MEASURING CHANGE BLINDNESS IN SPECIFIC PHOBIA: A REPLICATION

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Zofia A. Wilamowska

Certificate of Approval:

Jeffrey S. Katz Associate Professor Psychology	F. Dudley McGlynn, Chair Professor Psychology
Alejandro Lazarte Assistant Professor Psychology	Joe F. Pittman Interim Dean Graduate School

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Zofia A. Wilamowska

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Zofia A. Wilamowska

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Signature of Author

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Date

VITA

Zofia A. Wilamowska is the daughter of Bogdan M. Wilamowski and Barbara T. Wilamowska. Born on February 19, 1981 in Warsaw, Poland, Zofia completed her B.A. at the University of Wyoming in May 2003 majoring in Psychology and graduating with honors. She is currently pursuing her doctoral degree in Adult Clinical Psychology at Auburn University.

THESIS ABSTRACT

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Zofia A. Wilamowska

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People often fail to notice changes in visual scenes, a phenomenon know as "change blindness." At least some change blindness results because relevant changes in scenes occur during eye movements. The flicker paradigm was developed by Rensink, O'Regan, and Clark (1997) as a way to study blindness to change during eye movements. In the flicker paradigm brief blank-space intervals are interposed between repeated presentations of scene pairs in order to mimic the eye movements. The second scene of each pair is changed at some point and the time or trials needed to detect that the scene has changed is recorded.

Wheeler (2003) used the flicker task to study a possible relation between change blindness and fear. Half of his participants were snake phobic, half were not. Half of the image pairs he used included a snake, half did not. Half of the scene changes were made to central-interest aspects of the scene, half were made to marginal-interest areas. Wheeler found that snake-fearful participants took longer than did controls to detect

changes within the marginal areas of scene pairs that did not include a snake. Wheeler's result was clearly significant but not predicted. Therefore a procedural replication was undertaken that used twice the number of participants used by Wheeler.

Controls and snake-phobic participants completed Wheeler's (2003) flicker task. A 2 (Stimuli: neutral vs. feared) x 2 (Locations of change: central interest vs. marginal interest) x 2 (Groups: snake phobic vs. non snake-phobic) repeated measures ANOVA was performed on the number of repetitions required to detect changes between stimulus pairs. The snake phobic participants required fewer repetitions to detect changes than did the non-fearful participants; fewer cycles were required for detecting changes in the feared versus the neutral stimuli; and fewer repetitions were required to detect changes in central locations of interest than in marginal locations of interest. A three-way interaction between Stimuli x Locations of change x Groups was significant, $F(1, 22) = 7.148$, $p = .014$. Snake phobics required more repetitions than did control participants to detect changes in the marginal interest areas of neutral stimulus pairs.

A plausible explanation of the three-way interaction is that phobics were relatively unable to disengage from a visual search for feared stimuli (Fox, 1993, 1994, 2001, and 2002). According to Fox's disengagement theory, once a feared stimulus is attended to, a phobic individual is not able to quickly stop attending to it. In the present study, phobics may have still been processing the feared stimulus pairs during the presentation of the neutral stimulus pairs, and were delayed in detection of changes in the marginal interest areas of the neutral stimulus pairs.

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I. INTRODUCTION

Change has a considerable psychological impact on the human mind. To the fearful it is threatening because it means that things may get worse. To the hopeful it is encouraging because things may get better. To the confident it is inspiring because the challenge exists to make things better. - King Whitney Jr. (Simpson, 1988, p.100)

Overview

The phenomenon of change detection has been prominently researched for the past 20 years. As the quote above illustrates, the presence of change in our daily lives is relentless and unavoidable. One's ability to detect change has serious implications for one's well-being, whether the changes in our environments are the arrival of imminent threats, or opportunities to better ourselves or seek new challenges. However, it is surprising to find out, after reviewing a few prominent articles in the change detection literature, that detecting change is not as easy as one would expect. This inability to detect change, referred to as "change blindness," is a common occurrence in our daily lives whether we are: a shopper driving in the mall parking lot looking for an empty parking while not noticing that a driver just ahead of us is pulling out of their parking space; or graduate student rummaging through a fridge searching for a half-eaten piece of pizza, and not realizing that the tasty morsel is being continuously overlooked.

Research on change detection and change blindness has demonstrated that the key factor in being able to notice a change in one's environment is one's allocation of attention in the direction of the change (Rensink, 2002; Rensink, O'Regan, Clark, & 1997; Mack, 2003; Simons, 2000). According to some the study of attention selectivity in reference to anxiety disorders has demonstrated that anxious individuals have an attentional bias operating for pertinent feared or threatening stimuli (Mathews & MacLeod, 1985; MacLeod & Mathews, 1988; Williams, Watts, MacLeod, & Mathews, 1988; Mogg, Mathews, & Wienman, 1989; McNally, Rieman, & Kim, 1990; Kindt & Brosschot, 1997). As such, the attentional resources of anxious individuals are directed toward the feared objects, presumably in order to facilitate identification of possible routes for escape (Ohman & Mineka, 2001). To use an example of snake phobics participating in a modified Stroop task, where half of the target stimuli are neutral and the other half are feared, the individuals would spend considerably more time color-naming the displays which contain the feared stimuli (Williams, Watts, MacLeod, & Mathews, 1988). However, Fox (1993, 1994, 2001, and 2002) argued that anxious individuals respond differently to feared stimuli than to neutral stimuli because they are unable to disengage from processing the information contained in the threatening stimuli (currently coined "disengagement theory").

Interestingly, only one study (Wheeler, 2003) has integrated the research on change detection with the phenomenon of attention bias in phobias. Specifically, Wheeler examined phobic and non-phobic participants' detection of changes in neutral and feared stimulus pairs presented in a flicker paradigm (described below). Wheeler's results supported Fox's (1993, 1994, 2001, 2002) disengagement theory; phobic participants took longer than did non-phobic participants to detect changes in some neutral stimuli, presumably because they were still searching for prior feared stimuli. However, as a consequence of his small sample of participants, the results lacked statistical power. The current study was a procedural replication of the Wheeler experiment that used twice the number of participants used by Wheeler.

Snake Phobia

A specific phobia is defined as clinically significant anxiety provoked by exposure to a specific feared object or situation, often leading to the avoidance of the feared object or situation. (DSM IV-R, American Psychiatric Association, 2000). Specific phobias are typically grouped into three categories, namely: situational phobias (e.g., thunderstorms or darkness), mutilation phobias (e.g., injections or injuries), and animal phobias (e.g., spiders or snakes). The prevalence of specific phobias was determined by Fredrickson, Annas, Fischer, Wik (1996) to be 19.9% (26.5 % for females and 12.4 % for males) in a random sample of 1000 adults. More importantly, animal phobia had a prevalence of 12.1% in women and 3.3% in men.

Information Processing Theories in Specific Phobias

Traditionally, the attributes of cognitive processing associated with anxiety disorders have been subsumed under generalized hypervigilance for threat-related stimuli, where one's attention is narrowed and tightly focused on possible sources of threat. A phenomenon observed in numerous experiments with different purposes and methodologies over the past 40 years involves what has been called "narrowing of attention" during emotional arousal (Easterbrook, 1959; Baddeley, 1972). Easterbrook was one of the first to describe this phenomenon. He suggested that narrowing of attention is a preoccupation with mood congruent material during emotional reactivity that varies with the intensity of the emotion (i.e., the more intense the emotion, the narrower the attention). Specifically, the number of cues utilized by a person in attention to the environment decreases as one's emotional intensity increases. One becomes focused on the target mood-congruent stimuli as intensity of mood increases, at the expense of concurrent attention to other stimuli. Stimuli relevant to the emotion become more salient, whereas mood-incongruent or irrelevant stimuli are given less attention.

It is well established that changes occur in a number of various psychological processes during fear. It has been suggested, for example, in Bower's (1981) theory, that emotions are represented in mental networks of associations between memories, ideas, and concepts. Activation of one node in the associative network results in spreading activation through which the associated nodes are triggered. Bower's theory predicts mood-congruent biases in every stage of information processing. People would thus show a mood congruent perceptual, attentional, interpretational, and retrieval bias. For example, when a spider phobic is confronted with a fear-evoking stimulus (e.g., cobweb), the sight of the cobweb will activate his spider-phobic schema. This activation would result in the phobic becoming anxious, causing him to scan his environment for spiders, pay attention to other cues that would indicate the presence of spiders, and to perceive his immediate environment as dangerous.

The action of attentional bias in anxious patients may also be conceptualized in terms of the "information structure" theory described by Foa and Kozak (1986). According to this theory, emotions are represented as a network in many structures, which is similar to Bower's (1981) theory of emotions. These structures are not limited to actual information about stimuli and responses but also include interpretations about their meaning for the individual. In the case of fear, these structures serve as motor programs for escape and avoidance behavior (Foa & Kozak). Hyper-attention to fear-associated stimuli may lead to a facilitated triggering of the fear network by these stimuli. When fear-associated stimuli are detected (e.g., cobweb), processing resources are automatically diverted from less salient cues to these feared stimuli in order to escape the danger as quickly as possible. According to this theory, hyper-attention (or selective attention) to feared stimuli facilitates early escape.

Information Processing and Attention Bias in Phobics: A Representative Subset of Theories

Almost all studies examining attentional biases in specific phobias have been based on individuals with spider phobias, and in most cases researchers have relied on a modified version of the Stroop (1935) procedure. The standard Stroop requires the participant to suppress or inhibit a well-learned response (word reading) and instead implement a more novel response as quickly as possible (text color naming). Stimulus words used in the standard version of the Stroop are color names either concordant or discordant with text color (e.g., the word “red” written in red vs. blue ink).

Mathews and MacLeod (1985) modified Stroop’s (1935) paradigm. Instead of using words that described colors, they used threatening words with anxious patients in order to examine anxious patients’ attentional bias towards anxiety-provoking words. In their experiment, patients were grouped on the basis of whether their worries were predominantly social (e.g., patients who found it embarrassing to talk to new people) or physical (e.g., patients who thought it was likely that they would have a heart attack). The patients were tested on four Stroop cards, each containing 96 stimuli (12 words repeated eight times). The words on the first card represented physical threat (e.g., "disease" and "cancer"), those on the second card represented social threat (e.g., "failure" and "pathetic"), and those on the two other cards contained non-threatening (mostly positive) words (e.g., "secure" and "holiday").

Mathews and MacLeod's (1985) data indicated that control participants showed no difference in color-naming latencies between threat and non-threat cards. By contrast, not only did patients with anxiety show slower color naming for threat words than for the non-threat words, but also there was a relation between the types of threat word that most disrupted color naming and the type of worries that predominated in the participant. Whereas all anxious participants were disrupted on social threat words, only physical worriers were disrupted on the physical threat words. Mathews and MacLeod's study demonstrated some sort of attention-related bias for threatening words in anxious individuals for whom these words had a personal fear-evoking value.

Mogg, Mathews, and Wienman (1989) replicated Mathews and Macleod (1985) study. In their experiment anxious patients were administrated the modified Stroop task in which the words were largely drawn from Mathews and MacLeod's study. Mogg et al. confirmed that threat words selectively interfere with color-naming performance of generally anxious patients, compared to normal controls. The mean color-naming latencies for the physical threat words were longer for the phobics compared to the control group. The mean interference to name social threat words was greater for phobics compared to the non-phobics. Mogg et al.'s study confirmed Mathews and MacLeod's finding of some kind of attentional bias in relation to anxiety-laden words in anxious patients.

In relation to studying phobias, a modified version of the Stroop includes emotionally laden words that are variously colored and that have special significance to the participant (e.g., “cobweb,” or “tarantula” for spider phobic participants) and variously colored neutral words. During the task, the participant is instructed to name the color of each word as it is presented, and the time taken to name each color is measured. Differences in the time taken to name the colors of threat-related and neutral words are generally assumed to reflect differences in the expenditure of attentional resources that the participant is devoting to the meaning of the word itself. Fearful participants show interference effects (i.e., longer text color naming times) when stimuli are fear- relevant, which is believed to be due to their difficulty in ignoring the content of fear-relevant words. Most published studies based on the modified Stroop paradigm have found evidence of longer color-naming latencies for spider-related words in people with spider phobias (Kindt & Brosschot, 1997; Lavy & Van den Hout, 1993; Watts, McKenna, Sharock, & Trezise, 1986) and for snake-related words among people with snake phobias (Constantine, McNally, & Horning, 2001).

In order to examine attentional bias in spider phobics Watts, McKenna, Sharrock, and Trezise (1986) used both a general emotional Stroop task, containing threat words such as “fear,” “death,” and “grief”, and a specific Stroop task containing spider-related words such as, “hairy” and “crawl.” In their study, Watts et al. compared spider phobics’ performance on the emotional Stroop task to their performance on the spider Stroop task. The purpose of this comparison was to see if spider phobics’ attention was biased only towards fear related objects (like spiders) or whether their attention was biased towards a general array of threatening stimuli. Watts et al. found that spider phobic participants showed little disruption of color naming on general threat-related words compared with control participants, but they showed a very large interference in color-naming spider-related words. This finding indicated that spider phobics had an attentional bias only towards spider-related words.

Fox (1993, 1994, 2001, 2002) offered another perspective in relation to the attention bias literature. According to Fox, the Stroop paradigm is a poor test of selective attention because during the Stroop task participants selectively attend to different features of an object at one location rather than to the individual characteristics of separate objects. As such, attention is restricted to perceiving and selecting which set of sensory data to analyze (Treisman, 1969). According to Fox (1993), in order to remedy this problem of attention selectivity, a simple change in the stimulus display in the Stroop task would be to present the target stimulus (color) and the distractor stimulus (word) in separate spatial locations. Fox (1993) used a modified Stroop task in which color patches and the target stimuli were spatially separated In this study, high-trait anxious and low-trait anxious participants were required to color-name centrally located color patches which had neutral, color, and threat-related words printed above and below that color patch. The results afforded support for the idea that anxiety is associated with attentional bias in that highly anxious participants required more time than did low anxious participants to color-name threatening stimuli. However, another interesting finding that resulted from this study was that highly anxious individuals required more time to color-name non-threatening stimuli. This would indicate that once highly anxious individuals were exposed to threatening stimuli, they were presumably unable to disengage from processing the threatening stimuli and turn their attentional focus to non-threatening stimuli. Fox's research suggests that highly anxious individuals have difficulty disengaging their attention from threatening stimuli.

To further explore these findings, Fox (1994) employed Tipper's (1990) negative priming paradigm to test that high anxious participants differ from low anxious participants in showing reduced negative priming. Negative priming was described as a delay in response to a target location, if, on the preceding stimulus presentation, that location was one that had to be ignored. Explicitly, the participants were presented with a stimulus at a specific location in the display, and were then told to ignore that location in subsequent displays. In the displays that followed, the participants would show a lag in the naming of the stimulus because it would be located in the area, which they were previously told to ignore.

In the Fox (1994) study, it was predicted that if highly anxious participants had a problem with ignoring distracting information, then they should demonstrate little or no negative priming. The participants were asked to press one of four keys; the correct key spatially corresponded to the location of a target stimulus in the display. The target stimuli were displayed alone or in the presence of a distractor stimulus (color words, neutral words, or threat related words). There were two objectives in this experiment. The first goal was to determine if significant delays in participants' reaction times (interference) would occur in the presence of a distractor. The second aim of the experiment was to find out if interference, marked by delays in participants' reaction times, would occur when the target location of a stimulus matched the location of the distractor stimulus from the preceding display. In Fox's experiment, however, following the presentation of the distractor stimulus at one location, highly anxious participants did not show the expected delay in identifying the target stimulus in the following display. In other words, highly anxious participants did not experience negative priming effects.

Further experiments (Fox et al., 2001; Fox, Russo, & Dutton, 2002), using threat-related stimuli as target stimuli and either threat-related or neutral stimuli as distractors, also suggested that highly anxious individuals failed to show negative priming following threat. Fox concluded that high anxiety is associated with a general deficit in inhibiting/ignoring distracting information. In other words, these results suggest that high trait anxiety may be associated with a general inability to maintain attentional focus, rather than by an automatic attentional bias towards threatening information.

Ruiter & Brosschot (1994) also suggest that emotional Stroop interference is due to the greater cognitive effort which is required to shut out the perception of threatening stimuli. Many investigators have found that more emotionally disturbed individuals (high trait anxious or diagnosed with an anxiety disorder) have generally been slower to color name all stimuli, even neutral words (Fox 1993, 1994; Fox et al., 2001; Fox, Russo, & Dutton, 2002; Mathews, May, Mogg, & Eysenck, 1990; Wheeler, 2003). Again this raises the possibility that such individuals have a general difficulty maintaining attentional focus.

Change Blindness

The mechanism behind the Stroop task is not well understood and as a result, a different approach to measuring attention bias is needed. An example of such an approach may be the flicker paradigm that is used to study change detection. Most of us know what it is like to look at something but fail to see the obvious, such as a traffic light turning green. Such an inability to detect change has been termed as change blindness. Specifically, according to Rensink (2002) change blindness refers to the inability to detect large changes to objects and scenes. A familiar term which was introduced by Mack and Rock (1998) is called inattentional blindness and it refers to "the failure to see highly visible objects we may be looking at directly when our attention is elsewhere" Mack (2003, p. 180). Visual attention seems to be the critical factor in one's ability to eliminate change blindness. For the purpose of this discussion, visual attention is defined as "an internal mechanism for selecting certain visual codes for further processing at the expense of other visual codes" (Hollingsworth, Schrock, & Henderson, 2001, p. 296). It follows that attention enables change detection because it functions as a safeguard of representations of attended objects in visual short-term memory during the interstimulus interval, allowing for a comparison between the original and modified displays. In contrast, information which is not attended to will decay rapidly upon scene offset and will be overwritten by subsequent visual encoding. As a result, if there is no overlap between the changing and attended regions, the change between the displays will not be detected.

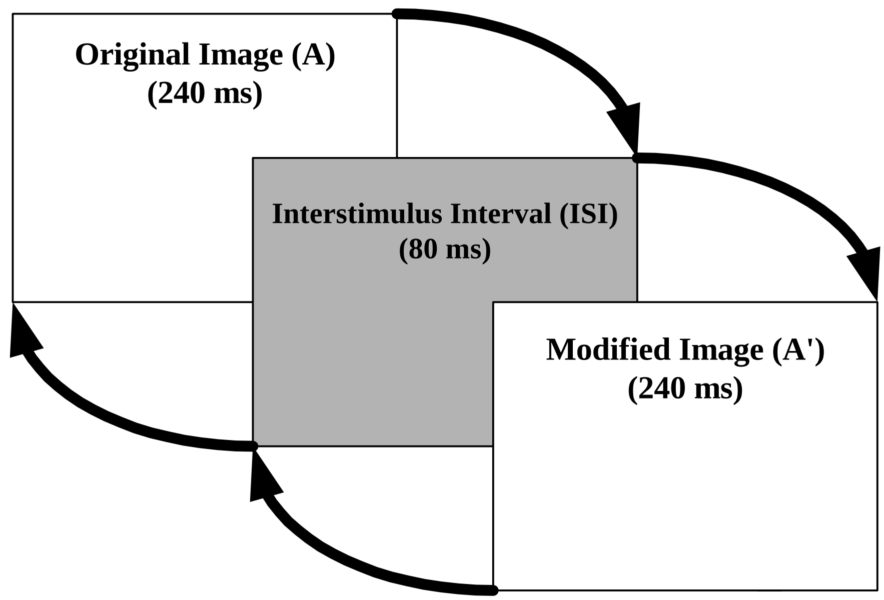
According to Rensink (2002), traditionally there have been several types of contingent change detection paradigms via which change blindness has been studied. The paradigms include: gap-contingencies, saccade-contingencies, blink-contingencies, splat-contingencies, occlusion contingencies, and cut-contingencies. In gap-contingent techniques a change between the presentation of the original stimulus and the altered stimulus is made during an interstimulus interval (Phillips, 1974; Pashler, 1988; Rensink, O'Regan, & Clark, 1997; Rensink, 2004). Using the saccade-contingent approaches, changes to the display are made during the participant's eye-movement (McKonkie & Zola, 1979; Grimes, 1996). In shift-contingent techniques the changes are made when the entire display is suddenly altered, because of a simulated saccade, such as a shift in the display (Sperling & Speelman, 1965). In blink-contingencies a change is made to the stimulus when the participants blink their eyes (O'Regan et al., 2000). In splat-contingencies the change is made at the same time as a brief distractor appears on the stimulus although not necessarily over the area that is changed (Rensink, O'Regan, & Clark, 2000) In occlusion-contingencies the change is made when the changing item is briefly "occluded" from the participants view (Simons & Levin, 1998). Finally, in cut-contingencies the change is made when a cut from one camera angle to another camera angle occurs (Levin & Simons 1997, 2000). Of interest here is gap-contingent change.

Phillips (1974) was one of the first researchers to study change blindness. He required participants to detect changes in displayed matrices consisting of partially filled grids of dots. In his gap-contingency paradigm, an initial display was succeeded by an interstimulus interval (ISI), and then followed by either an identical display or a display that differed by a single dot. Results of the study indicated that, even with large matrix displays, participants' performance was excellent when the ISI between the original and modified displays was less than about 100ms.

Pashler (1988) performed a series of experiments in which he attempted to determine the durations of stimulus and ISI displays that would create the greatest change blindness by means of the gap-contingency paradigm. Using an array of 10 alphanumeric characters as the original display, Pashler changed the display by masking the stimuli. Masking of the stimuli refers to a procedure whereby a stimulus (the target) is made difficult to detect because of a presentation of a second stimulus (the mask) in close temporal or spatial proximity to the original stimulus. Pashler tested a range of display durations ranging from 150ms to 500ms and three different ISI durations (34ms, 67ms, and 217ms). Pashler discovered that increasing the duration of the original and modified displays from 150 ms to 500ms produced only modest improvement in change detection. He found that change detection required fewest repetitions with 34 ms ISIs but only when no second stimulus (mask) was presented. When a mask was presented at the 34 ms ISIs by temporal proximity to the original stimulus, change detection increased to the level of the longer ISI conditions. Performance did not deteriorate much from 67 ms to 217 ms, and there was a clear, but much more modest, effect of masking in these conditions. Masking effects were reduced with the longer ISI, but never seemed to have disappeared.

Rensink, O'Regan, and Clark (1997) developed what has now commonly become known in the change detection literature as the flicker paradigm. The flicker paradigm is based on the gap contingency of change where an original image (A) and a modified image (A') are displayed on a computer screen, while the image pairs alternate repeatedly and a time interval or an ISI occurs between the paired images.

Figure 1. Flicker Paradigm with Interstimulus Interval (ISI)



Rensink, O'Regan, and Clark (1997) much like Pashler (1988), performed several time trials to determine effects on time trials to change detection of differing durations that the image pairs and ISI were displayed. Rensink et al. discovered that when the ISI was removed from the flicker paradigm, participants could immediately identify the change between the image pairs, presumably because the ISI was no longer present. Following Pashler's findings, Rensink et al. determined that the best display durations, for creating change blindness was 240 ms for the stimuli and 80 ms for the ISIs. These time durations for the image pairs and ISI have also been employed by Rensink, O'Regan, and Clark (2000), Rensink (2004), and Wheeler (2003). Research using the flicker paradigm has produced two primary findings. The first is that participants rarely detect changes during the first cycle of alternation (Rensink, O'Regan, & Clark, 1997). Second, changes to areas of a scene rated to be of "central interest" are detected faster than are changes to "marginal interest" areas. Central interest areas are rated as important and salient features of an image whereas marginal interest areas are rated as unimportant. In this respect Rensink et al. argued that this difference in detection performance was due to the fact that central interest areas were preferentially selected by visual attention. In studies of change detection, people are better able to report changes to attended than unattended objects. Central objects are more likely to attract attentional resources, and if we have a limited capacity for holding information across views, changes to objects that receive more effortful processing are more likely to be detected (Rensink, 2000).

The empirical approaches to studying change detection discussed thus far have employed still images as stimuli. Another area of research has chosen to focus on change detection in moving stimuli such as film. One of the first studies to perform an experiment using film was Neisser and Becklen (1975). In a study of selective looking, the researchers asked participants to view a film of two superimposed ball-passing games in which one group of players wore white uniforms and another group wore black uniforms. Participants were instructed to count the number of passes between members of one of the groups and to ignore the actions of the other team. During the game, a woman carrying an open umbrella walked from one side of the screen to the other. After viewing the video, the participants were subsequently asked to report whether they noticed anything unusual in the video. Only a fifth of the participants indicated the presence of the umbrella-carrying woman.

Simons and Chabris (1999) replicated Neisser and Becklen's (1975) study but instead of one unexpected event occurring during the video, they used two. Two conditions were developed for the study. In the first condition, replicating the stimuli used by Neisser and Becklen, a woman carrying an open umbrella walked across the screen. In the second condition, a person in a gorilla suit walked across the screen. Also, Simons and Chabris employed two video styles: (1) in the transparent condition, the white team, black team, and unexpected event were all filmed separately, and the three video streams were made partially transparent and then superimposed on each other by using digital-video editing software, and (2) in the opaque condition, all actors were filmed simultaneously and occluded one another and the basketballs. The participants' task for this study was again to count the number of passes between teams. Results indicate that across all conditions, more than half of the observers noticed the unexpected event. However, the umbrella-carrying woman was noticed more often than the gorilla overall. Interestingly, when participants were required to attend to the ball passes of the black team, they noticed the gorilla much more often than when they attended to the actions of the white team, seemingly indicating that people are more likely to notice an unexpected event that shares basic visual features (e.g., color) with the events they are attending to.

So far, this review of change detection research has discussed single changes to image-pairs. In the following series of experiments, reported by Angelone, Levin, and Simons (2003), the experimenters determined if there would be a difference in change detection based on having one change or two changes to the stimuli. The participants were required to watch a video of an actress asking a pedestrian for directions. The change in stimulus in the video, which occurred during a cut in the camera angle, was a change in an article of clothing that the actress was wearing or the object she was carrying. After viewing the video, the participants were presented with a lineup of four photographs of the actress wearing different types of clothing and carrying different objects. The participants' task was to identify a picture of the actress before the change had occurred in the video. Interestingly, results indicate that only 6.7% of the participants noticed a change in the video, however among the participants who missed the change, the accuracy in their performance on the lineup task was above chance. During the second experiment, another modification was added to the stimulus, which was a change in the actresses' identity (during a cut in the camera angle the original actress was removed from the scene and another actress took her place). The results of this study showed that 12.3% of the participants noticed a change in clothing or object in the video and 48% of the participants who missed the change were able to accurately identify the pre-change actress in the lineup task. Additionally, in the identity-change condition, more than half of the participants noticed a change in actresses, however, accuracy on the lineup task was comparable for the participants who noticed a change and those who missed it.

The findings of change blindness reported thus far have been based on artificial events, where participants were studied in controlled laboratory settings. An experiment reported by Simons, Chabris, Schnur, and Levin (2002) was carried out in a natural environmental setting. An experimenter who was holding a basketball approached a pedestrian and asked for directions to a gymnasium. While the pedestrian provided directions, a group of people passed between the pedestrian and the experimenter, and one member of the group surreptitiously removed the basketball. When the pedestrian finished giving directions, the pedestrian was asked if he or she noticed anything unexpected happen or if he or she had noticed a change. Most pedestrians did not spontaneously report the change, however, when asked further leading questions, many reported the presence of the basketball and were even able to describe its features. Intriguingly, even though the participants did not notice the change, they were still able to recall specific features of the change object suggesting that they held represented details of the changed object in their memories.

A different approach to studying change blindness was developed by McConkie and Zola (1979), Grimes (1996), and Hollingworth, Schrock, and Hernderson (2001). All three studies employed the use of an eye-tracking machine that records the positions and movements of the eyes; hence recording naturally occurring saccades. The premise behind the eye-tracker approach to studying change blindness is that as the participant's eyes begin to move, their targeted destination is calculated, and the stimulus in that location is altered before the eyes arrive. McConkie and Zola examined the synthesis of letter details by presenting sentences in which words were written with letters of alternating case presentation in the first image (as illustrated in line 1 below) and switching the case presentation of the letters in the successive image (as demonstrated in line 2 below).

1. ThE sPaCe ShUtTlE tHuNdErEd InTo ThE sKy On A cOlUmN oF sMoKe.
2. tHe SpAcE sHuTtLe ThUnDeReD iNtO tHe SkY oN a CoLuMn Of SmOkE.

The change that occurred in their study was based upon an overlap of the visual details of the two images. It was hypothesized that if the details of the letters were altered during an eye-movement, while the grammatical structure and the content structures of the text were sustained, any interference in the reading process could be credited to an inability to combine the visual details obtained from the two images. Results of this experiment demonstrated that not only did the experimental manipulation fail to produce any disruption to the reading process or the eye-movement patterns, but it also failed to produce the awareness that a change was occurring in the text. A plausible explanation for this finding is that the participants' attention was allocated to the semantic output produced by the text and, having most of their attentional resources focused on the meaning of sentence, the participants were unable to distribute attentional assets to the change, which was occurring right before their eyes.

Hollingsworth, Schrock, and Herderson (2001) also monitored participants' eye movements while they performed a gap-contingent change detection task. The purpose of their study was to determine whether fixation position (central vs. marginal) influenced the detection of scene changes in the flicker paradigm. Fixation position was differentiated from the orienting of visual attention by either requiring participants to maintain their eyes in a central fixation (no-movement condition) or allowing them to move their eyes freely (movement condition). The study also examined ease of change detection depending on the type of change occurring. Three change conditions were employed: deletions (an object was deleted from the scene), rotations (the object was rotated 90° about the horizontal axis of the object), and no change. Moreover, the experimenters examined the relation between participants' eye positions and change detection. The results indicated that the percentage correct in the eye-movement condition was higher than that in the no-movement condition, suggesting that there is a causal role for fixation position in the maintenance of information across discrete views of a scene, leading to the detection of change. There was also an effect of change condition; change detection was more successful for those image pairs where a deletion took place than in image pairs where an object rotation occurred. Finally, additional results demonstrate that the participants' eyes remained in the central region on only7.7% of the trials indicating that the participants detected changes by fixating on various potential changes; not by monitoring extrafoveal regions of the scene.

Another study focusing on the types of change occurring in change detection paradigms was performed by Agostinelli, Sherman, Fazio, and Hearst (1986). The authors suggested that the recognition of change involved two stages: detection of change and identification of the change. Agostinelli et al. speculated that if participants were informed about the detection and identification tasks prior to having to perform them, then the participants would be more likely to focus extra attention to the specific features of the initial stimulus, which would later function as an entity for comparison. The researchers expected that deletions should be easier for the participants to detect than additions because the deleted feature is present in the comparison entity (original image). This prediction was confirmed in an experiment employing the flicker paradigm that used images of simple drawings of everyday objects as stimuli.

Mondy and Coltheart (2000) also investigated detection and identification rates involving different types of changes in natural scenes across successive views. The changes to the displays were: addition of objects, deletion of objects, object color changes, and object location changes. Comparisons showed that correct change identification was significantly more likely for deletions than for additions. Identification of an added object and of a color change to an object did not differ significantly. Location changes were significantly less likely to be identified than were additions and color changes. In a second experiment that used the same materials, Mondy and Coltheart investigated the effects of additions and deletions of unique and duplicate objects on change detection. They found that changes to whole objects were more frequently identified than were changes to objects that were part of a larger object. Furthermore, deletions were again more likely to be identified than were additions. These results confirmed the findings of Agostinelli et al.'s (1986), in that the deletion of an object from a scene is much easier to detect than is the addition of an object. Mondy and Coltheart argued that their results extend Agostinelli et al.'s findings in two important ways. First, the deletion/addition condition in Mondy and Coltheart's experiment was relevant to real world settings having greater complexity than Agostinelli et al.'s drawn objects. Secondly, Mondy and Coltheart demonstrated that the results of the deletion/addition conditions occur both when the objects are elements or characters of whole objects and when they are whole objects.

In a study by Archambault, O'Donnell, and Schyns (1999) two change-detection experiments were conducted, which tested the prediction that people would perceive the features of an object differently if they learned to categorize them differently – that is, at different levels of specificity. Accordingly, Archambault et al. claim that the "perceptual features that people extract from objects depend on how they typically categorize them"(

Archambault et al., p .249) In their first experiment, two groups of participants were trained to categorize an identical set of 10 objects: half of the objects were computers, half of them were mugs. One group (computer-MUG) learned to categorize computers at a specific level where each object was individuated from the rest (e.g., “This is Peter’s computer”) and mugs at a general level (e.g, “This is a mug”). The other group (COMPUTER-mug) learned the opposite assignment of category level to objects - computers were categorized as general (e.g., “This is a computer”) and mugs as specific (This is Mary’s mug”). After categorization training was completed, the participants participated in a flicker paradigm using photographs of office scenes containing various office equipment including mugs and computers. The changes that occurred during the ISI were either the replacement of one type of mug with another mug, removal of a mug from the office scene, replacement of one type of computer with another computer, or removal of a computer from the office scene. Findings of the Archambault et al. study demonstrate that when participants knew an object at a specific or individuated level of categorization, they perceived the change of that object almost immediately. When the same object was known at a more general level, the same change took much longer to notice.

Ro, Russell, and Lavie (2001) compared detection of changes in human faces (which were categorized as having a more semantic value) versus other common objects (e.g., clothes) in a flicker paradigm. The researchers found that changes were detected far more rapidly and accurately in faces than in other objects. This advantage for faces, however, was found only for upright faces in multiple-object arrays, and was completely eliminated when displays showed one face only or when the pictures were inverted. These findings imply a special status for faces in competition for selective attention, and are consistent with recent findings that facial expressions have a unique capacity to draw attention (Gauthier & Tarr, 1997; Kanwisher, McDermott, & Chun, 1997; Tanaka & Farah, 1993; Fox, et al. 2000). In Angelone, Levin, and Simons' (2003), study, participants were also better at detecting changes in a person's identity, which was primarily determined by the person's face, than changes to the articles of clothing that an actress was wearing and objects that she was carrying. However, it is important to note that the alteration of facial presentation does not necessarily lead to change blindness. An important finding by Hochberg (1968) demonstrates that when displays of faces undergo a luminance reversal (as in a photographic negative) the ability to detect changes in faces is not affected.

Wheeler (2003) conducted a study that explored phobic and non-phobic participant's ability to detect changes in neutral and fearsome stimuli presented in a flicker paradigm. Wheeler used the gap-contingency technique with cycling presentations of the stimulus, where the change was made during the ISI (e.g. gray screen) between the presentation of the original stimulus and the modified stimulus. The stimuli used for the study were photographs of office scenes (neutral) and photographs of snakes (feared). The changes, which occurred between the stimulus pairs in Wheeler's study, were: deletion (an object was removed from the modified scene), change in object's location, and change in object's color. The stimulus-pairs were displayed for 240 ms, while the ISI was displayed for 80 ms. Wheeler's first hypothesis was that changes would be detected faster in central-interest locations than in the marginal-interest locations for both phobics and controls. Secondly, Wheeler predicted that phobic individuals would require fewer cycles in change detection than controls in response to fearsome stimuli. Findings from Wheeler's study confirmed the prediction that central interest changes would be detected faster than marginal interest changes. However, the results demonstrated that phobic individuals experienced significantly greater change blindness on stimuli that were neutral than on stimuli that were feared. A plausible explanation of this finding is Fox's (1993, 1994, 2001, and 2002) disengagement theory. According to that explanation, phobic participants experience an inability to disengage from a visual search for feared stimuli while viewing neutral stimuli, which results in longer change detection times on neutral stimuli for phobic participants.

Wheeler's (2003) findings were significant but not predicted. A noteworthy limitation of Wheeler's experiment was the small sample of participants employed. The purpose of the present work was to perform an exact procedural replication of Wheeler's study that used twice the number of participants as were used by Wheeler.

II. METHOD

Participants

357 participants were recruited from undergraduate psychology courses at Auburn University and were instructed to complete a screening packet for which they received extra credit. Twenty-eight participants (females = 25) were recruited from the screening pool to participate in the experimental portion of the study. However, only 24 participants (females = 22) were used in the data analysis for the following reasons: one participant was discontinued from the study because she was too uncomfortable with the stimuli and asked to be excused from the experiment; two participants were dropped from the study because they did not identify the correct places of change on the image pairs; and one participant was dropped because he pushed the space bar to continue with the experimental task without finding or verbally identifying the change that occurred between the image pairs. All participants received extra credit in exchange for their participation in the experimental portion of the study. Equal numbers of participants were assigned to the snake-phobic group (n = 12; females = 12) and control group (n = 12; females = 10).

Snake Phobia Measures

Fear Survey Schedule-II (FSS-II). The purpose of the FSS-II was to identify specific objects and situations that were anxiety provoking to the participants (see Appendix A). The FSS-II was originally developed by Wolpe and Lang (1964). The FSS-II is a self-report measure containing a list of 51 objects and situations that might be fear-evoking. The participants were instructed to rate their level of fear on each item. The items were rated on a seven-point Likert scale ranging from 0 (no fear) to 6 (terror). Mean scores on the FSS-II for non-clinical samples of men and women are 75.78 (SD = 33.84) and 100.16 (SD = 36.11), respectively (Geer, 1965).

Snake Phobia Questionnaire (SNAQ). The purpose of the SNAQ was to quantify the participant's subjective fear of snakes (see Appendix B). The SNAQ was originally developed by Klorman, Hastings, Weerts, Melamed, and Lang (1974). The SNAQ is composed of 30 snake fear-relevant items that are answered in the true or false format. Fredrikson (1983) reported that mean scores on the SNAQ among male and female college students were 5.80 (SD=3.82) and 9.06 (SD=6.09), respectively. In the same study, among individuals with snake phobias the mean score was 24.44 (SD=2.95).

Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV). The ADIS – IV is a comprehensive semi-structured interview for diagnosing all DSM-IV anxiety disorders and is highly regarded in this area (Brown, DiNardo, & Barlow, 1994). It contains specific components that target various anxiety disorders including specific phobia. For the purpose of this study, the ADIS-IV Specific Phobia module was used to obtain data on the frequency and intensity of participants' fears. The ADIS-IV Specific Phobia module is composed of a list of 17 types of specific phobias. The participants are asked to rank their level of fear and degree of avoidance. The rankings are based on a Likert scale ranging from 0 (no fear/never avoids) to 8 (very severe fear/always avoids). After rating their specific phobias, the participants were interviewed to rule out other possible diagnoses (such as Panic Disorder) and to determine the history of the participants' phobia and frequency and intensity of it.

Apparatus

Experimental events were controlled by a custom computer program written in Visual Basic on a Pentium 4 computer (Wheeler 2003). Stimuli were presented on a 17-inch Dell color monitor. The space bar on a computer keyboard or the left button on the mouse were used as the response devices to record the participants' responses.

The Stimuli

The study employed the same visual stimuli as the ones that were generated for the Wheeler (2003) study (See Appendix E). There were four types of stimuli: (1) pictures of snakes where the change occurred in the central-interest region of the snake, (2) pictures of snakes where the change occurred in the marginal-interest region of the snake, (3) pictures of an office where the change occurred in the central-interest region, and (4) pictures of an office where the change occurred in the marginal-interest region. Central-interest stimulus changes were defined as changes that were rated focal, more salient and more easily detected. Marginal-interest changes were those that were outside the stimulus' rated focal point and were more difficult to recognize (see Wheeler, 2003). For each original stimulus used, a modified image was created which was an exact replica of the original stimulus with the exception of either an object color change, object location change, or object deletion. The stimuli were presented with the original image (A) and the modified image (A') in the sequence A, A', A, A'…, with an ISI between successive stimuli. Each stimulus was presented for 240 ms, and each ISI for 80ms. Stimulus pairs were presented in random order. A total of 16 image pairs, four pairs of each type, were presented to each participant.

Procedure

The study consisted of two sessions, occurring approximately two weeks apart. Before the first session, participants were recruited via flyers and classroom announcements in undergraduate psychology courses at Auburn University. During the first session, participants were asked to review and complete an informed consent form (see Appendix C), then were asked to complete the FSS-II and the SNAQ. Those participants who had an elevated FSS-II snake-item score and a SNAQ score that did not suggest an unusual fear of snakes were thanked for their participation, given an extra-credit slip, and dismissed. Only those participants who reported a significant fear of snakes on the screeners (FSS-II = 5 or 6, and SNAQ $\geq$ 19) or those who reported none or minimal fear of snakes on the screeners (FSS-II = 0 or 1 and SNAQ $\leq$ 5) were asked to participate in the second session of the study.

For the second session, the participants were interviewed using the ADIS-IV by the experimenter. The interviewer was "blind" to the participants' scores on the screeners. After the completion of the interview, the participants were seated at the computer. The participants then received oral instructions on how to perform the flicker task (see Appendix D). After the instructions, the participants engaged in four practice trials of the flicker task. Finally, the participants performed the experimental flicker task. After completing the flicker task (or after having been excused from the session) the participants were thanked, debriefed about the experiment, and given extra-credit slips.

Flicker Procedure

The participants were instructed to observe the series of stimulus pairs and to press the response button, when they detected a change between the two stimuli. As noted already, the original stimulus (A) and the modified stimulus (A') were presented for 240ms with an ISI, of 80ms, between A and A'. The computer, on which the flicker task was administered, recorded the number of repetitions for each stimulus pair and the amount time elapsed for each stimulus pair for each participant. Also as noted already, one of the following changes was made to an object in each stimulus pair: deletion of object, change in location of object, or change of object's color.

In order to avoid identification errors or guessing, after pressing the response button, the computer paused for 5000 ms during which participants orally indicated where the change took place or in which object the change took place. During the administration of the flicker task, a researcher sitting behind the participants recorded identification errors.

III. RESULTS

The group means and ranges of scores on the FSS-II, SNAQ, and ADIS-IV are presented in Table 1. This experiment was designed to evaluate between-group differences for snake phobic participants versus controls and to compare within-group differences based on the location of the change (central-interest vs. marginal-interest) and type of stimulus (feared vs. neutral). The numbers of repetitions to change detection were analyzed. Each of the 24 participants provided one value for the number of repetitions to change detection for each of the 16 stimuli. The 384 values were analyzed with a 2 x 2 x 2 (Stimuli x Locations of Change x Groups) repeated measures analysis of variance.

Table 1. Mean Scores and Ranges for the FSS-II, SNAQ, and ADIS-IV

Measure						
		Phobics			Controls	
	M	Min	Max	M	Min	Max
FSS Scores on Snake Question	5.50	5.00	6.00	0.33	0.00	1.00
FSS overall scores	108.16	55.00	179.00	74.92	32.00	158.00
SNAQ	23.75	19.00	29.00	2.17	0.00	5.00
ADIS-IV	7.25	6.00	8.00	0.58	0.00	2.00

The mean number of repetitions required for each group to detect the changes among the different stimuli and different locations are presented in Table 2. There was a significant main effect found for Groups, $F(1, 22) = 4.411$, $p=.047$; members of the

Table 2. Mean Numbers of Repetitions to Change Detection for Different Pairs of Stimuli.

Variable	Phobics		Controls	
	M	SE	M	SE
Neutral/Central repetitions to change detection	8.58	0.88	5.67	0.72
Neutral/Marginal repetitions to change detection	92.65	17.73	45.87	7.47
Feared/Central repetitions to change detection	6.02	0.51	2.69	0.36
Feared/Marginal repetitions to change detection	37.75	4.62	47.08	6.57

control group (*M* = 25.32) detected changes among the stimulus pairs with fewer repetitions than did members of the phobic group (*M* = 36.25). There was also a significant main effect for Stimuli, $F(1, 22) = 7.490$, $p=.012$; changes made in fear-relevant stimuli were detected with significantly fewer repetitions (*M* = 23.39) than were changes made to the neutral stimuli (*M* = 38.19). Finally, there was a significant main effect for Locations of Change, $F(1, 22) = 101.225$, $p<.001$; changes made to central-interest areas were discovered with fewer repetitions (*M* = 5.74) than were changes made to marginal-interest areas (*M* = 55.83)

The difference in the numbers of repetitions to change detection for neutral vs. fearsome stimuli was greater for phobic participants than for the control group, $F(1, 22) = 8.280$, $p=.009$ (See figure 2). This result replicates the most important finding from Wheeler's (2003) experiment. The difference in the number of repetitions to change detection for central vs. marginal changes was greater for neutral stimuli than for fear-relevant stimuli, $F(1, 22) = 5.178$, p=.033 (See figure 3). Most importantly, there was a significant three-way interaction involving Stimuli x Locations of Change x Groups, $F(1, 22) = 7.148$, p=.014 indicating that the phobics required more repetitions than did control participants to detect changes in the marginal-interest areas of neutral stimuli.

Figure 2. Graph of Interaction between Groups and Stimuli

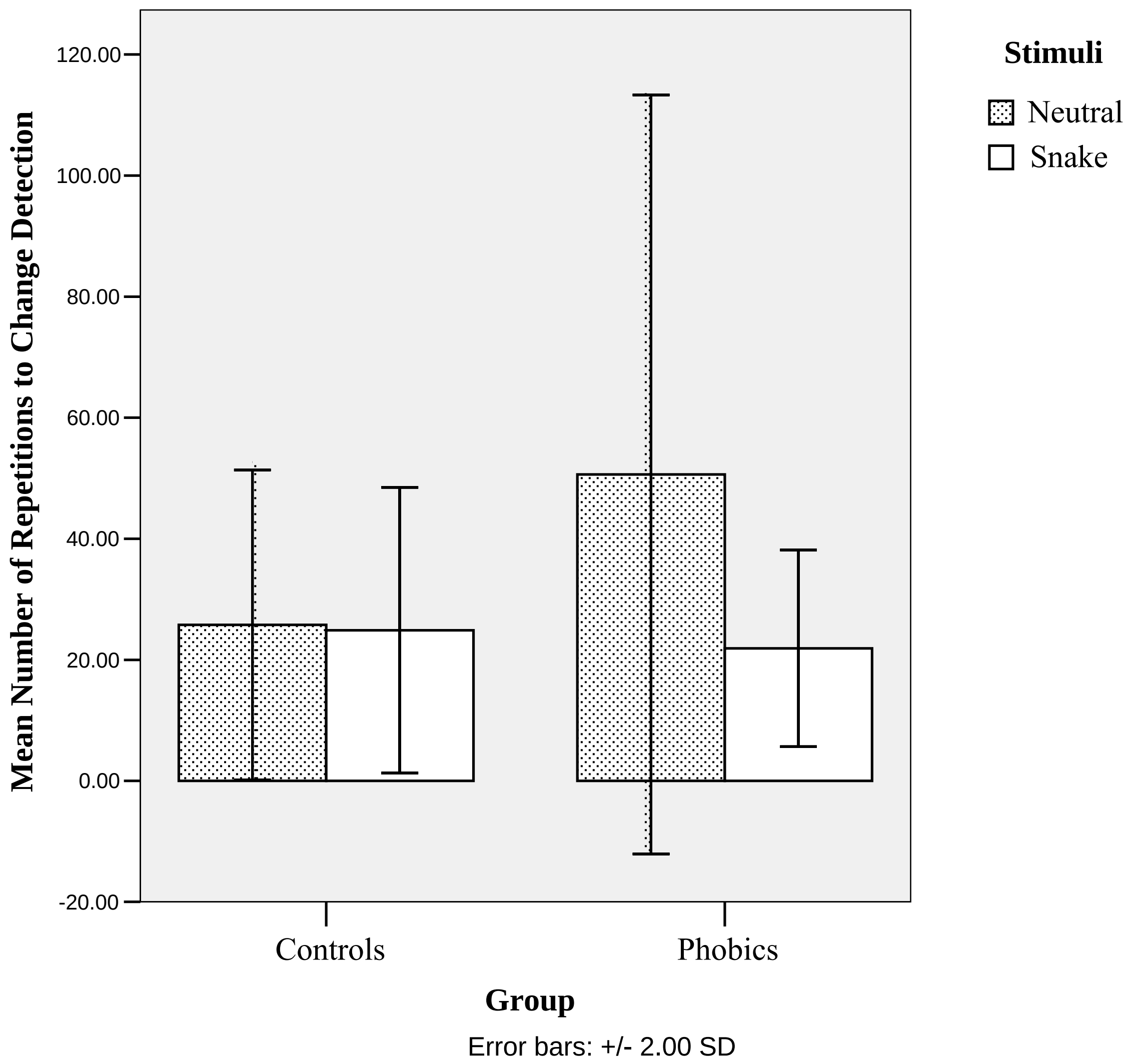
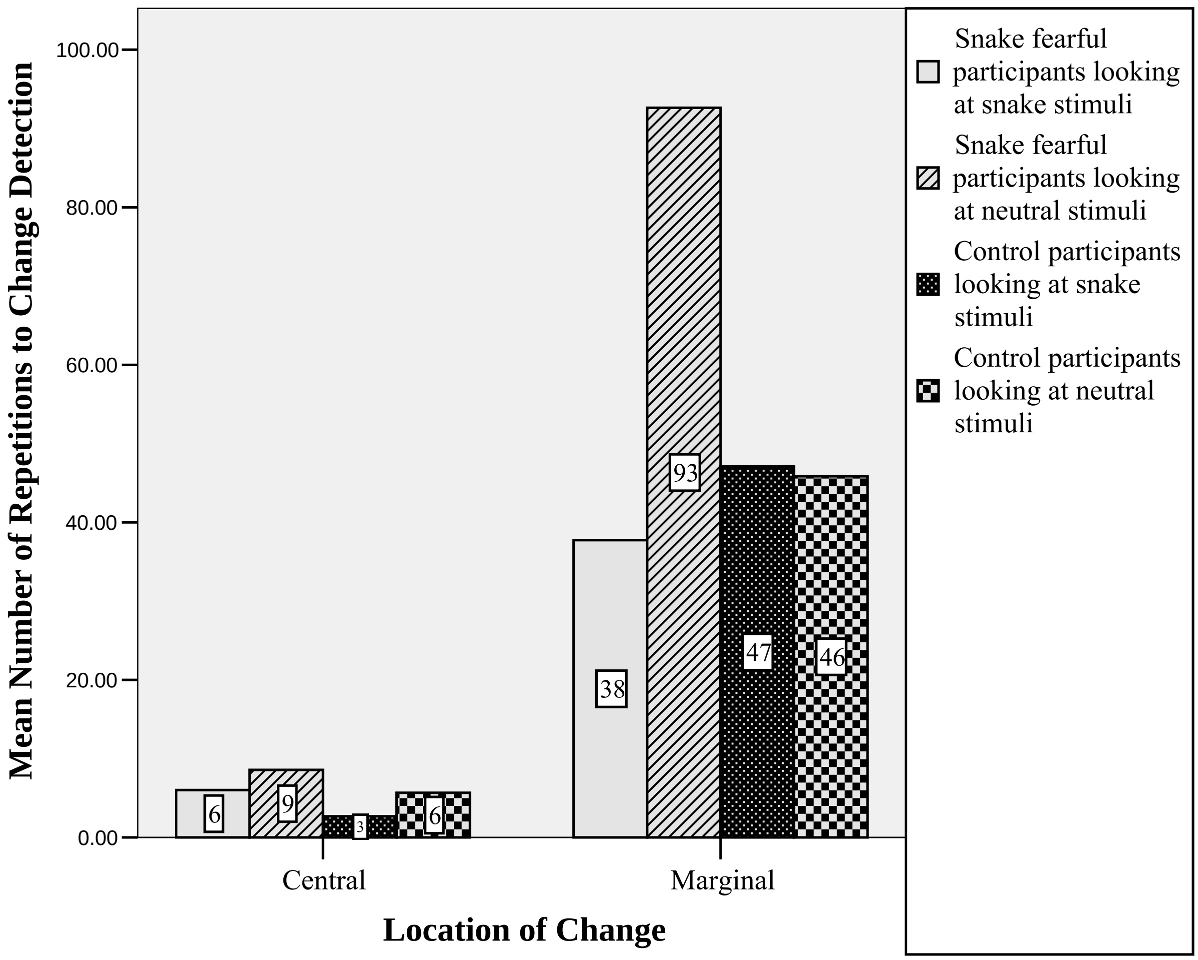


Figure 3. Bar Graph of Mean Number of Repetitions to Change Detection for Groups and Stimuli across Locations of Change.



When comparing the results of the current study with the results of Wheeler (2003), another interesting finding emerged. Change detection occurred with fewer repetitions for the participants in the current study than in Wheeler's (2003) experiment, $F(1, 34) = 304.148$, $p<.001$.

A post-hoc analysis was performed in order to determine whether the "central vs. marginal" dichotomy might be refined and studied. The analysis was conducted on only those pictures where the whole body of the snake was present in both members of the stimulus pairs. Consequently, the analysis was performed on three fear-relevant pictures where the changes occurred in the central-interest location and on two fear-relevant images where the changes occurred marginally. The means produced by the data for this analysis are presented in Table 3.

Table 3. Mean Numbers of Repetitions to Change Detection at Different Distances of the Change from the Snake's Head.

Distance from snake's head to the location of change on the snake's body		
	Mean number of repetitions to change detection	
	Phobics	Controls
	M	M
1. Central interest change occurring at snake's head area	1.30	1.25
2. Central interest change occurring behind the head area of the snake	1.70	1.92
3. Central interest change occurring on the lower neck of the snake	4.40	3.83
4. Marginal interest change occurring on the mid-body of the snake	57.00	51.75
5. Marginal interest change occurring on the tail of the snake	124.75	105.70

Interestingly, for both phobic and control participants the further away from the head the change on the snake's body took place, the more repetitions it took the participants to detect the change. As illustrated in Table 3, there was a significant difference in the number of repetitions to change detection between each stimulus and its successor in this group for which the change was further down the snake's body: Stimulus 1 vs. Stimulus 2, $t(23)=-2.806$, $p=.011$; Stimulus 2 vs. Stimulus 3, $t(23)=4.782$, *p*=.000; Stimulus 3 vs. Stimulus 4, *t*(23)=4.733, *p*=.000; and Stimulus 4 vs. Stimulus 5, *t*(23)=-2.549, *p*= 0.019.

IV. DISCUSSION

The present study replicated Wheeler's (2003) preliminary findings. It demonstrated that, for both snake-phobic participants and controls, change detection occurred faster for objects that were of central interest in the stimulus-pairs than for objects that were of marginal interest. This result is also consistent with the result of Rensink, O'Regan, and Clark (1997). The findings from the current study were also congruent with Wheeler's finding that change detection occurs faster for fear-relevant stimuli (snakes) than for neutral stimuli (office equipment) for both snake-phobics and controls. Furthermore, the current study also supported Wheeler's finding that the number of stimulus repetitions required for change detection in neutral stimuli was larger for snake-phobic participants than for controls, however, only among the marginal stimuli. A plausible explanation for this finding is that snake-phobics were relatively unable to disengage from a visual search for snake-related stimuli (Fox, 1993, 1994, 2001, and 2002). According to Fox's disengagement theory, once a phobic stimulus is attended to, a phobic individual is not able to quickly stop attending to it. In the present study, phobic participants may have in some way been processing the fear-relevant stimuli during the subsequent presentation of the neutral stimuli, and were thus less able than control participants to focus on the neutral stimuli and detect changes among them. This replication of Wheeler's study, provides more inferential support for the idea that phobics have a difficulty disengaging from fear-relevant stimuli when attempting to process neutral stimuli.

Interestingly, in the current study, there was a significant three-way interaction indicating that the phobics required more repetitions than did control participants to detect changes in the marginal-interest areas of neutral stimuli. This result was different from Wheeler's (2003) study in which, as noted above, only a two-way interaction (Groups x Stimuli) was found significant. The fact that the location of change interacted significantly with the stimuli and groups, demonstrates that the differences between central and marginal locations of interest influenced the number of repetitions required for change detection. This finding may provide further support for Fox's disengagement theory by demonstrating that a phobic's inability to disengage from fear-relevant information, while viewing a neutral stimulus, may be enhanced when the focus of their attention must be carried away from salient features of a stimulus to more marginal and unimportant aspects of the stimulus.

Although the current study replicated Wheeler's (2003) results, there was a significant difference between the two experiments in the numbers of repetitions needed to detect changes. Wheeler's experiment took place in a well-lit room where possible glare from the lights on the computer screen might have impaired visual acuity. The current experiment took place in a purposefully darkened room in order to minimize such glare. Of course, the differing times to change detections between the two experiments could mirror one or more other unknown factors.

Finally, when the fear-relevant stimuli were examined in a post-hoc analysis, a relation was found between the number of repetitions among stimulus pairs needed to notice the change and the distance of the location of the change on the snake's body from the snake's head. Of course, the analysis was performed on only those images where the whole snake was visible in both displays in the stimulus pairs. As result, only five snake pictures (three where the change occurred in the central interest location and two where the changed occurred marginally) were analyzed. Although the present study had a limited number of stimuli on which this analysis could be performed, the pattern noticed is still important to consider. Even though these results were found in both snake-phobics and controls, the finding should not be surprising. According to Ohman, Flykt, and Esteves (2001) mammals have evolved in environments where the reproductive potential of individuals was predicted on the ability to efficiently locate critically important events in their surroundings. For example, finding of food and mating partners were needed for survival of the gene pool. Detecting predators, which constituted a direct threat to the continued existence of the individual, was also in the interest of survival. In this respect, evolutionarily relevant threats, such as snakes, may be detected faster to get priority for processing in order to effectively and efficiently execute an escape from danger. Participants in both the phobic and control groups have the same evolutionary history. More importantly, when examining the features of the feared stimulus (the snake), it is the head which would cause the greatest fear response because this is the part of the snake that is dangerous. The further away the participant is from the head of the snake, the less danger there is of being bitten.

Limitations and Future Directions

Although the present study doubled the sample size of Wheeler's (2003) study, an even larger sample of participants would greatly increase the statistical power of the results. Moreover, the sample of stimuli used in the study was too small. Future attempts to study phobics using the flicker paradigm would benefit from the use of a larger set of fear-relevant and neutral stimulus pairs. Another limitation of the present study was observed during the post hoc analysis of the data where it was noticed that on the fear-relevant stimuli, all of the changes occurred on the snake. Future efforts should employ fear-relevant stimuli where the changes occur both on the snake's body and outside of the snake's body. In general, the hypothesis is that snakes will be of "central interest" to the phobics only. Change in stimulus pairs should be planned to take that notion into account. Another limitation noted in the study, was the possibility that there was too much variability in task difficulty within the marginal interest change stimulus-pairs. It appeared that on certain pairs of stimuli, participants were able to detect the change quickly while change detection took significantly longer on other pairs. Equating the level of difficulty in the marginal interest stimulus-pairs, would reduce within group variance and make the distinction between group performances more apparent. Finally, the administration of the ADIS-IV semi-structured interview before the administration of the flicker task, may have primed the participants to the nature of the experiment (Holle, Neely, & Heimberg, 1997; Amir, Beard, & Przeworski, 2005; Ellwart, Becker, & Rinck, 2005). Future attempts to study phobics with this experimental approach, should attempt to counterbalance the order of assessment (i.e. half of the participants could be assessed for snake phobia before the experimental task, and half after).

This research is new in that it is one of the first three studies (other than Wheeler, 2003 and Mulfinger, 2005) to use the flicker paradigm to study visual attention in a phobic population. Thus far, the concepts of change blindness and change detection have been used mostly in the field of cognition in attempting to gain a better understanding of human perceptual processes, and selective attention (Rensink, 2002). Future studies on change detection using the flicker paradigm might include other anxiety disordered groups. Attentional bias for exteroceptive stimuli is presumably more salient for specific phobics than for patients with panic disorder or generalized anxiety disorder. In addition, future research should examine the physiological status of participants during the flicker task. Attentional bias is driven, theoretically, by arousal and should not occur in the absence of arousal. Hence, comparisons could be made between participants who were and were not aroused during the experiment.

Finally, in order to better test Fox's (1993) disengagement theory using the flicker paradigm, a possible future direction in research should focus on manipulating the order of the neutral versus feared stimulus presentation. If phobics do in fact have an inability to disengage from fear-relevant stimuli while viewing neutral stimuli, perhaps an experimental manipulation should involve a comparison between the number of repetitions required for participants to detect changes in stimuli when the stimuli are presented in the following orders: neutral stimuli succeeding other neutral stimuli, neutral stimuli succeeding feared stimuli, feared stimuli succeeding neutral stimuli, and feared stimuli succeeding other feared stimuli. In contrast to the current study, where the presentation of the neutral versus feared stimuli was randomized for each participant, the manipulation where the stimulus presentation would be carefully ordered, would test whether there is a difference in the level of disengagement for phobic participants among the different orders of the stimulus presentation and would afford a test of Fox's disengagement theory.

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VI. APPENDIX A

Fear Survey Schedule II (FSS-II)

Instructions: Below are 51 different stimuli that can cause fear in people. Please rate how much fear you feel using the following rating scale and record your answer in the space provided.

0 = None 1 = Very little fear 2 = A little fear 3 = Some fear

4 = Much fear 5 = Very much fear 6 = Terror

_______1. Sharp objects
_______2. Being a passenger in a car
_______3. Dead bodies
_______4. Suffocating
_______5. Failing a test
_______6. Looking foolish
_______7. Being a passenger in an airplane
_______8. Worms
_______9. Arguing with parents
_______10. Rats and mice
_______11. Life after death
_______12. Hypodermic needles
_______13. Being criticized
_______14. Meeting someone for the first time
_______15. Roller coasters
_______16. Being alone
_______17. Making mistakes
_______18. Being misunderstood
_______19. Death
_______20. Being in a fight
_______21. Crowded places
_______22. Blood
_______27. Being with drunks
_______28. Illness or injury to loved ones
_______29. Being self-conscious
_______30. Driving a car
_______31. Meeting authority
_______32. Mental illness
_______33. Closed places
_______34. Boating
_______35. Spiders
_______36. Thunderstorms
_______37. Not being a success
_______38. God
_______39. Snakes
_______40. Being with a member of the opposite sex
_______41. Cemeteries
_______42. Speaking before a group
_______43. Seeing a fight
_______44. Death of a loved one
_______45. Dark places
_______46. Strange dogs
_______47. Deep water
_______48. Stinging insects

_______23. Heights
_______24. Being a leader
_______25. Swimming alone
_______26. Illness
_______49. Untimely or early death
_______50. Losing a job
_______51. Automobile accident

VII. APPENDIX B

Snake Questionnaire (SNAQ)

Instructions: Answer each of the following statements either True or False as you feel they generally apply to you. If the statement is true most of the time or mostly true for you, you would answer **true**. If it is mostly false or false most of the time, mark it **false**. Indicate your answer by placing a mark (**X**) in the appropriate column.

TRUE	FALSE		
______	______	1.	I avoid going to parks or on camping trips because there may be snakes about.
______	______	2.	I would feel some anxiety holding a toy snake in my hand.
______	______	3.	If a picture of a snake appears on the screen during a motion picture, I turn me head away.
______	______	4.	I dislike looking at pictures of snakes in a magazine.
______	______	5.	Although it may not be so, I think of snakes as slimy.
______	______	6.	I enjoy watching snakes at the zoo.
______	______	7.	I am terrified by the thought of touching a harmless snake.
______	______	8.	If someone says that there are snakes anywhere about, I become alert and on edge.
______	______	9.	I would not go swimming at the beach if snakes had ever been reported in the area.
______	______	10.	I would feel uncomfortable wearing a snakeskin belt.
______	______	11.	When I see a snake, I feel tense and restless.
______	______	12.	I enjoy reading articles about snakes and other reptiles.
______	______	13.	I feel sick when I see a snake.
______	______	14.	Snakes are sometimes useful.
______	______	15.	I shudder when I think of snakes.
______	______	16.	I don't mind being near a non-poisonous snake is there is someone there in whom I have confidence.
______	______	17.	Some snakes are very attractive to look at.
______	______	18.	I don't believe anyone could hold a snake without some fear.
______	______	19.	The way snakes move is repulsive.
______	______	20.	It wouldn't bother me to touch a dead snake with a long stick.
______	______	21.	If I came upon a snake in the woods I would probably run.

_______	_______	22.	I'm more afraid of snakes than any other animal.
_______	_______	23.	I would not want to travel "down south' or in tropical countries because of the greater prevalence of snakes.
_______	_______	24.	I wouldn't take a course in biology if I thought I might have to dissect a snake.
_______	_______	25.	I have no fear of non-poisonous snakes.
_______	_______	26.	Not only am I afraid of snakes, but worms and most reptiles make me feel anxious.
_______	_______	27.	Snakes are very graceful animals.
_______	_______	28.	I think that I'm no more afraid of snakes that the average person.
_______	_______	29.	I would prefer not to finish a story if something about snakes was introduced into the plot.
_______	_______	30.	Even if I was late for a very important appointment, the thought of snakes would stop me from taking a shortcut through an open field.

VIII. APPENDIX C

INFORMED CONSENT

FOR

- Measuring Change Blindness in Specific Phobias-

You are invited to participate in a research study of the role of attention in those who experience significant fear of snakes or spiders. This study is being conducted by Zofia Wilamowska, graduate student, under the supervision of F. Dudley McGlynn, Ph.D. We hope to learn if one's attention is different when one is experiencing anxiety. You must be at least 19 years of age to participate.

If you decided to participate, we will ask you to complete a questionnaire that takes about 10 minutes of your time. You will earn one (1) hour of extra credit for attempting to complete this form. Some who complete this form will then be asked to look at pictures on a computer screen that will display images that contain snakes or spiders. This will take about 45 minutes and an additional hour of extra credit will be provided after attempting to view the images displayed on the computer.

Other participants, immediately after completing the first questionnaire, will be asked to complete a second questionnaire that takes approximately 5 more minutes. One hour of extra credit will be awarded for these questionnaires. Some of those who complete the second questionnaire will be invited to make an appointment to respond to s set of interview questions, which will take approximately 35 minutes. Another hour of extra credit will be provided for this group of participants. Some who decide to respond to interview questions will then be invited to view the computer images described above. An hour (1) of extra credit will be offered; this would be a total of three (3) hours at this stage, for those who are invited and decided to view the images. Again, viewing the images should take approximately 45 minutes.

Some who are fearful of snakes or spiders might feel some discomfort when viewing the images displayed on the computer. There will not be presentation of any live snakes or spiders during the study. You may withdraw from participation at any time, without penalty, and you may withdraw any data that has been collected about yourself, as long as the data is identifiable. Your decision whether or not to participate will not jeopardize you future relations with Auburn University or the Psychology department.

A benefit available to all those who participate is extra credit. One might be able to earn up to three (3) hours of extra credit; however, all who participate are guaranteed to receive one (1) hour of extra credit. This is a RESEARCH project and not a treatment for fear of snakes or spiders. Referral information will be available for those who wish to seek treatment for such a fear. The results of this study may lead to a new line of research in the area of phobias by offering a new method for laboratory assessment.

Any information obtained in connection with this study and that can be identified with you will remain confidential. Only the principal investigator (Zofia Wilamowska) and faculty supervisor (F.D. McGlynn) will have direct access to identifiable information. All questionnaires will be coed and not contain any identifying demographic information of the participants completing them. Data from the interview computer task will be secured in the same manner. All code lists will be destroyed once data collection has ended and is no longer needed. Information collected through your participation will be used to fulfill an educational requirement for a masters thesis, may be published in a professional journal, and/or presented at a professional meeting. If so, none of your identifiable information will be included. If you have any questions we invited you to ask them now. If you have any questions later, Zofia Wilamowska (wilamza@auburn.edu, 334-844-4932) will be happy to answer them. You may also contact Dr. McGlynn, Ph.D. (mcglyfd@auburn.edu, 334-844-6472) if needed. You will be provided with a copy of this form to keep.

For more information regarding you rights as a research participant you may contact the Office of Human Subjects Research by phone or e-mail. The people to contact there are Executive Director E.N. “Chip” Burson (bursoen@auburn.edu, 334-844-5966) or IRB chair Dr. Peter Grandjean (grandpw@auburn.edu, 334-844-1462)

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER OR NOT YOU WISH TO PARTICIPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO PARTICIPATE.

______________________________   ________________________________

Participant’s signature Date Investigator’s signature Date

IX. APPENDIX D

Flicker Task Instructions

You have been selected to participate in a portion of this study that will require the use of a computer. At this computer, I am going to show you several pairs of pictures. Each pair of pictures is going to be identical with the exception of one small detail. I want you to find what is different between each pair of pictures as quickly as you can. Once you have found the difference, click the left button on the mouse or press the space bar. After pressing either the space bar or the left mouse button, verbally indicate the change that you noticed.

Do you have any questions thus far?

We are going to do a practice trial. Remember to hit the left mouse button or the space bar as soon as you can see what small detail is changing between images. Don’t forget to verbally indicate the change that you noticed.

Do you have any questions?

The program will stop automatically when you have finished all of picture pairs. This part of the experiment will take approximately 45 minutes.

I need to inform you that some of these pictures are going to show snakes or spiders in them. Remember your informed consent that you signed, which states that you are free to leave at any time, as you are a volunteering participant of this study. Please be assured that you are not in any danger of coming into contact with a real snake or spider, only pictures of them.

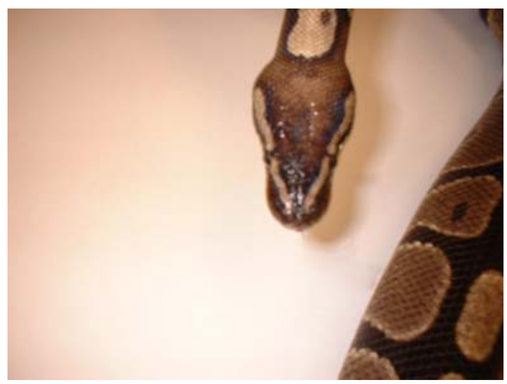
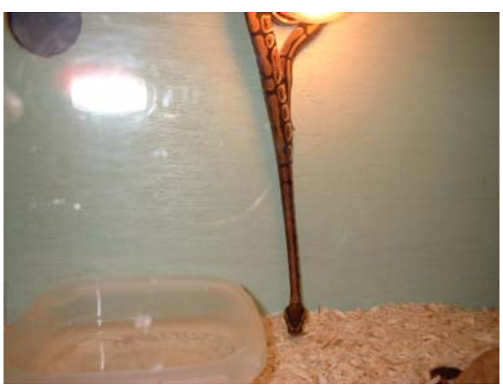
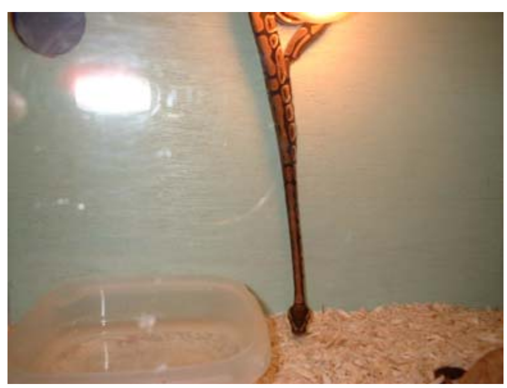
Any questions?

X. APPENDIX E

Stimuli

1) Pictures of snakes where the change occurred in the central-interest region of the snake.




2) Pictures of snakes where the change occurred in the marginal-interest region of the snake.






3) Pictures of an office where the changes occurred in the central-interest region.

4) Pictures of an office where the changes occurred in the marginal-interest region.


Southern Style
Potato Chips
1.99
Petrode
CAUTION


Southern Style
Potato Chips
1.99
Petrode
CAUTION