode that overrides the automatic threat detection system, should the threat be high, and turns this into a controlled process. After this, a goal engagement system either maintains attention on the threatening object or allows the individual to continue with the task. It would be useful to verify this procedure within a single experiment that demonstrates the level of threat that has (consciously) been appraised and provides a choice to continue looking or continue with the current goals. The integration of these findings within one experiment would contribute to understanding the phenomena and possibly contribute to cognitive therapy for the conscious parts of the process.

While Fox et al (2001; 2002) suggest that anxiety causes delayed disengagement, this interpretation was based on the procedural ambiguities of emotional Stroop and the Probe-detection tasks. The findings from the experiments included in this thesis provide partial support that rapid engagement does occur when threatening objects are presented and this is a function of phobia. To illuminate this process fully, an experiment that is able to measure the engagement and disengagement components of attention within a single experiment would prove useful in assessing the full pattern of attentional involvement in the detection and response to threat in the environment.

This could be attempted to an extent with a modification to the inattentional blindness experiment. If the original set up of the experiments remained the same, but after the presentation of the critical stimulus an additional stimulus was presented within the 200ms permitted by the experiment, depending upon the stimulus, this might be used to measure whether attention disengages from the feared object. For example, in the context of spider phobia, presenting the spider as the critical stimulus and measuring detection of this would provide an indices of rapid engagement. If, after 100 ms an additional object were placed in the display, this would be the measure of whether attention had disengaged from the spider and moved to the other object. The second object could be neutral to measure the effect generally, or emotionally valenced to examine whether such stimuli are able to break the delayed disengagement of visual attention. The combination of measuring both rapid detection and delayed disengagement would allow for a unified theory of attentional processing in anxiety disorders.

8.14 Summary of thesis and major conclusions

In summary, the thesis presented here began with the suggestion that models of anxiety disorders were not fully supported by the experimental data, due to methodological difficulties associated with each of the dominant approaches, as outlined in the introduction. Furthermore, it was suggested that the current literature on attentional bias in anxiety had not demonstrated how threatening stimuli draw attention when they are not expected and / or are moving. It was suggested that these methodological criticisms could be addressed by the inattentional blindness paradigm. The results from a total of eight experiments indicated, firstly, that the inattentional blindness paradigm is able to assess predictions that spider fear causes a rapid engagement of threatening stimuli. However, there was only partial evidence that this bias exists when anxious individuals are not expecting to see the stimulus. There was no evidence that a moving image of a spider is able to attract attention in spider fearful individuals. There was evidence to suggest that low fearful individuals do not notice spider images and this finding persisted despite a systematic increase in saliency and points to spider fear not having an evolutionary basis. The findings described in his thesis, therefore, make a significant contribution to the literature on attentional bias in spider fear and anxiety more generally, and points to a new method of assessment that overcomes the methodological difficulties associated with other methods. Notwithstanding the methodological benefits of the inattentional blindness paradigm, it was further suggested that there are difficulties associated with its use and these have been highlighted in the thesis. Therefore, overall, this thesis presents a thorough assessment of attentional bias in spider fear, the contemporary literature on the subject and the practicality of assessing the phenomenon with a new experiment method.

Appendix A – Fear of Spiders Questionnaire

Fear of Spiders Questionnaire

This questionnaire is designed to assess your fear of spiders. Please read it carefully and **respond to all questions.**

1 = not like me; 7 = more like me.

1	If I came across a spider now, I would get help from someone else to remove it.	1	2	3	4	5	6	7
2	Currently, I am sometimes on the look out for spiders.	1	2	3	4	5	6	7
3	If I saw a spider now, I would think it will harm me.	1	2	3	4	5	6	7
4	I now think a lot about spiders	1	2	3	4	5	6	7
5	I would be somewhat afraid to enter a room now, where I have seen a spider before.	1	2	3	4	5	6	7
6	I now would do anything to try and avoid a spider	1	2	3	4	5	6	7
7	Currently, I sometimes think about getting bit by a spider	1	2	3	4	5	6	7
8	If I encountered a spider now, I wouldn't be able to deal effectively with it.	1	2	3	4	5	6	7
9	If I encountered a spider now, it would take a long time to get it out of my mind,	1	2	3	4	5	6	7
10	If I came across a spider now, I would leave the room	1	2	3	4	5	6	7
11	If I saw a spider now, I would think it would try to jump on me.	1	2	3	4	5	6	7
12	If I saw a spider now, I would ask someone else to kill it.	1	2	3	4	5	6	7
13	If I encountered a spider now, I would have images of it trying to get me.	1	2	3	4	5	6	7
14	If I saw a spider now, I would be afraid of it.	1	2	3	4	5	6	7
15	If I saw a spider now, I would feel very panicky.	1	2	3	4	5	6	7
16	Spiders are one of my worst fears.	1	2	3	4	5	6	7
17	Would feel very y nervous if I saw a spider now.	1	2	3	4	5	6	7
18	If I saw a spider now, I would probably break out in a sweat and my heart would beat faster.	1	2	3	4	5	6	7

Appendix B – The hospital Anxiety and Depression Scale

Appendix C – Consent form

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I understand that my participation in this project will involve completing a short experiment designed to assess visual processing abilities. After the experiment, I understand that I will be required to complete a short questionnaire asking me about my levels of anxiety and depression.

I understand that my participation in this study is entirely voluntary and that I can withdraw from the study at any time for any reason.

I understand that I am free to ask questions at any time. If for any reason I experience discomfort in any way I am free to withdraw or discuss my concerns with Richard Brailsford or Dr. Philip Tyson.

I understand that the information provided by me will be held anonymously such that it is impossible to trace the information back to me individually. I understand that, in accordance with the Data Protection Act, this information may be retained indefinitely. Finally, I also understand that at the end of the study I will be provided with additional information and feedback.

____
, consent to participate in the study conducted by Richard Brailsford,

Age__________________

Signed

Date:

Appendix D – Debriefing form

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Experiment Debriefing

Thank you for participating in the experiment; the experimental procedure is taken from the literature on inattentional blindness. The purpose of these experiments is to see whether people with spider phobia notice either a word or image when their attention is already focussed on a task. The aim of the PhD research project is examine attentional biases in phobias and anxiety disorders.

The experiment would not have worked if you were told a spider might be present. While this omission was essential, I must apologise for keeping this from you. If you are experiencing any discomfort please tell the experimenter as soon as possible.

I would ask you, if possible, not to tell anybody about this debrief, because if they were to participate, and they have knowledge of what I am doing, **the experiments will not work!**

Your right to withdraw your data from the study is not affected.

Finally, thank you again for participating, and if you know anybody who might be willing to participate, please tell them to call by the psychology laboratories or contact me by email.

Cheers,

Richard Brailsford,

Department of Natural and Social Sciences, University of Gloucestershire.

Appendix E – Information on anxiety and depression

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Information on Anxiety

Anxiety is a normal human emotion that serves an important purpose. For example, without a certain level of anxiety about exams, the chances are you would not revise for them or pass them. However, for some people anxiety is a more pervasive difficulty, which inhibits people's lives. Using the earlier example, it may be the case that if your exam anxiety was too high you would not attend the exam and, again, fail it. Anxiety comes in many forms: for example, some people are nervous about confined spaces, some about open spaces. Some of us are nervous around people and some of us are nervous about being alone.

Phobias are a specific form of anxiety and many have an evolutionary basis. For example, throughout the course of human history, many spiders were dangerous, and in some countries remain so; therefore, rapidly detecting them in our environment is an important psychological function. However, as with anxiety, for some people they create more difficulties, and disrupt peoples daily functioning on a chronic basis.

What can I do if I suffer from anxiety?

Certain levels of anxiety are necessary, however, if you, or someone you know, suffer from a high level of anxiety, there are many things you can do to alleviate the difficulties. Medical treatments involve drugs such as Prozac. Psychological treatments focus on behavioural and talking therapies. For both treatments, it is advisable to seek advice from a health professional (i.e. a GP, a Clinical / Counselling Psychologist or a Counsellor or Nurse). However, there are also many helpful resources.

You can:

1. **Contact the University of Gloucestershire student counselling service on 01242 71XXXX (website: www.glos.ac.uk/departments/studentservices/counselling/index.cfm)**
2. **There are a number of helpful websites that will enable you to understand any phobias you might have, a particularly good one is called 'Phobia: what do you fear?, which can be found on http://hub.lcp.linst.ac.uk/archive/gmd2002/keythemes/phobia/origin.html**
3. **This website holds a great deal of useful information about anxiety http://www.kentmedway.nhs.uk/your_health/mental_wellbeing/phobias_and_anxiety.asp**
4. **The book 'Feeling Good: The New Mood Therapy', by Psychiatrist Dr. David Burns, is an excellent step-by-step self-help guide for anxiety and depression and is available on prescription from the NHS and via Amazon.co.uk , for less than £5.**

Once again, thank you for participating in this research project.

Richard Brailsford.

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