THE STRUCTURE OF ATTENTIONAL BIASES IN ANXIETY: A LATENT VARIABLE ANALYSIS OF ANXIETY-RELATED MODULATIONS OF ATTENTIONAL CONTROL

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ABSTRACT

THE STRUCTURE OF ATTENTIONAL BIASES IN ANXIETY:
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Anxiety is reliably associated with an attentional bias such that anxious individuals selectively attend to negative or threatening information (Bar-Haim et al, 2007). More recent work has found that anxious individuals are also more distractible by physically salient, yet affectively neutral stimuli (Moser et al, 2012; Moran & Moser, 2015). The present study extended these findings by examining the interrelationships between anxiety, distraction by threat, distraction by physical salience and more general cognitive abilities, such as working memory capacity and perceptual/motor Speed, in 200 undergraduates.

In this study, I aimed to answer three primary questions: 1) does performance in attention tasks involving affective stimuli and performance in those involving neutral, salient stimuli rely on similar or dissociable mechanisms? 2) Does anxiety independently predict performance in these types of tasks or does it predict attentional performance in a more domain-general way? 3) Can the relationship between anxiety and attention be better accounted for by deficits in working memory capacity and perceptual/motor Speed?

A series of confirmatory factor analyses revealed that attention tasks differed as a function of the type of distracter: those that appeared at the same time as the target and those that appeared as an abrupt onset prior to the target. Tasks involving neutral and negative stimuli loaded together on the same factors. A series of structural equation models revealed that 1) anxiety predicted the variance that was shared between these types of tasks rather than the

specific types of tasks and 2) the association between anxiety and attention could not be completely accounted for by working memory capacity and perceptual/motor speed. These findings provide some support for theories proposing that anxiety's wide-ranging relationships with cognition are reducible to deficits in general abilities; however, they also demonstrate unique associations between anxiety and attentional control.

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CHAPTER ONE

Introduction

Anxiety has been reliably linked with a “negative attention bias” (NAB) – that is, anxious individuals preferentially attend to environmental stimuli that are negatively-valenced or potentially threatening (Bar-Haim et al., 2007). Information processing biases, such as this, are a key component of nearly all cognitive formulations of anxiety (e.g. Beck et al., 1976; Mogg, Mathews & Weinman, 1987; Bar-Haim et al., 2007), are targets of recently developed interventions aimed at the treatment of anxiety (Hakamata et al., 2010) and, by some accounts, are possible risk factors in the development of anxiety (e.g. MacLeod et al., 2004). Thus, NAB has become one of the most widely-studied phenomena in the literature on anxiety and cognition (see Bar-Haim et al., 2007 for a review of over 150 studies).

Another line of theoretical and empirical work suggests that the link between anxiety and attention may be broader than previously thought (e.g. Eysenck et al., 2007; Moser, Becker, & Moran, 2012). Such work has focused on selective attention in the absence of negative/threatening stimuli and has found that anxious individuals exhibit similar attentional biases in the presence of visually salient, yet affectively neutral, stimuli (attentional capture). While previous research has generally examined NAB and attentional capture in isolation, they are often assumed to be mediated by a single, underlying attentional control mechanism (e.g. Eysenck & Calvo, 1992; Eysenck et al; 2007; see Posner & Rothbart, 2000 for a similar notion).

The goal of the current study is to test the generality of anxiety-related attentional biases. In particular, this study will examine whether resisting distraction – regardless of whether that distraction comes in the form of a physically salient stimulus or negative/threatening stimulus – relies on a fairly domain-general “executive attention” ability or whether it relies on more separable mechanisms corresponding to NAB and attentional capture. Unlike previous research, which has generally been limited to the study of anxiety and individual tasks, the current study will take a multivariate approach to the study of anxiety and cognition which will allow for an examination of the interrelationships between anxiety, NAB and attentional capture. This approach will also allow for NAB and attentional capture to be examined at the construct level rather than at the level of individual tasks. To this end, participants completed a battery of tasks tapping NAB and attentional capture which were used to generate latent variables. The benefit of such an approach is that error-variance associated with any one task and can be statistically removed thereby leaving a more “pure” measure of the construct of interest. In the sections that follow, the literature on anxiety and attention is briefly reviewed and the research questions and methods are reiterated in more detail.

Finally, research also suggests that anxiety is associated with broader cognitive impairments (e.g. working memory; Eysenck et al., 2007; see Moran, under review, for a meta-analysis). Given that such deficits predict performance during attentional control tasks (e.g. Lavie & de Fockert, 2005), it is possible that anxiety-related attentional biases can be better accounted for by these general cognitive deficits. Thus, an additional goal of the current study was to evaluate the potential role of these deficits in mediating the link between anxiety and attention.

Anxiety and NAB

The Measurement of NAB. One of the earliest, and most commonly used, tasks in the study of anxiety and attention is the affective Stroop – a modified version of the Stroop color-naming task (Stroop, 1935). In the affective Stroop, neutral and negative words are displayed in a variety of colors and participants are tasked with reporting the color of the word. An attentional bias for negatively-valence information is assumed to be reflected in slowed response times to negative words relative to neutral words. A large body of literature indicates that both clinical and sub-clinical anxiety are associated with increased response times to negative words (e.g. Mathews & MacLeod, 1985; Mogg & Bradley, 1998; also see Williams, Mathews & MacLeod, 1996 and Bar-Haim et al., 2007 for reviews).

In order to examine anxiety and spatial attention, Macleod, Mathews and Tata (1986) developed the probe detection task (dot probe) which is thought to provide a more direct measure of the allocation of attention to negative information. In the dot probe task, two stimuli – typically words or images – are simultaneously presented at peripheral locations for a brief duration (typically 100-500ms). Following stimulus offset, a probe stimulus appears in one of the locations previously occupied by a word/image and participants are required to respond to the probe's location or identity. On critical trials, one of the two images/words is negative while the other is neutral. An attentional bias is inferred from slower responses to probes that replace the neutral stimulus relative to probes that replace the negative stimulus under the assumption that response times will be faster when stimuli occupy an attended location (e.g. Posner, Snyder & Davidson, 1980). Similarly, several studies have investigated NAB in a variant of the Posner spatial cueing paradigm (Posner, 1980). In this task, participants are presented with two peripherally-located boxes and must detect a probe located within one of the boxes. On each trial, one of the boxes is cued with a neutral or negative stimulus and RTs are typically faster when a negative stimulus validly cues the target location. As with the affective Stroop, anxiety predicts greater response times to the target following a negative or threatening stimulus. This has been documented across a wide range of symptom severities, age and types of anxiety (Bar-Haim et al., 2007; Fox et al., 2001).

While the affective Stroop and cueing paradigms are the most commonly used tasks, a number of other tasks have been developed to investigate NAB and its association with anxiety. Several studies have examined performance during visual search. In these studies, participants are presented with a search array consisting of neutral and negative stimuli (e.g. a matrix of snake, spider, flower and mushroom images; Öhman et al., 2001) and participants are required to detect a discrepant stimulus (e.g. one spider among eight flowers). Typically, response times are faster when the discrepant stimulus is negative (Byrne & Eysenck, 1995; Öhman et al., 2001; Rinck et al., 2003; Miltner et al. 2004; Rinck et al., 2005; Cisler et al., 2009). Additionally, some studies have reported flat search slopes suggesting attention was automatically captured by the negative stimulus (Öhman et al., 2001). Most importantly for the present study, several of these visual search studies have also found that these effects were greater for anxious participants.

Theoretical Mechanisms of NAB. A number of models have been proposed to account for NAB and its relationship to anxiety. In general, these models consist of a two-stage process (Williams et al., 1988; 1996; Öhman, 1996; 2005; Mogg & Bradley, 1998; Bar-Haim et al., 2007; see Wells & Matthews, 1994 for an exception). The first stage consists of a pre-attentive "threat-detection mechanism" that evaluates incoming environmental stimuli for potential threats. Models differ with respect to the nature of this detector. Some accounts (e.g. Williams, 1996; Williams et al., 1988) propose that incoming stimuli are evaluated on a simple valence (i.e. positive/negative) dimension. Other accounts (e.g. Öhman, 1996; 2005) propose that the detector is tuned to detect stimuli which signaled a threat to survival during the evolutionary history of the organism (e.g. snakes and spiders should be tagged as threats but a gun might go undetected). Regardless of the tuning of the detector, it is generally agreed upon that this process is mediated by amygdala activation (e.g. LeDoux, 1995; 1996; 2000) and that it occurs very rapidly – likely prior to the conscious identification of the stimulus. The threat-detection mechanism then feeds into the second, “action-control mechanism” stage. At this stage, incoming stimuli which were tagged as negative or threatening during the first stage immediately receive attention. Positive stimuli do not attract attention as the immediate detection of positive stimuli is assumed to be less critical for survival.

Theories differ somewhat with respect to how anxiety modulates the functioning of this system. Mogg and Bradley (1998), for example, proposed that the first stage outputs an interrupt signal upon detecting a threat; this signal interrupts current goals and directs processing resources to the source of threat. Anxiety is assumed to be characterized by a lower threshold in this stage (i.e. the threat-detection mechanism is more likely to tag a stimulus as potentially threatening). Williams and colleagues (Williams et al., 1988; 1996), on the other hand, propose that anxiety modulates the second, attention allocation stage. They propose that capture by threat can be overridden by top-down attentional control and that anxiety impairs the ability to control attention in the face of threat.

All of these models are generally consistent with the NAB findings reported over the course of the last 30 years – regardless of the specific mechanisms; anxiety is reliably associated with greater attention to negative/threatening stimuli (Bar-Haim et al, 2007). However, over the same period of time, several findings that cannot be accounted for by existing theories began to accumulate (e.g. Ansari et al, 2008; Derakshan et al, 2009; Moser et al, 2012; Moran & Moser, 2015). In these studies, anxious individuals were found to be more distractible by irrelevant stimuli even in the absence of threat. These findings are difficult to reconcile with theories that propose that anxiety specifically influences a process related to threat-detection. The following section will review distractibility in the absence of threat as it relates to anxiety.

Anxiety and Attentional Control

The Relationship between Anxiety and Attentional Control. As noted earlier, anxiety predicts greater interference from negative words in the affective Stroop (Bar-Haim et al., 2007). However, some evidence suggests that this effect extends to the standard Stroop design. Pallak and colleagues (1975) administered the Stroop to participants under two conditions: a “safe” condition and a threat-of-shock condition. Incongruent trials were slowed by the threat-of-shock condition but congruent trials were not. Work by Hochman has found similar results in both adults (Hochman, 1967) and children (Hochman, 1969) using other anxiety manipulations.

A series of studies by Calvo and colleagues (Calvo & Carreiras, 1993; Calvo & Castillo, 1995; Calvo & Eysenck, 1996) examined the association between anxiety and distraction during a reading comprehension task. In these studies, participants read passages of text while irrelevant distracter words were flashed on the screen. Importantly, these distracter words were non-emotional in nature. These studies found that self-reported anxiety predicted greater interference from the distracters. Similarly, self-reported anxiety predicts more frequent off-task glances when a distracter is present in adults and children (Nottelman & Hill, 1977; Alting & Markham, 1993).

Additional evidence for a link between anxiety and impaired attentional control comes from studies of self-reported attentional control ability. The cognitive failures questionnaire (Derryberry & Reed, 2002) and attentional control scale (Broadbent, Cooper, FitzGerald, & Parkes, 1982) were developed to measure trait attentional control ability. Both of these studies reported moderate correlations with trait anxiety – that is, trait-anxiety predicts higher scores on the cognitive failures questionnaire and lower scores on the attentional control scale.

The most direct demonstrations that anxiety is associated with impaired attentional control have come from studies examining “attentional capture” – i.e. the selection of an object regardless of the goals of the observer (Theeuwes, 2010). Recent work, for example, has shown that anxiety is associated with impaired performance during tasks involving abrupt onset stimuli. Derakshan and colleagues examined anxious individuals’ performance during the anti-saccade task. In this task, participants fixate on the center of a visual display until a cue appears on one side of the display. Participants are required to resist the tendency to fixate on the cue and to shift attention to the opposite side of the display. Across two studies (Ansari, Derakhshan, & Richards, 2008; Derakhshan, Ansari, Hansard, Shoker, & Eysenck, 2009), anxiety predicted greater anti-saccade latencies but did not predict performance on pro-saccade trials – i.e. control trials in which participants fixate on the cue itself. Similarly, Poy et al. (2003) found that sensitivity to punishment – a construct closely related to anxiety (Torrubia, Avila, Molto & Caseras, 2001) – was associated with increased costs in an affectively-neutral exogenous cueing paradigm (Posner, 1980).

More recently, Moser and colleagues have examined the association between trait-anxiety and performance in Theeuwes’ additional singleton search (Theeuwes, 1992; 2010). In this task, participants view circular arrays consisting of 10 discrete circles and diamonds. On half of trials all shapes are presented in the same color (either red or green); on the other half of trials, a distracter item is presented in the opposing color (e.g. one green item among 9 red items). The primary finding in this task is that response times to the target are slower when a color-defined distracter is present than when no distracter is present (Theeuwes, 2010). Theeuwes (2010) has argued that the slowed response times result from the bottom-up selection of the distracter stimulus before the target can be selected. Using this task, Moser et al (2012) and Moran and

Moser (2015) have demonstrated that anxiety predicts the degree of slowing produced by the discrepant item across two separate samples. Esterman and colleagues (2013) have replicated these findings in a sample of PTSD patients.

To summarize, several lines of research have supported a link between anxiety and attentional processes in the absence of threat. Although the evidence supporting this link is not as extensive as the NAB literature (see Bar-Haim et al., 2007), it nonetheless provides evidence that anxiety is characterized by broad attentional biases across wide age ranges (i.e. children, college-age adults and adults in their 30s, e.g. Nottelman & Hill, 1977; Moser et al., 2012; Esterman et al., 2013), tasks of varying complexity (e.g. reading comprehension and visual search, Calvo & Castillo, 1995; Moser et al., 2012), methods of measuring attentional control (self-report and performance-based, Broadbent, et al. 1982; Derryberry & Reed, 2002), and levels of symptom severity (sub-clinical and clinical, Moser et al., 2012; Esterman et al., 2013). Additionally, a small amount of research suggests that anxiety inductions can causally influence attentional control (Pallak et al, 1975; Hochman, 1967; 1969).

Attentional Control Theory. Although the models discussed in the last section are capable of explaining instantiations of NAB, these models are unable to account for attentional biases in anxiety that extend beyond threat-relevant stimuli. As noted earlier, models of NAB generally posit a two-stage process. The first stage is a threat-detection mechanism that evaluates environmental stimuli for possible threats. The output of this mechanism feeds into the second stage of these models which consists of mechanisms that modulate the allocation of attention. Accordingly, anxiety is thought to modulate either the initial threat-detection mechanism or the subsequent attentional mechanism. None of the models discussed thus far can account for anxiety-related attention biases in the absence of threat-relevant information (e.g. it is unclear how these models predict longer RTs for anxious participants when the stimuli consist of a color-singleton in an otherwise homogenous array of stimuli).

Eysenck and colleagues have attempted to parsimoniously account for anxiety's relationship with attentional performance by proposing their attentional control theory (ACT; Eysenck et al., 2007; Eysenck & Derakshan, 2009; Derakshan & Eysenck, 2011; also see Eysenck & Calvo, 1992). According to ACT, anxiety – and worry in particular – acts as a type of dual task that consumes available WMC and interferes with performance in a wide range of tasks. Specifically, research suggests that 1) worry itself is an attentionally-demanding activity insofar as it requires maintaining and elaborating on a self-relevant topic and appears to rely heavily on frontal regions (e.g. Paulesu et al, 2009). 2) Research also demonstrates that anxiety increases the allocation of attention to threat (e.g. Bar-Haim et al, 2007). Given that worry typically consists of a preoccupation with potential failures and negative consequences, worry can be considered to be an internally-generated threatening stimulus that automatically captures attention.

Importantly, mounting research suggests that selectively attending to relevant information – particularly in the face of distracting information – is reliant on available working memory capacity. For example, Kane and Engle (2003) examined individual differences in working memory capacity and performance of the Stroop task. Low-span participants committed more errors in response to incongruent stimuli than did high-span participants. Similarly, Ahmed and de Fockert (2012) investigated performance on the letter-flanker task as a function of individual differences in WMC. In this study, high-span participants were better able to constrain their attention to relevant information. In addition to this correlational work, several studies have demonstrated a causal relationship between working memory and attentional control. Lavie and colleagues (Lavie, Hirst, de Fockert & Viding, 2004; Lavie & de Fockert, 2005) have demonstrated that loading working memory results in increased distracter interference during performance of the flankers task and Theeuwes' singleton search task.

With this in mind, the key proposals of ACT can be formulated as follows: NAB and attentional capture in the absence of threat are thought to be instantiations of the same inability to control attention in the face of distraction. That is, controlling attention in the face of distraction – regardless of the source of this distraction – is assumed to be reliant on the same domain-general attentional mechanism. This is similar to the "executive attention" mechanism hypothesized by Posner and Eysenck (Engle, 2002; Engle et al, 1999a,b; Kane et al, 2001; Posner & Peterson, 1990; Peterson & Posner, 2012; also see Corbetta & Shulman, 2002). This attentional control mechanism is thought to be heavily reliant on available WMC resources (Eysenck et al, 2007; Lavie et al, 2004). Importantly, anxiety is assumed to affect the control of attention in a highly domain general way by restricting available WMC.

This is consistent with a great deal of research suggesting that anxiety is associated with poorer performance on measures of WMC. With respect to self-reported anxiety, nearly 200 studies have been conducted examining the relationship between anxiety and WMC. Moran (under review) recently conducted a meta-analysis (N = 18,252) and found that anxiety predicted moderate impairments in WM task performance. There is also evidence suggesting that anxiety can causally impact WM performance. For example, Shackman and colleagues (2006) conducted an experiment in which they manipulated anxiety using a threat-of-shock design while participants completed the N-Back. Participants were less accurate in the threat condition relative to the safe condition (see Vytal et al., 2012; 2013; Robinson et al, 2013 for similar results).

Although the proposals that 1) anxiety is characterized by a single, underlying attentional control deficit and 2) anxiety's effects are mediated by WMC are central to ACT, they remain largely untested. As noted earlier, several hundred studies have examined NAB (Bar-Haim et al., 2007) and a growing number of studies have investigated anxiety and more general attentional control deficits (reviewed above). However, there are no studies that have examined the interrelations between these constructs. Similarly, while several hundred studies have examined the interrelations between anxiety and WMC, no studies have examined whether anxiety's relationship with attention can be more parsimoniously accounted for by WMC deficits. These gaps in the literature form the bases for the primary questions of the present study.

The Present Study

The current study will first examine whether 1) NAB and attentional capture reflect a common impairment in attentional control or multiple, independent attentional biases and 2) whether anxiety continues to predict attentional control once WMC is accounted for. In attempting to evaluate these hypotheses, some existing data are suggestive. However, these data are often indirect or equivocal. One of the most commonly cited findings in support of the "single factor" hypothesis is the finding that NAB and attentional capture involve activation in similar brain regions – in particular, posterior parietal regions (e.g. Corbetta & Shulman, 2002; Vuilleumier, 2005) – likely reflecting the fact that both of these involve a shift of attention. However, NAB and attentional capture clearly involve activation in different brain regions as well. For example, the amygdala appears to activate during tasks using negative stimuli for more regularly than during tasks using neutral stimuli (Vuilleumier, 2005). With respect to behavioral performance, Bar-Haim and colleagues (2007) reported that non-anxious participants failed to show any systematic bias favoring threat-relevant stimuli whereas attentional capture by physically salient stimuli appears to be far more robust in unselected populations (e.g. Moser et al., 2012; Moran & Moser, 2015). This suggests that NAB and attentional capture manifest differently in anxious and unselected groups. However, the null effect found by Bar-Haim et al (2007) may have been due to the fact that they averaged across many types of stimuli. For example, Vogt and colleagues (2008) examined the role of "arousal" in the ability of negative stimuli to capture attention. "Arousal", in this context, refers to the degree to which a stimulus activates appetitive and defensive/aversive responses (e.g. Bradley et al, 2001; Lang, 1995; this topic will be returned to in the Discussion). For example, a picture of a sunset may activate the appetitive system but may not be very arousing whereas an image of large spider may activate the aversive system and may be very arousing – that is, the spider activates the aversive system to a greater degree than the sunset activates the appetitive system. In Vogt et al (2008), participants completed a dot probe task which included positive and negative images which varied in self-reported arousal. This study found that negative images only captured attention when they were highly arousing. Overall, then, the extant literature does not seem to provide a clear consensus on the relationship between NAB and attentional capture.

With respect to the mediational role of WMC, the literature provides somewhat more promise. In a pair of studies, Owens and colleagues (2008; 2012) found that anxiety predicted poorer academic performance in 11-14 year old children. Importantly, WMC mediated the association between anxiety and academic performance – i.e. the association between anxiety and academic performance was no longer significant once WMC was accounted for. These findings have been replicated in younger children (Vukovic et al, 2012) and college students (Ganley & Vasilyev, 2014). While not directly relevant to attentional control, these studies provide some support for the notion that anxiety-related cognitive impairments can be attributed to WMC deficits. To the author's knowledge, no studies have examined anxiety, WMC and attentional control in the same study.

Summary of Research Questions and Overview of Analyses

1a) Do NAB and attentional capture represent a single underlying construct or two, more specific constructs?

A number of confirmatory factor analyses were performed on the RTs from eight attention tasks (i.e. 4 neutral and 4 affective; described below) in order to determine the psychometric separability or unity of performance in these tasks. The following three models were compared:

CFA 1) A single factor for all eight tasks

CFA 2) Two uncorrelated factors corresponding to neutral tasks and affective tasks

CFA 3) Two correlated factors corresponding to neutral tasks and affective tasks

1b) If the initial CFAs support a multi-factor solution, an additional goal will be to determine if anxiety predicts the variance shared by the different tasks (as ACT predicts) or if anxiety is independently related to the different types of tasks.

To test this, I will conduct a series of structural equation models. In the first model, anxiety will be used to predict performance in the two types of tasks in order to confirm that anxiety predicts performance in these tasks. Then, a second order factor representing the variance that is shared between the types of attention tasks will be extracted. If anxiety predicts the shared variance, then it is expected to predict the second order factor and not the first orders factors. If it independently predicts the attention tasks, then it is expected to predict the first order factors and not the second order factor.

2) Can these anxiety-related attentional biases be better accounted for by broader deficits in WMC?

In order to determine whether the association between anxiety and NAB/ attentional capture remains significant after controlling for WMC, another structural equation model will be conducted in which anxiety and WMC are both used to predict performance in attention tasks. If WMC mediates the relationship between anxiety and attention, then 1) the path between anxiety and attention will no longer be significant once WMC is accounted for and 2) the indirect path leading from anxiety to attention via WMC will be significant. Given that all of the attention tasks involve measures of response time, the role of general perceptual/motor speed will also be evaluated in this analysis.

CHAPTER TWO

Method

Participants

Two-hundred fifteen participants were recruited to participate in the current study from Michigan State University's research participation pool. Data from 6 participants were dropped from analyses because they indicated that they did not meet one of the participation criteria (i.e. normal color vision). An additional 8 participants were excluded due to missing values on one or more tasks (all due to computer error). Finally, 1 participant was excluded because they had already participated in this study during a previous semester. The final sample consisted of 200 students. Several factors were taken into account when determining this sample size:

1) *Power*. The interrelationships between the tasks used the current study (described below) have rarely, if ever, been assessed. However, a recent meta-analysis summarizing the association between anxiety and threat-related attentional biases reported an aggregate effect size of $r = .21$ (Bar-Haim et al., 2007). A power analysis (G*Power software) indicated that a sample of 200 participants would result in approximately 85% power to detect this effect.
2) *Recommendations for sample size when conducting factor analyses*. There are two categories of general recommendations for determining the sample size for factor analytic work. The first category stresses the importance of the variable-to-participant ratio and suggests that a ratio between 2 and 20 will be adequate for generating the underlying factors (Hair, Anderson, Tatham, & Black, 1995; Nunnally, 1978; Gorsuch, 1983; Cattell, 1978; Kline, 1979); along similar lines, Lawley and Maxwell (1971) recommended at least 51 more participants than the number of variables.

Given that the primary analyses of the current study involves factor analyzing eight variables (i.e. 4 tasks measuring perceptual-saliency and 4 tasks measuring affective-saliency), the strictest of these criteria would require a sample of N = 160. However, given that the communalities and loadings were not known *a priori*, I aimed to collect a larger sample (see MacCallum, Widaman, Zhang, & Hong, 1999; MacCallum, Widaman, Preacher, & Hong, 2001; Velicer & Fava, 1998). The second category stresses the absolute number of participants. Along these lines, several authors have suggested that sample sizes should not be smaller than 100 (Gorsuch, 1983; Kline, 1979), 150 (Hutcheson & Sofroniou, 1999) or 200 participants (Guilford, 1954; MacCallum, Widaman, Zhang & Hong, 1999; however, see Cattell, 1978; Comrey & Lee 1992). Thus, a sample size of 200 appears to be adequate for the current study.

General Procedure

Participation in this study involved two laboratory visits in order to minimize participant fatigue. Upon arrival for the first visit, participants provided written consent and were told that they were participating in an experiment examining attention and memory. Participants were tested in groups of 3-5. On each day of the experiment, participants completed 7-8 tasks (described below) over the course of 2-3 hours.

Stimuli for the computer tasks were presented on a Pentium R Dual Core computer, using E-Prime software (Psychology Software Tools, Inc.) to control the presentation and timing of all stimuli. Participants were seated approximately 60 cm in front of a 19in (48.26cm) monitor.

Description of Tasks

When choosing attention tasks, an attempt was made to 1) involve different types of stimuli (e.g. faces and words), 2) choose tasks that vary in their task demands (e.g. discriminate shapes, identify a color) in order to ensure that the results of the current study were not reliant on a specific set of stimuli or task demands and 3) choose tasks that have previously been related to individual differences in anxiety. Additionally, an attempt was also made to match tasks on as many variables as possible with the exception of affective content. Four tasks were chosen and two versions of each task were created: one involving physically salient stimuli and one using affective stimuli. First, Theeuwes' (1992; 2010) singleton search task was used as we, and others, have shown, that performance in this task relates to trait-anxiety (e.g. Moser et al., 2012). In the affectively neutral version, salient color singletons were presented among targets and non-targets in the search array. In the affective version, the color singleton was replaced with a schematic face displaying either a neutral or angry expression. Secondly, A variant of the Posner cueing task (Posner, 1980) was used as Poy and colleagues (2003) have shown that performance in this task is predicted by punishment sensitivity – a construct closely related to anxiety (Torrubia et al., 2001). In the neutral version, the target was cued by an abrupt onset; in the affective version, the target was cued by neutral and negative words (e.g. Fox et al., 1993; 2001). Third, a variant of a Landolt C search task (e.g. Fukuda & Vogel, 2011) was chosen. In this task, participants searched for a target Landolt C while ignoring abruptly onsetting distracter stimuli. In the neutral version, the distracters consisted of irrelevant boxes; in the affective version, they consisted of schematic faces. Finally, participants completed the Stroop task. The neutral version consisted of the standard Stroop task in which color-words are presented in various colors. In the affective version, neutral and negative words were used (see Eysenck et al., 2007; Bar-Haim et al., 2007).

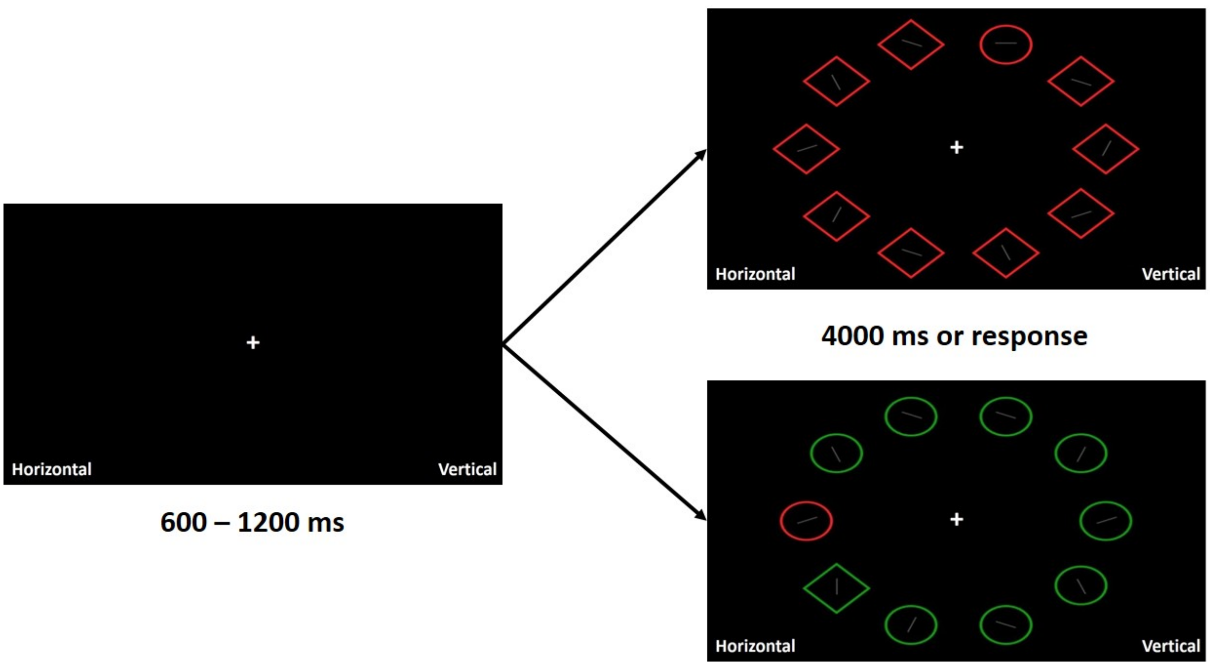
As noted in the introduction, tasks tapping other related cognitive functions were included to determine the specificity, or lack thereof, of anxiety's effects on cognition. With respect to working memory, common tasks which measure multiple facets of working memory were chosen. The working memory battery included 1) the Operation Span (OSPAN), which requires participants to simultaneously rehearse letters while performing mathematical operations, 2) the change detection task (e.g. Luck & Vogel, 1997) which requires participants to maintain visual patterns and 3) the N-back which requires participants to continuously update the contents of working memory. Finally, there was a battery of commonly used measures of perceptual/motor speed (e.g. Salthouse, 1996): Pattern Comparison, Letter Comparison and Digit Copying.

Theeuwes Singleton Search

Neutral Theeuwes Singleton Search. The Theeuwes search was identical to the procedure used by Moser and colleagues (2012). A visual search array consisting of 10 discrete shapes positioned along the radius of an imaginary circle (11° radius) was presented on each trial. Shape stimuli consisted of unfilled diamonds (4.5° x 4.5°) and circles (1.7° radius) with either a red or green outline. On half of trials, one diamond was presented with 9 circles; on the other half of trials, one circle was presented with 9 diamonds. On each trial, the 9 similar shapes (non-targets) contained a grey line segment (1.5° x .2°) oriented 22.5° from either the vertical or horizontal plane (selected at random). The unique shape (target) contained a line segment oriented either horizontally or vertically (selected at random). In the distracter-absent condition, all 10 items were the same color. On distracter-present trials, one of the non-unique shapes appeared in the opposite color (distracter) as the other non-unique shapes. The participants' task was to identify the orientation of the grey line segment contained within the target. Each trial began with the presentation of a central fixation cross (+) which remained present for a variable duration (600-1200 ms). The search array was then presented for 4 seconds or until a response was given. An example trial is presented in Figure 1. The entire task consisted of 320 trials. There were an equal number of distracter-present and distracter-absent trials; circles and diamonds appeared as the target stimulus with equal frequency.

Figure 1.

Example distracter-absent (top right) and distracter-present (bottom right) trials from the neutral Theeuwes search task. Participants were required to locate the unique shape (circle in the top right and diamond in the bottom right) and identify the orientation of the line segment contained within that shape



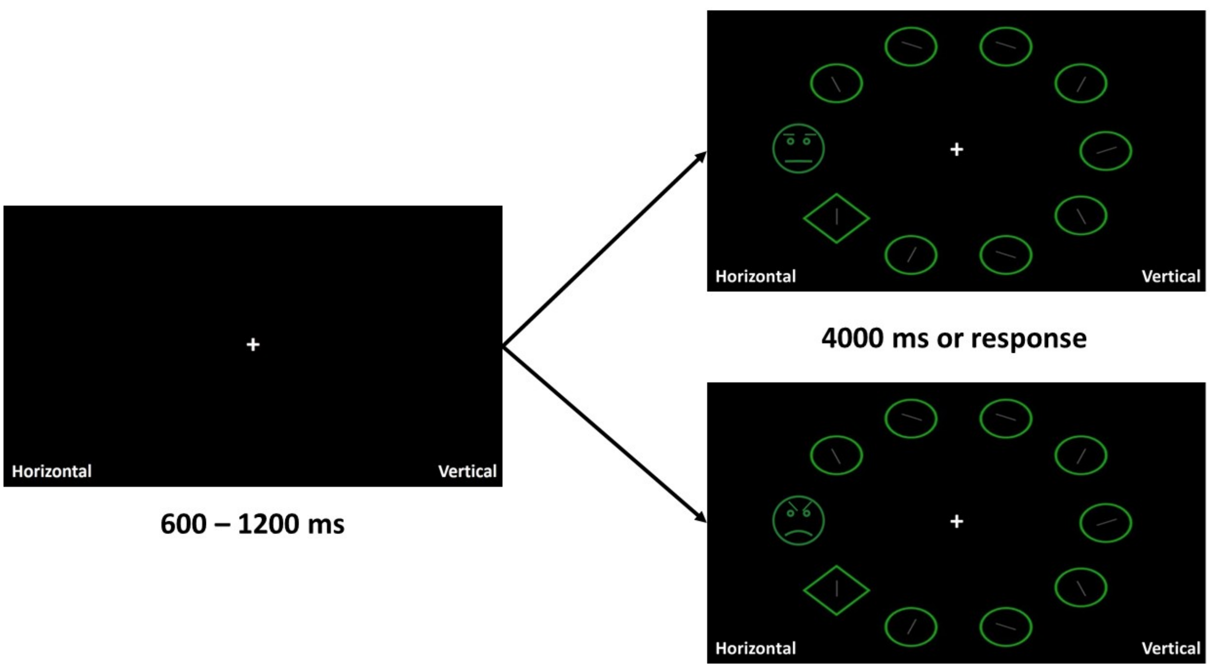
Affective Theeuwes Singleton Search. The singleton search was modified from the versions used by Moser et al (2012) and Devue et al (2011). A visual search array consisting of 10 discrete objects (shapes and faces) positioned along the radius of an imaginary circle (11° radius) was presented on each trial. Shape stimuli were identical to those used in the Neutral

Singleton Search. Face stimuli were schematic images created by assembling standard facial features and had a radius of 1.7°.

As in the affectively neutral version of this task (see above), the target stimulus was a circle (among diamonds) on half of trials and a diamond (among circles) on the other half of trials. Distracter-absent trials were identical to those in the neutral search task. For distracter-present trials, the color singleton was replaced by a schematic face; the neutral and angry faces appeared with equal frequency. The participants' task was the same (i.e. to identify the orientation of the grey line segment contained within the target shape). The procedure and timing of the task were the same as the neutral search. An example trial is presented in Figure 2.

Figure 2.

Example neutral-distracter (top right) and threat-distracter (bottom right) trials from the affective Theeuwes search task. Participants were required to locate the unique shape and identify the orientation of the line segment contained within that shape

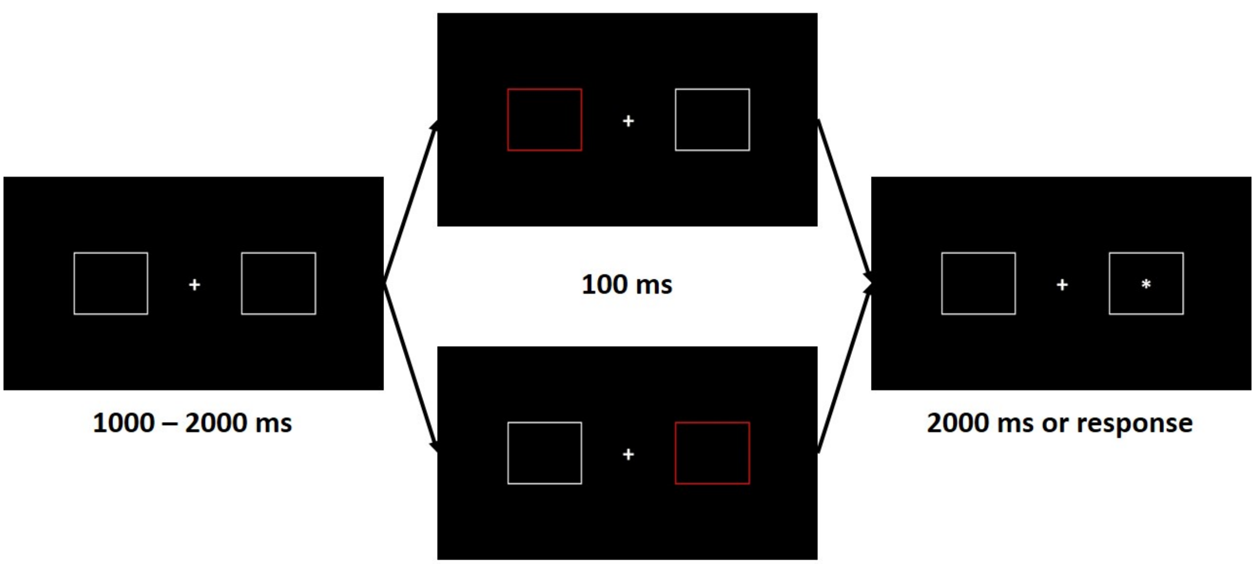


Posner Cueing

Neutral Posner Cueing. Throughout the task, a central fixation cross and two identical, white unfilled boxes (approximately 5° from the center) were displayed against a black background. At the beginning of each trial, the boxes were present for between 1000 and 2000 ms. This was followed by a cue which consisted of one of the boxes turning red. The target (*) appeared at the center of one of the peripheral boxes 100 ms following the cue. The target remained present for 2 seconds or until a response was given. An example trial is shown in Figure 3. The task consisted of 304 trials. Half were valid and half were invalid trials.

Figure 3.

An example invalid trial (top) and valid trial (bottom) from the Posner cueing task. Participants were required to locate the target stimulus

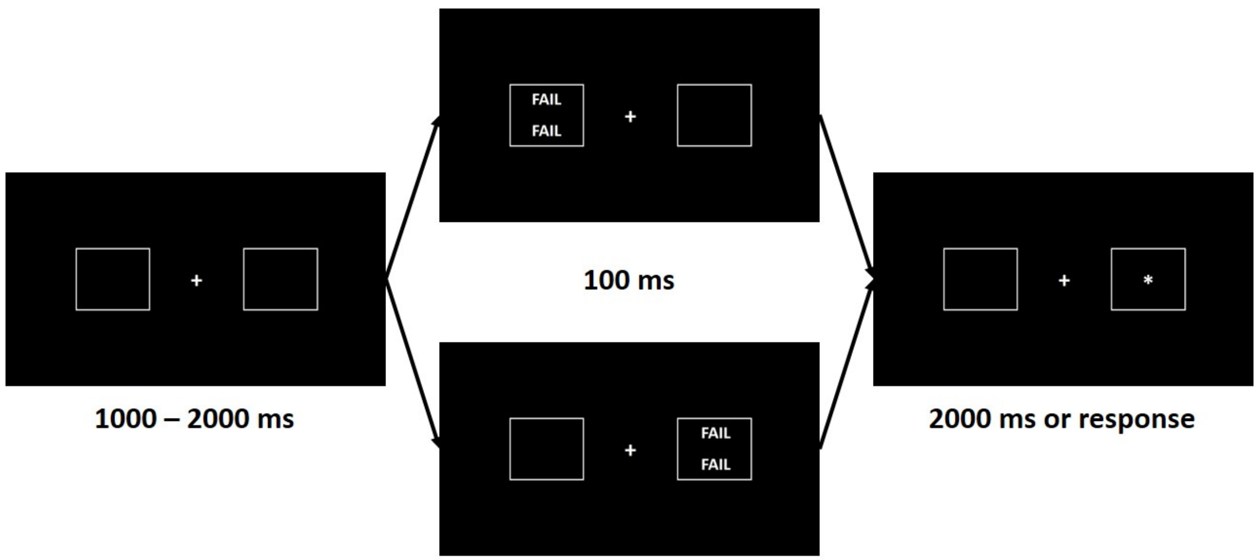


Affective Posner Cueing. The Affective Posner Cueing task was modified from that used by Fox et al. (2001). Throughout the task, a central fixation cross and two identical, white unfilled boxes (approximately 5° from the center) were displayed against a black background. At the beginning of each trial, the boxes were present for between 1000 and 2000 ms. Following fixation, a cue was presented; the cue consisted of the same word presented twice in capital letters one line above and below fixation within one of the peripheral boxes. The cue remained present for 100 ms. The target (*) then appeared at the center of one of the peripheral boxes 100 ms following the cue. The target remained present for 2 seconds or until a response was given. An example trial is depicted in Figure 4.

Word stimuli were chosen from the Affective Norms for English Words list (ANEW; Bradley & Lang, 2010) set. Ninety-six neutral and negative words (48 each) were selected to represent a wide range of objects and scenarios. The words were chosen to be highly arousing (Vogt et al, 2008). Each word appeared as a valid cue four times and as an invalid cue four times. Words used in this task did not overlap with those used in the Stroop.

Figure 4.

An example negative-invalid trial (top) and negative-valid trial (bottom) from the affective Posner cueing task. Participants were required to locate the target stimulus

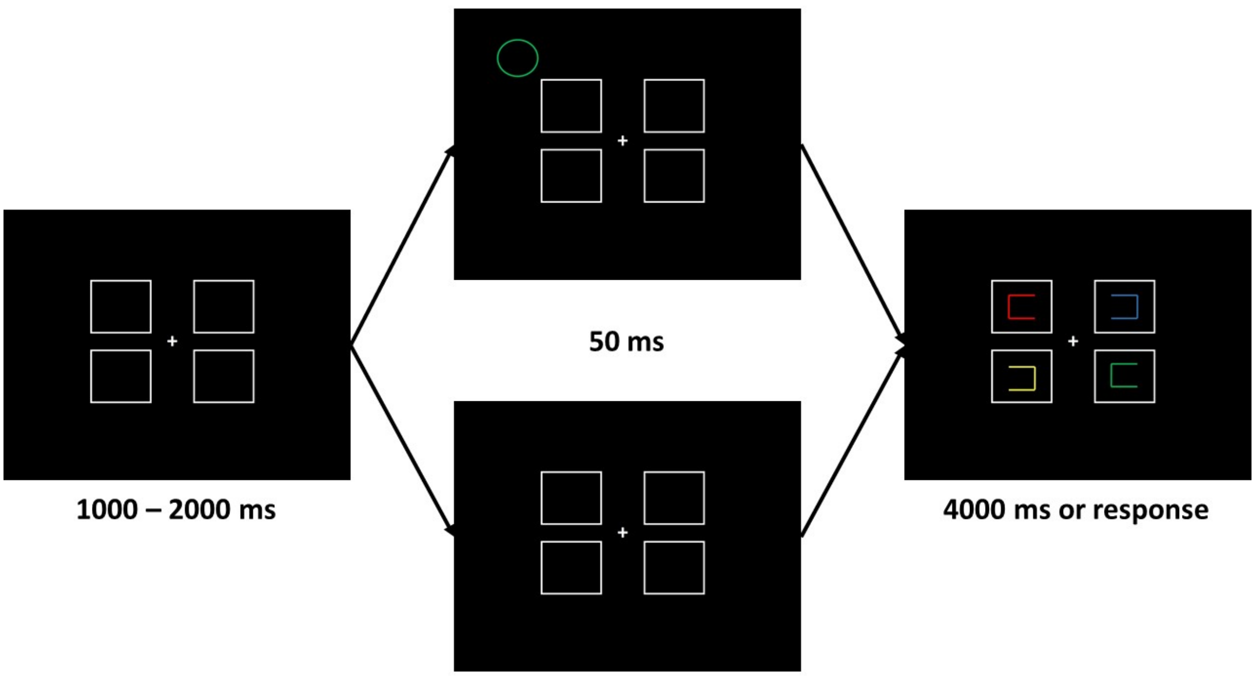


Landolt C Cueing task

Neutral Landolt C Cueing. Throughout the task, four white, unfilled boxes (2° x 2°) were displayed on a black background and placed around a central fixation cross. At the beginning of each trial, the four boxes were present for between 1000 and 2000 ms. On uncued trials, an additional 50 ms passed before a Landolt C (1° x 1°) appeared in each box. Each Landolt C appeared in a unique color (blue, red, green and yellow) and participants were required to report the orientation of the Landolt C with the target color. The target color was counterbalanced across participants. The search array was present for 4000 ms or until a response is given. Cued trials were identical to uncued trials with the following exception: the search array was preceded by a task-irrelevant circle which flanked one of the non-target positions. The color of the distracter circle was selected from the non-target colors. The distracter circle remained present for 50 ms. An example trial is shown in Figure 5. The entire experiment consisted of 288 trials. Half of trials were cued and half were uncued. For cued trials, the location and color of the circle were randomly selected with the constraint that all possible colors and locations were selected with equal frequency.

Figure 5.

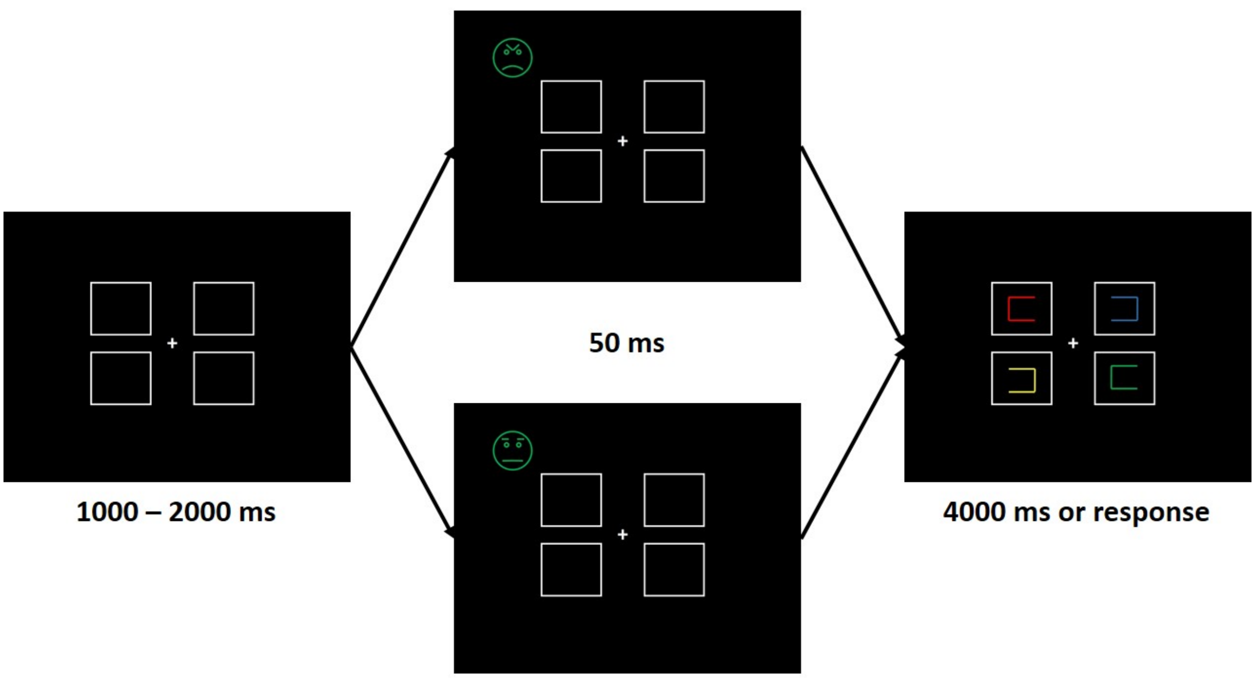
An example cued (top) and uncued (bottom) trial in the neutral Ladolt C cueing task. Participants were required to identify the orientation of the C presented in the target color



Affective Landolt C Cueing. Throughout the task, four white, unfilled boxes (2° x 2°) were displayed on a black background and placed around a central fixation cross. At the beginning of each trial, the four boxes were present for between 1000 and 2000 ms. On uncued trials, an additional 50 ms passed before a Landolt C (1° x 1°) appeared in each box. Each Landolt C appeared in a unique color (blue, red, green and yellow) and participants were required to report the orientation of the Landolt C with the target color. The target color was counterbalanced across participants. The search array was present for 4000 ms or until a response was given. Cued trials were identical to uncued trials with the following exception: the search array was preceded by a schematic face which flanked one of the non-target locations. The color of the face was selected from the non-target colors. Faces displayed either anger or a neutral expression and remained present for 100 ms. An example trial is presented in Figure 6. As in the neutral version, half of trials were cued and half were uncued. For cued trials, the location, color and emotion of the face were randomly selected with the constraint that all possible options were selected with equal frequency.

Figure 6.

An example negative-cued (top) and neutral-cued (bottom) trial in the affective Ladolt C cueing task. Participants were required to identify the orientation of the C presented in the target color

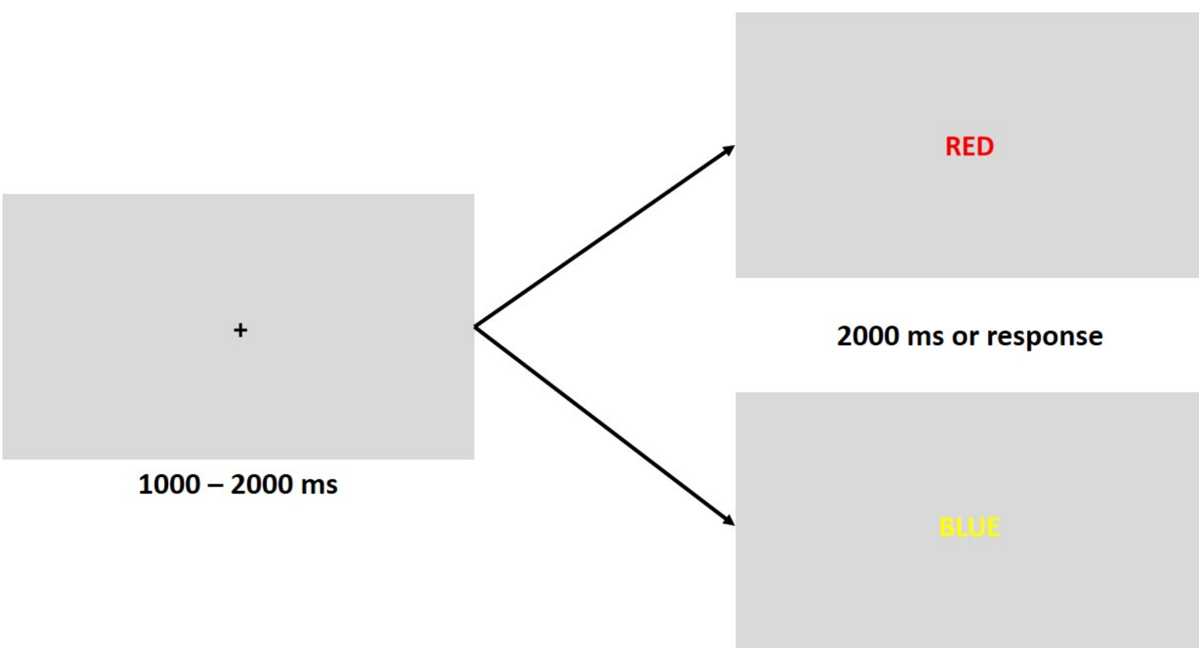


Stroop

Neutral Stroop. Each trial began with a fixation cross for 1000-2000ms. This was followed by the presentation of a word for 2000 ms or until a response was given. Each word was displayed in a randomly selected color (with the constraint that all colors appeared with equal frequency) from the following list: yellow, green blue and red. On half of trials, the word and its color matched (e.g. the word "red" was displayed in a red font) and, on the other half of trials, they did not. Participants were required to indicate the color of the word using one of four color-coded buttons. An example trial is presented in Figure 7. There were 120 total trials. All words appeared equally often and appeared equally often as congruent and incongruent stimuli. Each colored button corresponded to one of the possible target colors.

Figure 7.

Example congruent (top right) and incongruent (bottom right) trials in the neutral Stroop task. Participants were required to identify the color of the word

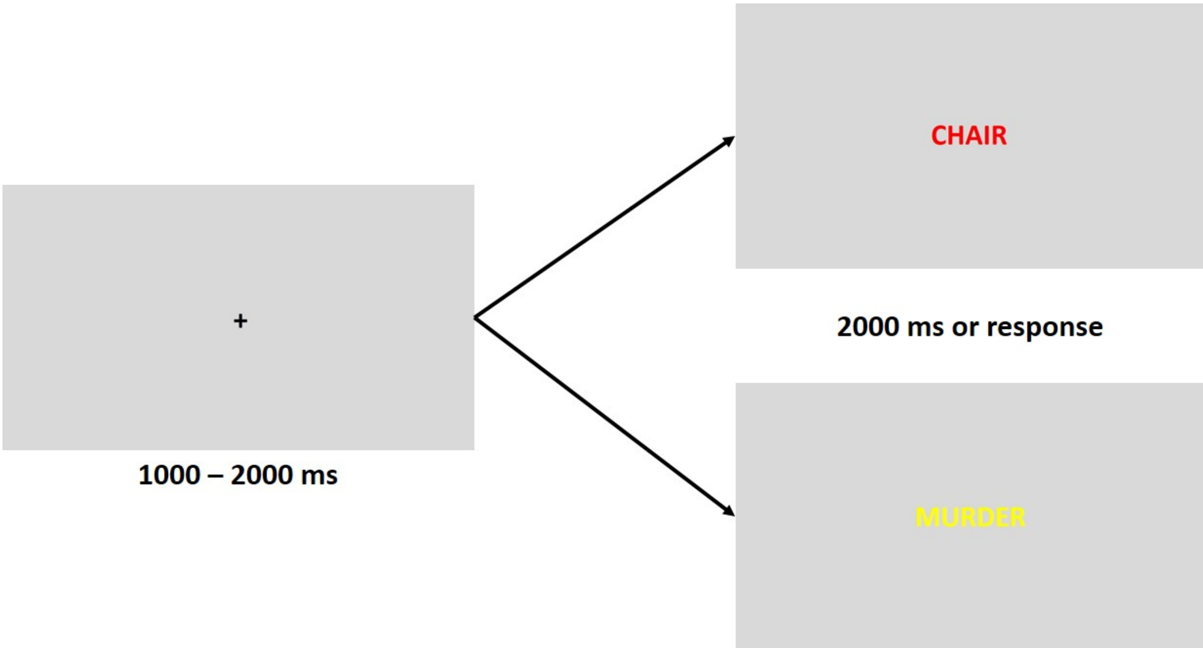


Affective Stroop. One hundred-twenty neutral and negative words were chosen from the Affective Norms for English Words list (ANEW; Bradley & Lang, 2010). As with the Affective Posner Cueing task, words were chosen to represent a wide range of objects and scenarios. The words were chosen to be highly arousing (Vogt et al, 2008).

Each trial began with a fixation cross for 1000-2000ms. This was followed by the presentation of a word which lasted for 2000ms or until a response was given. Each word was displayed in a randomly selected color (with the constraint that all colors appeared with equal frequency) from the following list: yellow, green blue and red. An example trial is shown in Figure 8. Participants were required to indicate the color of the word using one of four colored buttons. Each colored button corresponded to one of the possible target colors.

Figure 8.

Example neutral (top right) and negative (bottom right) trials in the affective Stroop task. Participants were required to identify the color of the word



Working Memory Capacity

Operation Span (OSPAN). The OSPAN required participants to solve mathematical operations while retaining unrelated letters for subsequent recall. Each item began with the presentation of a math problem which took the form of a parenthetical multiplication or division problem followed by a number to add or subtract from the product or dividend (e.g. (8/2) + 3). Participants were then presented with a single number accompanied by a box marked “True” and a box marked “False.” Participants were instructed to indicate whether this number was the correct solution to the preceding math problem. Each solution was followed by a letter which participants were required to memorize. Each set of math problem/letter pairings was followed by a recall screen in which the participants recalled the letters in their serial order.

Set sizes ranged from three to seven; each set size appeared three times. For each math problem/letter sequence, letters were randomly chosen from the following list: F, K, P, S, H, L, Q, T, J, N, R, and Y. Letter and number stimuli were presented in a standard, black font against a white background. Per Conway and colleagues (2005), the OSPAN was scored using a partial-credit unit-scoring procedure wherein each item was scored individually as the number of letters recalled in the correct serial position.

N-Back. The N-Back task was modeled after the 3-back task used by Kane et al (2007). Participants were presented with a sequence of letters selected from the following list of phonologically distinct letters: B, F, H, K, M, Q, R and X. For each letter, participants were required to indicate whether the current letter matched the letter presented three back (for example, participants would respond “match” to the second “B” in this sequence: B-Q-X-B-R). There were four lists of 48 trials. During each list, each letter was presented as a foil (letters that do not match the letter 3-back) five times and as a target once (letters that match the letter 3-back).

Each trial began with the presentation of a black fixation cross against a white background for 500 ms. This was followed by a letter stimulus presented in a standard, black font for 500 ms. Each letter was followed by a 2000 ms ITI during which the participant was able to respond. Letter presentations were randomly varied between upper and lower case in order to prevent matching based solely on perceptual features. N-Back scores were computed as the percentage of correct responses given that this is the most commonly-used N-Back measure in the anxiety literature (see Moran, under review, for a review).

Visual Change Detection. The visual change detection task was based on the work of Luck and Vogel (1997). Participants were presented with sets of 4, 6 and 8 colored squares. Each square subtended approximately .65° x .65° of visual angle and was positioned randomly with the constraint that items were separated by at least 2° (center-to-center). On each trial, the color of each square was selected randomly from a list of 7 possible colors: black, blue, green, purple, red, white and yellow.

Each trial was initiated by the participant. There was then a blank screen for 500 ms followed by fixation cross for 1000 ms. The memory set was then presented for 100 ms and was followed by a blank screen for 900 ms. The test display then appeared and remained present until a response was given. One each trial, the test display was identical to the initial memory set display with two exceptions: 1) on half of trials, one of the items, selected at random, appeared in a different color relative to the corresponding item in the memory set. 2) For all trials, a black circle appeared around one of the items (on trials in which a change occurred, the discrepant item was circled; on trials in which no change occurs, the circled item was chosen at random) indicating that this item was to be compared with the corresponding item in the memory set. Per the recommendations of Rouder, Morey, Morey and Cowan (2011), visual working memory capacity (k) was calculated as follows:

$$k = N(H - FA)$$

where N is the set size, H is the hit rate and FA is the false alarm rate.

Perceptual/Motor Speed

Letter Comparison. Participants were given two forms and an instruction sheet. Each form contained pairs of strings of letters separated by a horizontal line. Participants were instructed to compare each pair and write “S” (same) or “D” (different) on the horizontal line and to work as quickly as possible.

Digit Copying. Participants were given two forms and an instruction sheet. Each sheet included 100 pairs of boxes with a digit in the top box and a blank bottom box. Participants were tasked with copying the digit in the top box into the bottom box. Participants were instructed to work as quickly as possible

Pattern Comparison. Participants were given two forms and an instruction sheet. Each form contained pairs of patterns separated by a horizontal line. Participants were instructed to compare each pair and write “S” (same) or “D” (different) on the horizontal line and to work as quickly as possible.

Standard procedures for administering and scoring processing speed tasks were followed (e.g. Salthouse, 1996; Conway et al., 2002; McCabe et al., 2010). Each task was administered via pen-and-paper and participants had 30 seconds to complete each page. A stopwatch was used to time performance. Each task was scored as the total number of correctly completed items.

Self-Report

In addition to the tasks listed above, participants completed the following self-report measures of anxiety:

The STAI-T (Spielberger & Gorsuch, 1983) is a 20-item questionnaire measuring the extent to which participants generally feel anxious. The PSWQ (Meyer, Miller, Metzger, & Borkovec, 1990) is a 16 item questionnaire gauging trait-worry – i.e. the extent to which participant generally engage in worry. The MASQ-Ar (Watson & Clark, 1991) is a 17 item scale measuring arousal or physiological anxiety (e.g. sweaty palms, racing heart). Scale scores were computed as the average of the individual items. Copies of these measures can be found in Appendix A.

CHAPTER THREE

Results

Data Preparation

Descriptive statistics for demographic variables and measures of cognitive ability are presented in Table 1.

With respect to attention tasks, only correct trials were analyzed. A preliminary analysis of RT difference scores (e.g. distracter trials minus no-distracter trials) revealed that the difference scores were quite unreliable ($\alpha s \leq .3$). This is common for difference scores (e.g. Nunnally, 1978), however, it presents a very serious problem for conducting correlational analyses. The extent to which any two variables can correlate is limited by their reliability (e.g. Nunnally, 1978; Thorndike, 1949). Thus, these difference scores will likely fail to correlate simply due to unreliability. The help mitigate this problem, the correlational analyses will focus on raw RTs recorded during distraction trials (i.e. distracter-present trials, invalid trials and incongruent trials). While this method has its own problems, it does help solve the problem of unreliability. A discussion of the problems raised by using raw RTs and attempts to mitigate those will be raised later in the manuscript.

In order to evaluate the CFAs and SEMs, I report several indices of fit as is typically recommended (Kline, 1998). I report the chi-square statistic which reflects whether the difference between the observed and reproduced correlation matrices is statistically significant. As a significance test, the chi-square is highly influenced by sample size; when the sample size is as large as the sample in the current study, even small differences between the observed and reproduced correlation matrices can be significant. Thus a number of other indices are also reported. χ^2/df is the ratio of the chi-square to its degrees of freedom; this statistic is less influenced by sample size and values lower than 2 are used to indicate a well-fitting model. In addition, I report the root mean square error of approximation (RMSEA), comparative fit index (CFI), Normed Fit Index (NFI), Tucker-Lewis index (TLI) and standardized root mean square residual (SRMR). The following cutoffs are used to indicate a well-fitting model (see Hu and Bentler; 1998; 1999; Kline, 1998): RMSEA ≤ .06; CFI ≥ .90; NFI ≥ .90; TLI ≥ .90; SRMR ≤ .08. Finally, I also report the *p* of close fit (PClose) and the Akaike Information Criterion (AIC). PClose tests the null hypothesis that RMSEA is equal to .05 which is referred to as a “close-fitting model.” Values lower than .05 indicate that the fit is significantly worse than a “close-fitting model.” The AIC was computed as the difference between the estimated and saturated models. Thus, negative values indicate better fit and positive values indicate worse fit.

Table 1.

Descriptive Statistics for Demographic Variables and Measures of Cognitive Ability

Variable	M	SD	Skew	Kurtosis
Age	19.52	2.10	5.35	46.35
% Female	62	49	–	–
% Caucasian	76	43	–	–
% Right Handed	88	32	–	–
STAI-T	2.16	0.54	.39	-.41
PSWQ	3.38	0.95	-.27	-.67
MASQ-Aar	1.62	0.52	1.29	1.85
OSPAN (%)	72.76	21.36	-1.22	1.05
Change Detection (k)	3.48	1.11	-1.12	1.40
N-Back (%)	79.01	11.52	-1.72	1.29
Digit Copying	52.95	7.96	.08	.11
Patter Comparison	21.63	3.25	-.18	.37
Letter Comparison	12.28	2.40	.36	.13

Univariate Analyses of Attention Tasks

In order to confirm standard attentional capture effects in each of the tasks, *t*-tests were conducted comparing the baseline condition (e.g. the no-distracter condition for the neutral

Theeuwes task; neutral word trials for the affective Stroop task etc.) and the distraction condition (e.g. the distracter condition for the neutral Theeuwes task; negative word trials for the affective Stroop task etc.) for both RTs and Accuracy.

Attentional capture effects are presented in Table 2. For all tasks, participants were slowed by the presence of the distracter. Accuracy was either decreased or not affected by the distracter condition for all tasks thereby counter-indicating a speed/accuracy tradeoff.

Table 2.

Response Times and Accuracy for the Attention Tasks

Task	**Baseline: M (SD)**	**Distraction: M (SD)**	***t*-test**	**Skew**	**Kurtosis**
		RTs			
Theeuwes - Neutral	1034.54(169.70)	1139.90(178.30)	21.76***	.45 / -.01	.66 / .04
Stroop - Neutral	620.97 (72.79)	697.11 (93.00)	19.39***	.08 / .15	.39 / .08
Posner - Neutral	329.24 (41.02)	369.48 (40.91)	30.57***	1.23 / 1.30	1.09 / 1.51
Landolt - Neutral	544.69 (66.12)	552.09 (66.36)	5.44***	1.27 / 1.12	1.63 / 1.41
Theeuwes - Affective	863.33 (133.49)	940.00 (141.56)	23.43***	.61 / .79	.89 / 1.52
Stroop - Affective	630.14 (83.19)	644.62 (84.10)	3.45***	.06 / .14	.04 / .32
Posner - Affective	356.36 (44.58)	367.00 (48.67)	4.10***	1.18 / .46	1.72 / 1.37
Landolt - Affective	519.43 (55.34)	522.49 (58.10)	2.41**	1.16 / 1.25	1.56 / 1.64
		Accuracy†			
Theeuwes - Neutral	93.63 (9.42)	90.41 (12.04)	6.68***	-3.63 / -2.37	14.44 / 5.25
Stroop - Neutral	95.08 (9.20)	88.58 (17.68)	5.97***	-2.87 / -5.59	7.35 / 35.61
Posner - Neutral	98.55 (2.56)	95.25 (5.07)	10.91***	-3.87 / -1.97	18.94 / 4.99

Table 2 (cont'd)

Landolt - Neutral	95.21 (6.65)	94.93 (6.81)	1.67	-4.76 / -4.62	29.96 / 28.71
Theeuwes - Affective	93.98 (7.90)	93.58 (9.04)	1.78	-4.22 / -3.76	20.13 / 16.36
Stroop - Affective	95.11 (6.58)	94.73 (6.87)	1.07	-5.99 / -7.21	54.32 / 73.51
Posner - Affective	96.58 (5.52)	93.31 (7.43)	7.25***	-2.08 / -2.78	5.47 / 9.60
Landolt - Affective	93.72 (7.63)	93.30 (7.77)	2.18*	-3.71 / -3.47	16.56 / 15.48

* $p < .05$; ** $p < .01$; *** $p < .001$

Note. Baseline refers to no distracter trials (Theeuwes and Landolt Tasks), congruent trials (Stroop task), and valid trials (Posner Task). Distraction refers to distracters trials (Theeuwes and Landolt Tasks), incongruent trials (Stroop task) and invalid trials (Posner task).

† Because accuracy data were highly non-normal, these effects were replicated using the Wilcoxon signed-rank test. The pattern of findings was identical to that presented in the table.

Is Attentional Capture a Unitary Construct?

Confirmatory Factor Analyses of Attention Tasks. Table 3 reports correlations and reliability estimates for all variables used in subsequent analyses. In order to test the generality of attentional capture, I performed a series of confirmatory factor analyses (described earlier): a single factor model consisting of all attention tasks, a two-factor model corresponding to affective and neutral tasks (with uncorrelated factors), and a two-factor model corresponding to affective and neutral tasks (with correlated factors). An a priori decision was made to allow errors to correlate for matched pairs of tasks only due to the similarity in stimuli and task demands (e.g. the errors for the two Theeuwes tasks were allowed to correlate but these errors were not allowed to correlate with those of other tasks). Per standard CFA conventions, latent variables are represented with circles and observed variables are represented with rectangles. Straight arrows leading from latent variables to observed variables depict factor loadings whereas curved arrows between variables depict the correlation between those variables.

Table 3.

Correlation Matrix for Anxiety, Attention, WMC and Perceptual/Motor Speed Tasks

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
1.STAI	(.91)																
2.PSWQ	.70	(.94)															
3.Arousal	.51	.45	(.85)														
4.OSPAN	-.17	-.20	-.16	(.82)													
5.CD	-.23	-.15	-.17	.32	(.62)												
6.N-Back	-.19	-.21	-.27	.36	.40	(.91)											
7.Digit	-.01	.02	-.11	.16	.04	.09	(.90)										
8.Letter	-.06	-.06	.04	.15	.15	.09	.23	(.74)									
9.Pattern	-.12	-.08	-.10	.17	.25	.10	.37	.47	(.77)								
10.Stroop-N	.25	.18	.21	-.15	-.12	-.09	-.18	-.16	-.14	(.82)							
11.Landolt-N	.26	.24	.18	-.21	-.23	-.15	-.18	-.14	-.26	.33	(.87)						
12.Posner-N	.18	.21	.19	-23	-.29	-.25	-.23	-.18	-.26	.28	.61	(.86)					
13.Theeuwes-N	.23	.16	.20	-.24	-.22	-.19	-.12	-.16	-.22	.35	.34	.23	(.85)				
14.Stroop-A	.24	.20	.19	-.25	-.28	-.19	-.23	-.15	-.23	.60	.46	.42	.30	(.83)			
15.Landolt-A	.22	.22	.17	-.19	-.19	-.17	-.20	-.14	-.23	.32	.85	.57	.30	.40	(.86)		
16.Posner-A	.23	.21	.20	-15	-.21	-.19	-.17	-.13	-.16	.27	.67	.72	.32	.45	.60	(.82)	
17.Theeuwes-A	.27	.19	.21	-.18	-.19	-.23	-.16	-.13	-.21	.40	.50	.35	.66	.43	.41	.34	(.85)

Note. Reliability coefficients are presented along the diagonal
$|rs| \geq .139$ are significant, $p < .05$; $|rs| \geq .182$ are significant, $p < .01$; $|rs| \geq .231$ are significant, $p < .001$;

Numbers presented near latent variables, but not along a path, represent the variance of that variable.

The single-factor model (CFA 1) is depicted in Figure 9. All loadings and correlations were significant (*ps* < .01). However, the fit for this model was somewhat marginal. As shown in Table 4, the SRMR, RMSEA, NFI, TLI, and CFI all indicated acceptable-to-good fit. On the other hand, χ^2/df was somewhat high (>2), PClose was marginal (near .05) and AIC was positive.

Table 4.

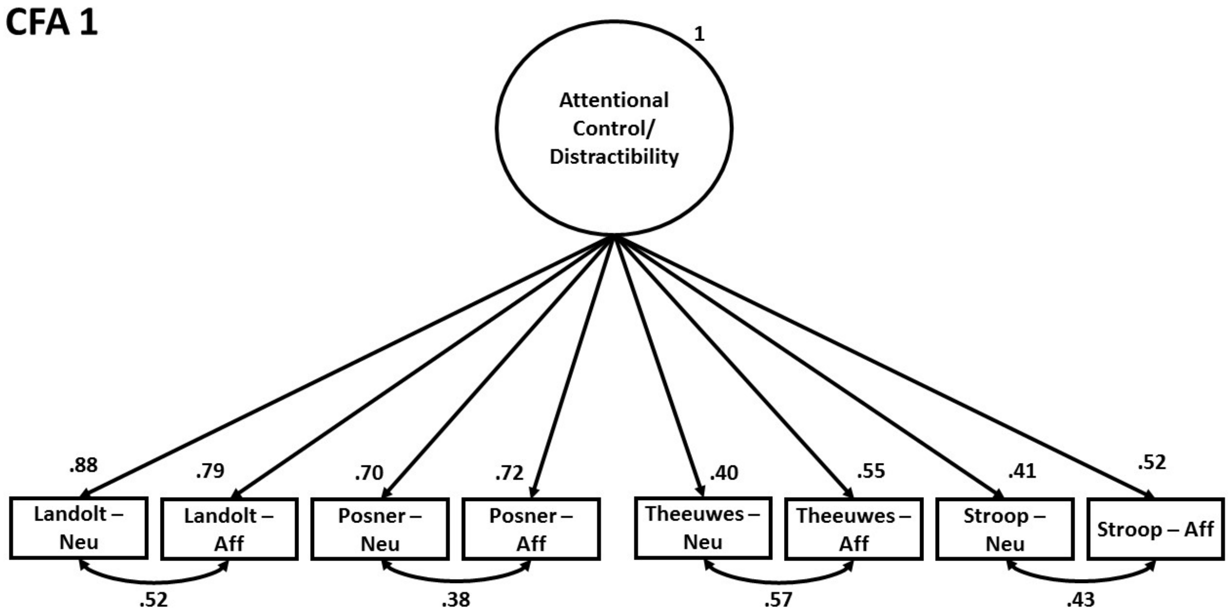
Fit Statistics for the CFA and SEM Analyses

Model	χ^2	χ^2/df	SRMR	RMSEA	NFI	TLI	CFI	PClose	AIC
CFA 1	36.56**	2.28	.05	.07	.96	.96	.98	.07	0.98
CFA 2	261.81*	16.36	.33	.28	.71	.50	.71	<.001	229.81
CFA 3	32.13**	2.14	.05	.08	.96	.96	.98	.11	2.13
CFA 4	22.80	1.52	.03	.05	.97	.99	.98	.29	-7.20
SEM 1	50.31	1.36	.04	.04	.96	.98	.99	.64	-23.69
SEM 2	192.34*	1.23	.05	.03	.92	.97	.98	.96	-119.7

* $p < .05$, ** $p < .01$, *** $p < .001$

Figure 9.

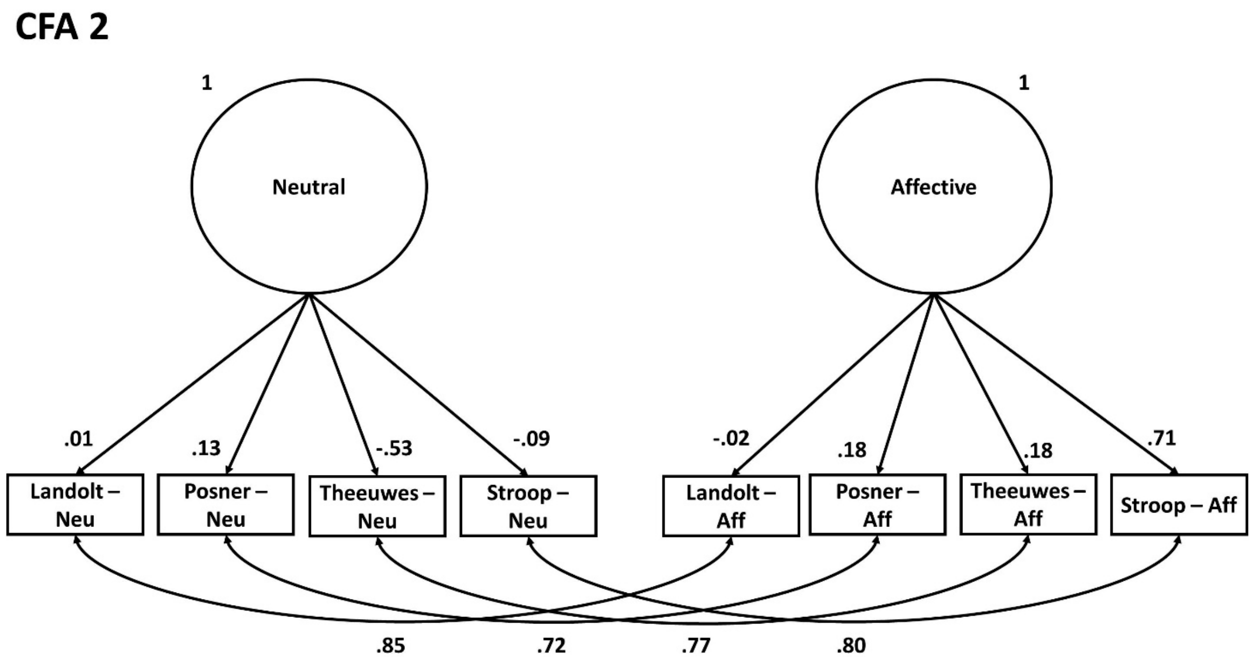
A confirmatory factor analysis consisting of a single attentional control/distractibility factor. Curved paths connecting observed variables represent correlated error terms.



The results of CFA 2 – i.e. the two factor model with uncorrelated errors – are presented in Figure 10. While the correlations between errors were significant (*ps* < .001), none of the loadings approached significance (*ps* > .11). Additionally, fit statistics universally indicated very poor fit (Table 4). As CFAs 1 and 2 had equivalent degrees of freedom, fit could not be directly compared with a χ^2 difference test. However, the fit indices suggest that CFA 2 should be rejected.

Figure 10.

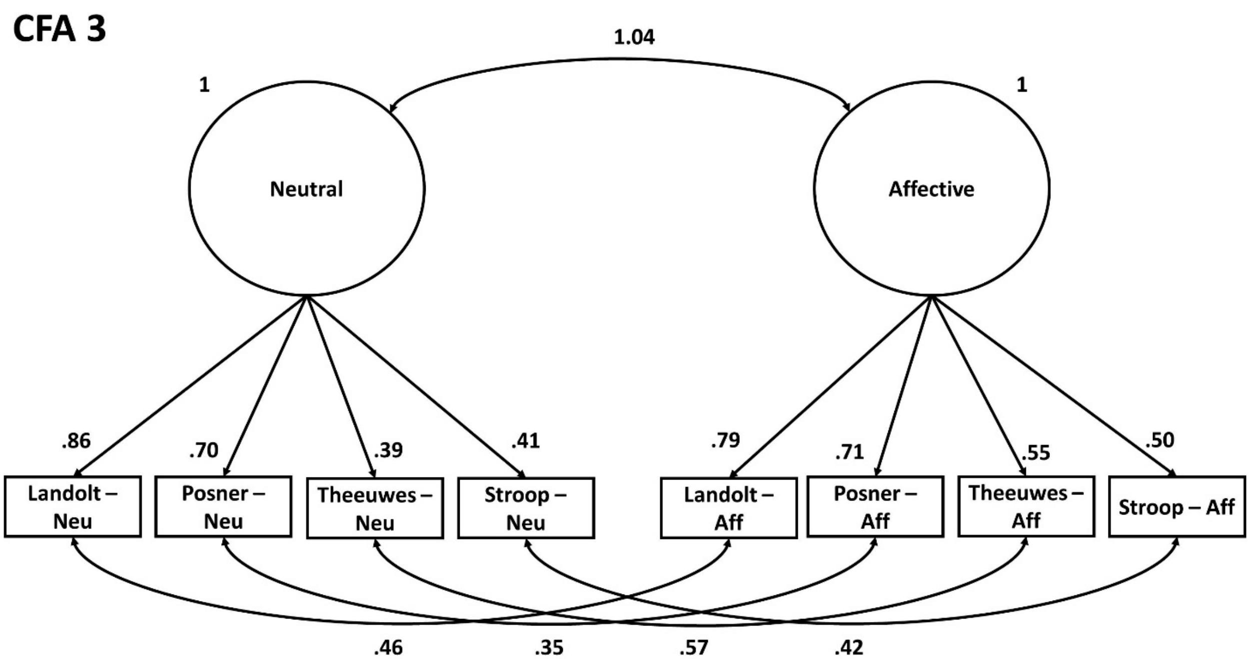
A confirmatory factor analysis consisting of two factors for tasks using neutral and affective stimuli. Curved paths connecting observed variables represent correlated error terms



CFA 3 – i.e. the two factor model with correlated factors – is depicted in Figure 11. All loadings and correlations are significant (*ps* < .01). As with CFA 1, the fit indices for CFA 3 were somewhat mixed. The SRMR, RMSEA, NFI, TLI, PClose and CFI all indicated acceptable-to-good fit whereas χ^2/df was somewhat high (>2) and AIC was positive. When compared with the previous models, CFA 3 provided significantly better fit than CFAs 1 ($\chi^2(1)$ difference = 4.43, $p = .03$) and 2 ($\chi^2(1)$ difference = 229.69, $p < .001$). However, an examination of the correlation between the latent factors revealed a problem. The correlation between the neutral and affective factors exceeded 1 (1.04). Solutions such as these are referred to as "Heywood Cases"; these are artifactual and can indicate substantial problems with the model under question.

Figure 11.

A confirmatory factor analysis consisting of two factors for tasks using neutral and affective stimuli. Curved paths connecting observed variables represent correlated error terms and curved paths between constructs represent correlations between the constructs



The causes and solutions for Heywood Cases are still debated in the statistical literature. Some of these will be explored here in order to determine if this model may nonetheless be admissible. Early work into this issue noted that under-identified models (Rindskopf, 1984) highly non-normal data, and extreme outliers (Bollen, 1987) can give rise to Heywood solutions. Under-identification and non-normal distributions can be likely be ruled out as 1) the model is over-identified and 2) an examination of the skewness and kurtosis values in Table 2 suggests only moderate deviations from normality.

To examine the role of outliers in this solution, participants who were more than 3 standard deviations from the mean on any attention task were removed from the analysis and

CFA 3 was recomputed. This resulted in an even greater correlation between the neutral and affective factors (r = 1.06). However, only 8 participants (4%) met this criterion and were removed from this analysis. A second, more conservative, analysis was conducted in which participants scoring greater than 2 standard deviations from the mean on any attention task were removed. This resulted in 39 participants (19.5%) being removed from the dataset. Removing these participants also resulted in a larger correlation between the neutral and affective factors (r = 1.06). Thus, it appears that this correlation cannot be attributed to outlying data-points. Given that 1) these participants do not seem to have a large impact on the CFA results[1], 2) these values, while far the mean, are possible scores and that several deviant scores are to be expected in a sample this large and 3) removing these participants would reduce the sample size considerably, these participants were retained for all subsequent analyses.

A number of other simulation studies (Van Driel 1978, Dillon, Kumar & Mulani 1987, Sato 1987, Bollen 1989, Kolenikov & Bollen 2012) have found that configurally misspecified models – that is, models containing the wrong number of factors or the wrong factor-to-indicator correspondences – can also produce Heywood solutions. It is not possible to definitely demonstrate that this is the case. However, the solution produced by this model is clearly artifactual and, should be ruled out.

Given the marginal fit of CFA 1 and the deficiencies of CFAs 2 and 3, the structure of the attention tasks was further examined by submitting these variables to an exploratory factor analysis (principal axis factoring with promax rotation). This analysis produced a fairly clear two factor solution; the loadings are shown in Table 5. The first factor consisted of tasks in which the distracting stimulus abruptly appeared prior to the target (hereafter referred to as "dynamic"

[1] CFA 4 (see below) was also analyzed with this reduced dataset. As with the primary analyses, all fit indices indicated good fit ($\chi^2(15) = 23.23$, $p = .08$; $\chi^2/df = 1.55$; SRMR = .03; RMSEA = .06; NFI = .96; TLI = .97; CFI = .98; PClose = .34; AIC = -6.77).

tasks). The second factor consisted of the tasks including more static displays (referred to as "static" tasks). The factors were highly correlated (*r* = .59).

Table 5.

Factor Loadings for the Exploratory Factor Analysis

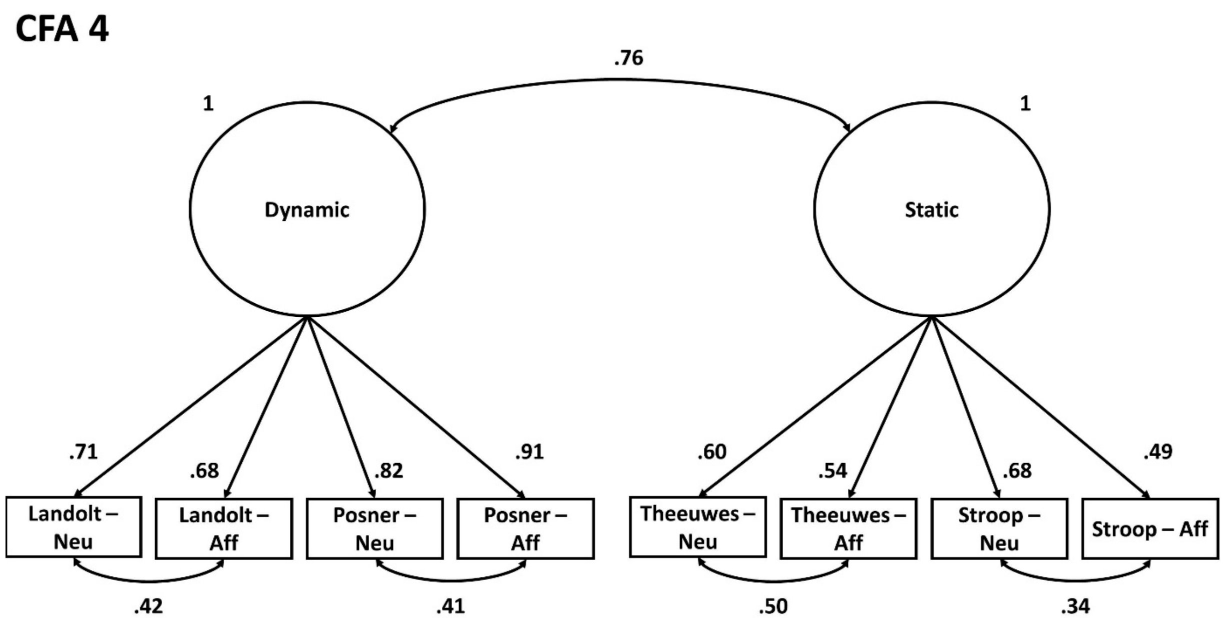
Task	Factor 1 Loading	Factor 2 Loading
Posner – Neutral	**.84**	-.06
Posner – Affective	**.80**	-.03
Landolt – Neutral	**.79**	.07
Landolt – Affective	**.83**	.02
Theeuwes – Neutral	-.09	**.75**
Theeuwes – Affective	-.01	**.83**
Stroop – Neutral	.07	**.54**
Stroop – Affective	.14	**.44**

Note. The primary loading for each variable is presented in bold.

To more stringently evaluate the model implied by the EFA, this model was submitted to a CFA. This model included two correlated factors corresponding to dynamic and static tasks (see Figure 12). All loadings and correlations were significant (*ps* < .05) and, as shown in Table 4 (CFA 4), all fit indices indicated strong fit. When directly compared with the preceding models, CFA 4 provided significantly better fit than CFA 1 ($\chi^2(1)$ difference = 13.78, $p < .001$) and CFA 2 ($\chi^2(1)$ difference = 239.01, $p < .001$). CFAs 3 and 4 could not be directly compared as they have the same degrees of freedom; however, as noted in the preceding section, CFA 3 appears to from serious configural misspecifications and should be rejected.

Figure 12.

A confirmatory factor analysis consisting of two factors: dynamic distracter tasks and static distracter tasks. Curved paths connecting observed variables represent correlated error terms and curved paths between constructs represent correlations between the constructs



The Role of using Raw RTs. In all preceding analyses, raw RTs were used rather than difference scores (e.g. RTs of Theeuwes Distracter present trials were used rather than Distracter Present – No Distracter difference scores). This was done due to the low reliabilities of the difference scores. However, given that raw RTs were used in the preceding CFAs, one could argue that these factors represent more general processing speed instead of attentional control. Several steps were taken to guard against this possibility. First, I conducted an additional CFA in which RTs were residualized for perceptual/motor speed. To do this, a series of regression analyses were conducted in which RTs were predicted using measures of perceptual/motor speed. The residuals from this analysis were then entered into a CFA. The details of this analysis can be found in Appendix B. In short, this analysis also found that CFA 4 fit the data well. It should also be noted that a general speed account of these findings would predict a single factor solution. Instead, the best fitting model included two factors.

Even if these findings cannot be accounted for by general speed, the fact that neutral and affective tasks loaded together may still present a problem. That is, even in the affective tasks, it is likely stimulus salience played a role (e.g. the angry face in the Affective Landolt was still an abruptly onsetting stimulus). Thus it is possible that these tasks loaded together due to physical salience and not because of some commonality between NAB and attentional capture. To attempt to guard against this possibility, CFAs 1-4 were reevaluated using disattenuated correlations for the difference scores. That is, the correlations between the difference scores were corrected for unreliability. These analyses are presented in Appendix C. In short, CFA 4 again provided the best fit for the data. Thus, it does not seem that the present findings can be attributed to the use of raw RTs rather than difference scores.

The Roles of Anxiety, WMC and Perceptual/Motor Speed

The confirmatory factors analyses revealed that performance on these attention tasks can be described in terms of two underlying factors defined by the properties of the distracter: static and dynamic distracters. While clearly distinct, these factors were highly correlated and shared approximately 58% of their variance (CFA 4). The next set of analyses sought to examine the interrelationships between anxiety, WMC, Perceptual/Motor Speed and attentional performance.

Before examining whether anxiety predicts performance in the attention tasks, I first conducted a series of analysis to determine if the factor structure of CFA 4 was invariant across levels of anxiety. Measurement invariance refers to whether scores from a construct have the same meaning in different groups (Meade & Lautenschlager, 2004). These analyses are presented in detail in Appendix D. In short, all analyses indicated that this factor structure was invariant across levels of anxiety. That is, these tasks appear to be measuring the same constructs in high- and low-anxious individuals.

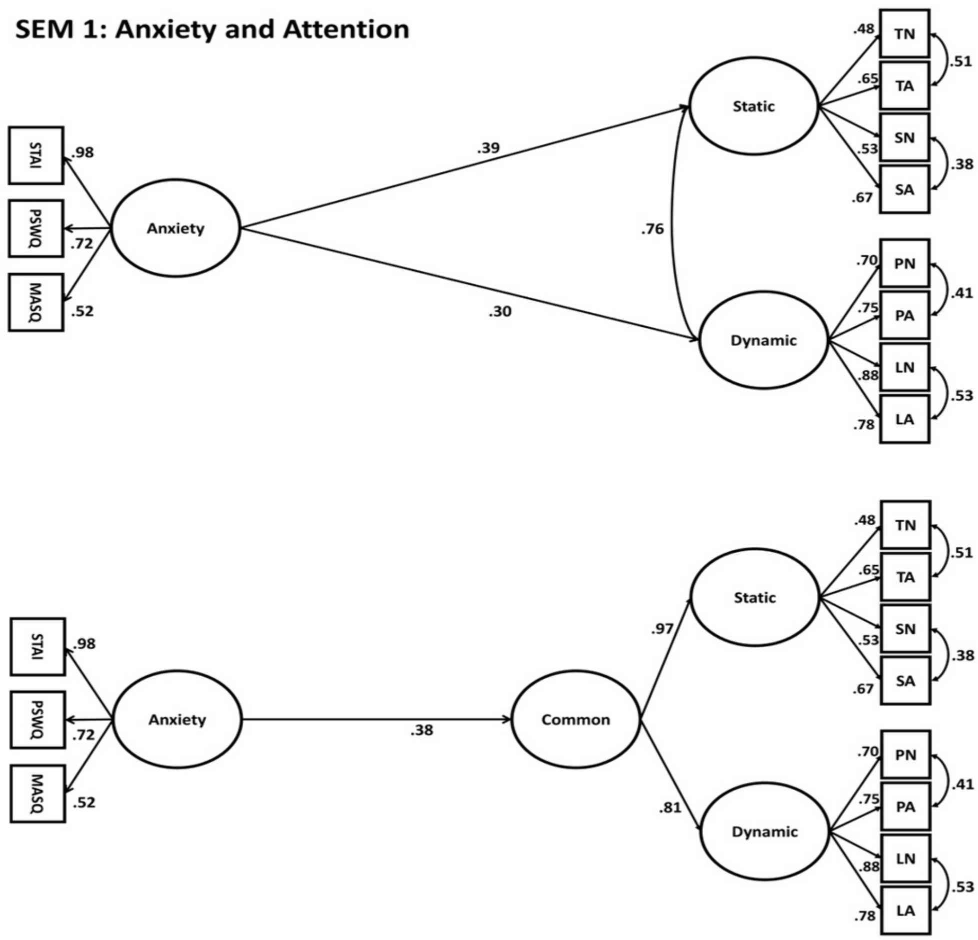
The roles of anxiety, WMC and Perceptual/Motor Speed in predicting attentional task performance was evaluated via structural equation modelling. As with the CFAs, circles represent latent variables and rectangles represent observed variables. Straight paths leading between variables depict path coefficients which, like semipartial correlations, can be interpreted as the correlation between the predictor and outcome controlling for the contribution of other predictors.

Anxiety and Attention. The first analysis aimed to determine the “type” of attention with which anxiety is most closely coupled. First, an Anxiety factor was defined as the shared variance between the three anxiety self-reports (i.e. the STAI, the PSWQ and the MASQ). Then, the Anxiety factor was used to predict the attention factors. This analysis is depicted in the top of Figure 13. Anxiety significantly predicted both attention factors ($ps < .05$).

A second analysis was conducted in order to determine the independence of these effects – that is, does anxiety predict variance that is unique to these factors or the variance that is shared between them? To test this, the common variance was extracted as a second-order factor (labelled “Common” in the bottom of Figure 13). In this analysis, the Common factor represents the variance that is shared between the dynamic and static factors; the dynamic and static factors, on the other hand, represent the variance that is unique to those factors. As shown in the bottom of Figure 13, anxiety significantly predicted the Common factor ($p < .01$). Importantly, if anxiety is allowed to predict the dynamic and static factors, these coefficients are small and non-

Figure 13.

A structural equation model relating anxiety to attentional control. All paths are significant (ps < .05). Curved paths connecting observed variables represent correlated error terms. The paths connecting latent variables are standardized path coefficients linking these constructs. Key: TN = Theeuwes – Neutral; TA = Theeuwes – Affective; SN = Stroop – Neutral; SA = Stroop – Affective; PN = Posner – Neutral; PA = Posner – Affective; LN = Landolt – Neutral; LA = Landolt – Affective; STAI = State-Trait Anxiety Inventory; PSWQ = Penn State Worry Questionnaire; MASQ = Mood and Anxiety Symptom Questionnaire; Common = Variance that is shared between Static and Dynamic distracter tasks



significant (≤ .1, *ps* > .2). The fit statistics for this model also indicated good fit (SEM 1 in Table 4). These results suggest that anxiety predicts attentional performance at a fairly high level rather than at the level of task-specific processes.

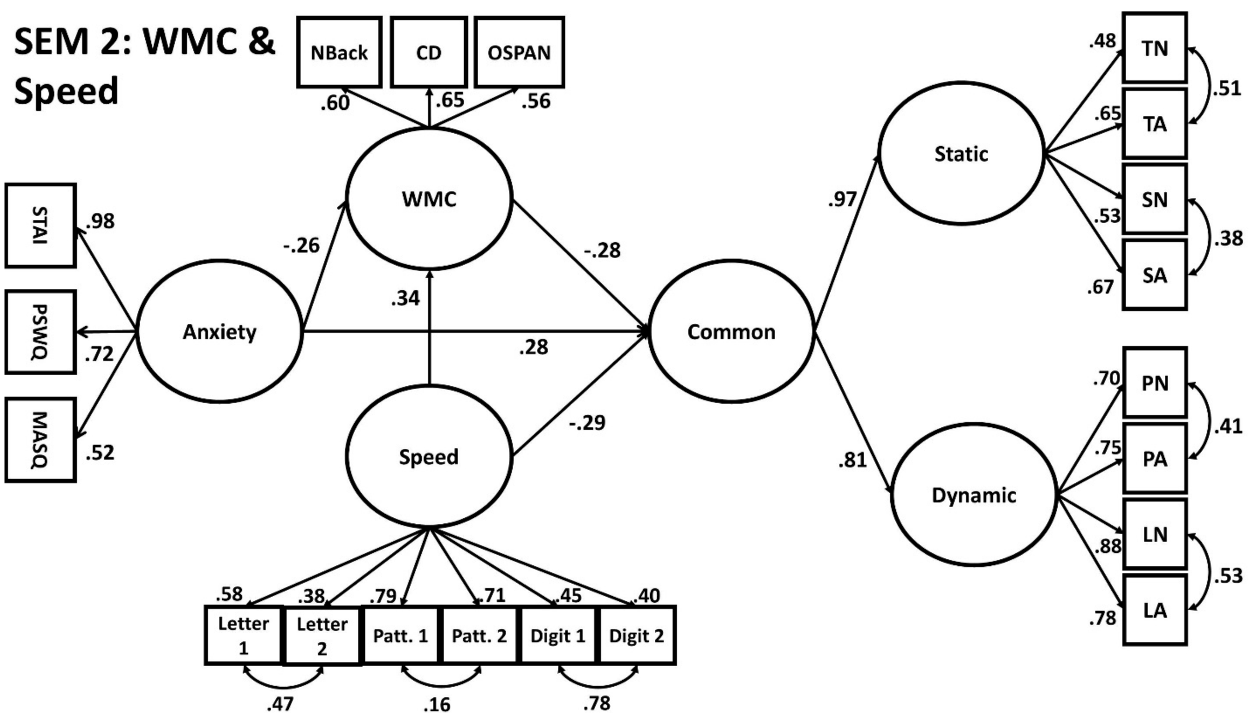
WMC and Perceptual/Motor Speed. The next set of analyses aimed to examine the roles of WMC and Perceptual/Motor Speed. The WMC factor consisted of the OSPAN, the change detection task and the N-Back. Similarly, the Perceptual/Motor Speed factor consisted of the two pages of the Digit Copying task (Digit 1 and Digit 2), the Letter Comparison task (Letter 1 and Letter 2) and the Pattern Comparison task (Patt. 1 and Patt. 2). Additionally, because the stimuli and task requirements were identical across pages of a task (e.g. Digit 1 and Digit 2), error terms for matched pairs were allowed to correlate. This model is depicted in Figure 14.

The model provided a good fit (see Table 4); all path coefficients depicted in Figure 14 were significant (*ps* < .05) as were the loadings (*ps* < .001). The NFI was somewhat low (.92) but still acceptable and all other indices were strong. Importantly, there was a moderate, significant effect of anxiety on attention such that anxiety predicted greater distraction. In addition to its direct effect on attention scores, anxiety appears to indirectly affect attention via WMC. When the direct and indirect effects are combined, the total effect is 0.38 (see Figure 13). The direct effect of anxiety, when WMC is accounted for, is only .28. It should be noted, however, that these data indicate that anxiety's relationship with measures of attention cannot be completely attributed to deficits in WMC. While anxiety was associated with decreased WMC, both anxiety and WMC made independent contributions to performance on attention tasks.

As with the preceding CFAs, the use of Raw RTs on distracters trials, rather than difference scores, leaves open the possibility that anxiety actually predicted slower RTs in a more general level. However, this possibility seems unlikely for two reasons. First, Anxiety was

Figure 14.

Structural equation model relating Anxiety, Perceptual/Motor Speed, WMC, and Attentional Control. All paths are significant (ps < .05). Curved paths connecting observed variables represent correlated error terms. The paths connecting latent variables are standardized path coefficients linking these constructs. Key: TN = Theeuwes – Neutral; TA = Theeuwes – Affective; SN = Stroop – Neutral; SA = Stroop – Affective; PN = Posner – Neutral; PA = Posner – Affective; LN = Landolt – Neutral; LA = Landolt – Affective; CD = Change Detection; Letter = Letter Comparison; Patt. = Pattern Comparison; Digit = Digit Copying; Common = Variance that is shared between Static and Dynamic distracter tasks



unrelated to general Perceptual/Motor Speed (*p* > .05; see Figure 14) and anxiety and speed both predicted attentional performance. This indicates that anxiety and speed are accounting for independent variance. Second, an additional SEM was conducted in which the Anxiety factor predicted performance on No-Distracter trials. This analysis can be found in Appendix E. In short, the paths leading from anxiety to the No-Distracter trials were non-significant (*ps* > .2). This is consistent with a large body of research finding that anxiety predicts performance on trials in which the need for attentional control is high (e.g. Ansari et al, 2008; Derakshan et al, 2009; Fox et al 2001; Moran & Moser; 2015 Moser et al, 2012; see Eysenck et al, 2007 for a review) and suggests that anxiety's effects on attentional capture cannot be accounted for by decrements in general Perceptual/Motor Speed.

CHAPTER FOUR

Discussion

The current study aimed to address three main questions. First, is "attentional control" in the face of distraction – whether the distracter is neutral or affective – a unitary construct? Second, does anxiety relate to attentional control at a general level or does it predict performance in specific types of tasks. Finally, can anxiety's relationship with attentional control be more parsimoniously explained by deficits in general cognitive abilities such as WMC and Perceptual/Motor Speed?

To address these questions, 200 undergraduates completed measures of attentional capture by salient distracters, attentional capture by negative/threatening stimuli, working memory capacity, perceptual/motor speed and anxiety. Then a series of confirmatory factor analyses and structural equation models were used to examine attentional capture and its relationship to other variables. The confirmatory factor analyses found that performance on the attention tasks is best explained by two underlying factors – dynamic tasks and static tasks – which, while separable, shared roughly 58% of their variance. This latter finding suggests that these tasks primarily measure a domain-general ability to resist distraction but that a substantial minority of the variance relates to more task-specific abilities. With respect to anxiety, this study found that 1) anxiety was most closely coupled with the more domain-general variance shared by both types of tasks. When the common variance was extracted, anxiety no longer predicted the dynamic or static factors. 2) The relationship between anxiety and attentional capture could not be completely accounted for by WMC and Perceptual/Motor Speed, instead a robust relationship between anxiety and attention capture remained when accounting for general cognitive abilities.

The Generality of Attentional Control

The "Common" Attention Factor. One of the primary questions of the current study concerned the structure of tasks measuring attentional capture and NAB – that is, can negative/threatening stimuli capture attention like physically salient stimuli? The answer appears to be a qualified yes. The answer seems to be "yes" because 1) there was no clear differentiation between tasks using neutral and affective material. CFAs 2 and 3 explicitly tested the seperability of these tasks. CFA 2 provided extremely poor fit and was the worst-fitting model of any tested in this study. CFA 3, while providing marginally acceptable fit, resulted in an inadmissible solution. This solution could not be attributed to either non-normal data or outlying data points suggesting that CFA 3 was configurally misspecified. Additionally, the best fitting model involved negative and neutral stimuli loading on the same factors – that is, dynamic distracter tasks loaded together regardless of valence as did static distracter tasks. This is qualified, however, because CFA 1 – the single factor model – provided only marginal fit. The best-fitting model included two highly correlated factors suggesting some degree of domain-specificity.

The best fitting model included two factors which shared roughly 58% of their variance. A likely candidate explanation for this shared variance is what Posner, Engle and colleagues have termed "executive" attention (Engle, 2002; Engle et al, 1999a,b; Posner & Peterson, 1990; Peterson & Posner, 2012). This refers to the ability to maintain contextual information (e.g. relevant stimuli, task goals etc.) in a readily accessible state and to suppress irrelevant distractions or erroneous responses (see also Dempster, 1991; 1992; Hasher & Zacks, 1988; Zacks & Hasher, 1994). Executive attention is typically assumed to be necessary in tasks where an irrelevant distracter must be suppressed or an incompatible response must be inhibited. Performance in these tasks seems to be, at least partially, determined by the ability to maintain goals and resistant interference regardless of whether this interference comes in the form of negative/threatening stimuli, abrupt onsets, static distracters or mutually exclusive responses. This interpretation is bolstered by the fact that WMC contributed significant variance to the Common attention factor. Previous research suggests that available WMC is necessary to successfully constrain attention to relevant information. For example, Lavie and de Fockert (2005) examined Theeuwes' singleton search performance under high and low WM load. Despite that fact that the stimuli and task demands were quite different across the WM load task and visual search task, RTs on distracter-present trials increased under the high WM load condition. Given that anxiety predicted this Common factor, this interpretation would also be consistent with Eysenck and colleagues' proposal that anxiety should "…impair the functioning of the inhibition function…" (Eysenck & Derakshan, 2011, p. 956) as well as empirical findings indicating that anxiety predicts increased interference from distracters but does not affect perceptual/motor speed (see Eysenck et al, 2007 for a review).

However, it should also be noted that 1) roughly 42% of the variance in dynamic and static tasks was unshared and 2) WMC was not the only significant predictor of the Common attention factor. Perceptual/Motor Speed also made significant contributions. The meaning of these findings as well as the interpretation of the Common factor will be returned to throughout the Discussion.

The Dynamic vs Static Distinction. The particular division observed in the attention tasks (i.e. dynamic vs static) is somewhat surprising. Theeuwes (e.g. Theeuwes, 2010) has long argued that both abrupt onsets and static, but salient, stimuli capture attention and that both of these types of capture rely on the same preattentive analysis. Specifically, this preattentive analysis computes local feature differences but does not have access to the dimension from which the feature difference originates (e.g. color, luminance etc.). Attention is assumed to then shift to the location with the largest feature difference (i.e. salience) regardless of the dimension from which the difference originated. The present results are highly consistent with the first assumption – that both static and dynamic stimuli are capable of capturing attention. It is worth noting that, in some cases, the capture effect was quite small. For example, the raw capture effect for the Landolt Cueing task was only M = 7.4 ms. However, 1) the standardized effect size was quite reasonable (*Cohen's d* = .38) and the effect was highly significant (p = .0000002) and 2) none of the tasks failed to find evidence of attentional capture suggesting that both types of stimuli are capable of reliably capturing attention.

With respect to the second assumption, the present results provide less support. Indeed, these results indicate that separate, albeit related, mechanisms are involved in the performance of these types of tasks. This finding may be best understood within Posner and Peterson's taxonomy of attentional networks (Posner & Peterson, 1990; Peterson & Posner, 2012). Posner and Peterson propose that performance on attention tasks involves at least three functionally and anatomically distinct networks: alerting, orienting and executive attention. Alerting refers to achieving and maintaining an alert state – i.e. a high state of sensitivity to incoming stimuli – and seems to involve the activation of thalamic regions as well as right frontal and parietal regions (Fan et al. 2005). Alerting is typically manipulated by using a warning signal that indicates that a stimulus is forthcoming but does not provide information regarding the location of the target. Orienting involves aligning attention with the source of incoming stimuli – either overtly or covertly – and involves the superior parietal lobe, temporal parietal junction and the frontal eye fields (Corbetta & Shulman, 2002). Orienting is typically manipulated by presenting a "cue" stimulus which may indicate where in space a target will occur (Posner, 1980). When the target appears in an invalidly cued location, attention must be disengaged from the cued location and reoriented to the target location; this process appears to involve activation of the temporal parietal junction (Corbetta & Shulman, 2002). Executive attention involves resisting or resolving interference from competing stimuli. Executive attention is usually studied in tasks involving competition between mutually exclusive responses such as the Stroop task or the attention network task (a variant of the Flanker task). These tasks tend to activate frontal regions such as the anterior cingulate cortex and lateral prefrontal cortex (Botvinick et al. 2001, Fan et al. 2005). The tasks used in the current study likely differed in the extent to which they relied on these three networks.

The alerting network seems the least likely to have influenced the pattern of results obtained in the current study. As noted earlier, alerting is typically modulated by presenting a warning signal which increases preparedness in a fairly general way. No such signals were presented in these tasks and ITIs were varied randomly from trial to trial. One could argue that some degree of temporal preparedness was unavoidable insofar as the ITIs were constrained to be within a given range. That is, as the ITI duration increased on a given trial, the likelihood of the stimulus being presented soon increased. This is likely true (Walter et al, 1964); however, this would be true of all attention tasks used in this study and thus does not provide an adequate explanation for the two factor model.

Orienting and disengagement may have played a role in separating dynamic and static tasks. The Posner and Landolt tasks used in the present study are very similar to the canonical tasks used to examine orienting and disengagement. That is, these tasks involved 1) an abruptly onsetting stimulus which appeared prior to the target stimulus and 2) disengaging attention from the location of the abrupt onset when the target occurred elsewhere in the display. This would also be consistent with some theories of NAB which propose that the slowed RTs observed in response to threatening stimulus result from slowed attentional disengagement (e.g. Fox et al, 1993; 2001; 2005). However, it should be noted that the static tasks likely involved some degree of orienting/disengagement as well. For example, Hickey et al (2006) examined the N2pc, an ERP component which is largest at electrodes that are contralateral to the attended location, during performance of the Theeuwes task. This study found an N2pc elicited at electrodes contralateral to the distracter followed by and N2pc elicited at locations contralateral to the target. This finding suggests that attention was initially oriented to the distracter location before being disengaged and reoriented to the target location. Although the extent to which individual differences in this task reflect disengagement from the distracter rather than some other processes – e.g. resisting initial capture – is currently unclear (e.g. see Fukuda & Luck, 2011).

Differences in executive attention would seem to be another candidate for explaining the factor structure found in the current study. As noted above, executive attention is typically defined as the ability to resist or resolve interference (Posner & Peterson, 1990; Peterson & Posner, 2012). The Stroop is among the most commonly-used tasks for examining executive attention insofar as it requires participants to resolve the competition between mutually exclusive responses. Additionally, the Theeuwes task involves the simultaneous presentation of a goal-relevant target and an irrelevant, but salient, distracter. Successful performance of this task requires participants to suppress the distracter in service of locating the target (Theeuwes, 2010). Importantly, competition between targets and distracters is greatest when they are presented simultaneously (Desimone & Duncan, 1995). For example, Mathot et al (2010) found that distracter effects were greatly reduced when the distracter was presented 50-75 ms prior to the target and Theeuwes and colleagues (2000) found that distracter effects were eliminated when targets and distracters were offset by 150 ms. While it is likely that the Posner and Landolt tasks involved some degree of competition and executive network involvement (i.e. the time between distracter and target onset was less than 150 ms and performance in both tasks was predicted by measures of WMC), it is nonetheless possible that the cueing design used in the Posner and Landolt tasks reduced the extent to which these tasks involved the executive attention network.

Within this view, the fact that the Stroop tasks and the Theeuwes tasks factored together may initially seem problematic. While no task is completely “process-pure”, there would seem to be at least two different processes that contribute to Stroop and Theeuwes performance. The Stroop task involves some degree of response competition. That is, on incongruent trials the word and the color conflict thereby activating mutually exclusive responses. The Theeuwes task, on the other hand, is a compound search task (Duncan, 1985) in which participants search for one aspect of the target stimulus (i.e. shape) while responding to another aspect of the stimulus (i.e. the orientation of the target line). Importantly, the lines contained within the non-targets were never horizontal or vertical meaning that they were not associated with a response. This minimizes the extent to which response competition could have played a role in the Theeuwes task. Instead, the Theeuwes task involves inhibiting interference from distractors rather than responses. With this in mind, one might wonder why these tasks formed a factor in the current study.

One explanation may be found in the work of Friedman and Miyake (2004). In this study, the authors examined the interrelationships between measures of response competition, measures of distracter interference (i.e. tasks involving resisting or resolving interference from external distracters) and measures of proactive interference (i.e. task in which previously relevant information may intrude from memory). This study found that response competition tasks and distracter interference tasks were highly correlated but neither correlated with proactive interference tasks. These findings may imply some general ability to resolve interference or possibly the ability to maintain task goals in the face of interference – regardless of whether the interference comes in the form of distracting stimuli or incompatible responses. Thus, the fact that the Stroop and Theeuwes tasks factored together may be reflective of the shared variance between inhibiting distracters and inhibiting responses.

It is likely that these tasks all involved orienting/disengagement and executive attention at least to some degree. Fan et al (2002), using the attention network task, found that alerting, orienting and executive attention were uncorrelated ($|rs| < .2$, $ps > .2$). However, in the present study, the dynamic and static factors were highly correlated and all eight attention tasks were significantly correlated ($rs \geq .27$) suggesting a greater degree of interdependence than previously reported. Of course, it cannot be ruled out that the small correlations reported by Fan et al (2002) were the result of unreliability. However, if this is the case, one would still conclude that these networks interact to a greater degree than Fan et al (2002) suggests. Thus, these tasks were likely not differentiated based on *which* network(s) they activated but, rather, *the degree to which* each network was activated.

This raises the possibility of an alternative explanation for the fact that these factors correlated so highly. Earlier, this common variance was interpreted as representing some domain general attentional control ability. While possible, it is also possible that this factor may actually represent an amalgam of processes that were shared by each of the tasks. That is, if all tasks involved orienting/disengagement, executive attention and perceptual/motor speed, at least to some extent, then the second order factor may actually represent variance related to all of these processes. Indeed, the fact that both WMC and Perceptual/Motor Speed predicted separate variance in the Common factor could be interpreted as consistent with this explanation. Unfortunately, it is not possible to adjudicate these explanations at the present time.

Bottom-up vs Contingent Capture. The degree to which attentional capture is contingent on attentional control settings has become highly debated topics over the last two decades. Theeuwes (1991; 1992; 2010) has long argued that the most salient item in a visual display will automatically capture attention regardless of the participant's intentions. Folk and Remington (Folk et al,1992; Folk et al, 1994; Pratt et al, 2001), however have argued that capture is contingent on the participant's attentional set. That is, an irrelevant distracter will capture attention if it is defined by the same features that define the target. While the present findings cannot settle this question, they can help to explain some of the discrepant results. First, as will be explained below, the current results suggest that some studies demonstrating contingent capture may have been underpowered. Second, the factor structure of the present study implies that those who propose that capture is contingent and those who propose that capture is driven in a bottom-up fashion have been describing partially distinct phenomena.

Contingent capture is typically studied in tasks that are similar to the Landolt C task used in the current study. In these tasks, participants must identify a target that appears in one of several boxes. Prior to target onset, a cue abruptly appears and disappears near one of the boxes. Given that the distracter in the Landolt C task never cued the correct box and never appeared in target color, a contingent capture account would predict that this task should not produce capture effects. However, the distractor effect, while small (M = 7.4 ms; *Cohen's d* = .38), was significant (p = .0000002). This finding would seem inconsistent with theories that posit that capture is entirely contingent on the similarity of the distracter and target features. However, the magnitude of this effect may account for why previous contingent capture studies have failed to find an effect – that is, a possible explanation for this discrepancy is statistical power. Roughly 57 participants are required to achieve a reasonable amount of power (≥ .8) for this effect size. In their original study on contingent capture, Folk et al (1992) included no more than 24 participants in any one task (achieved power ≤ .43). To the best of the author's knowledge, all other studies on the topic have been similarly underpowered. Note that this is not to say that capture *cannot* be contingent. Numerous studies demonstrate that selective attention, even attentional capture, can be influenced in a top-down way – e.g. by the contents of WM (e.g. Downing, 2000; Farah, 1985; Olivers et al, 2006; Pashler & Shiu, 1999; Soto et al, 2005). Rather, it may be that previous failures to find bottom-up capture using these tasks may have been underpowered given the relatively small effects.

Second, these findings suggest that much of the work on contingent capture and bottom-up capture refer to distinct phenomena. Studies demonstrating contingent capture have tended to use exogenous cueing paradigms in which an abrupt onset distracter precedes the target (e.g. Folk et al, 1992; Folk et al, 1994). Theeuwes' demonstrations of bottom-up capture, on the other hand, have involved a color-defined distracter presented concurrently with the target. The extant literature has tended to treat "attentional capture" as a unitary construct and has assumed that these manipulations affect the same mechanisms. The present findings imply that static and dynamic distracters cannot be used interchangeably. It is possible that orienting/disengagement is more contingent on top-down attention settings. Or perhaps, as Theeuwes (2010) claims, competition effects only emerge when the target and distract co-occur in time and contingent capture designs reduce competition. In any case, the present study suggests that findings from one design cannot necessarily be applied to studies using the other design without qualification.

The Overlap between Attentional Capture and NAB. The current study found no clear evidence for a distinction between attentional capture by physical salience and the negative attention bias. That is, neutral and affective versions of the same tasks loaded on the same factors and models that separated neutral and affective tasks provided the worst fit of any models tested in the current study. A possible explanation may be found in the literature on emotion and attention.

Broadly speaking, three classes of theories have emerged regarding the relationship between emotion and attention: categorical negativity theories (e.g. Pratto & John, 1991), evolutionary threat theories (e.g. Öhman et al, 2001), and arousal theories (e.g. Bradley et al, 2001; Lang, 1995). Categorical negativity theories propose that organisms constantly, and automatically, scan their environments for potential threats. Incoming stimuli are very coarsely evaluated along a "valence" (i.e. positive/negative) dimension. All incoming stimuli that are tagged as negative receive immediate attention. Positive stimuli do not attract attention as the immediate detection of positive stimuli is assumed to be less critical for survival. Evolutionary threat theories posit similar mechanisms as categorical negative theories – i.e. incoming stimuli are quickly tagged as "threats" and "non-threats" and the stimuli which were tagged as threats receive attention. However, these theories posit that the evaluator can only recognize stimuli which signaled a threat to survival during the evolutionary history of the organism (e.g. snakes and spiders should be tagged as threats but a gun might go undetected). These two theories have proven to be somewhat problematic from an empirical point of view. For example, a meta-analysis conducted by Bar-Haim and colleagues (2007) found that negative/threatening stimuli did not attract attention in non-anxious individuals thereby contradicting categorical negative theories. This may not be a problem for evolutionary threat theories as Bar-Haim et al (2007) averaged across many types of stimuli. However, several studies have failed to find that evolutionary threats attract attention (e.g. Constantine et al, 2001; Kindt & Brosschot, 1997; Thorpe & Salkovskis, 1998; Kindt & Brosschot, 1999; Lavy et al, 1993; Merckelbach et al, 1993).

Arousal theories posit that emotion is organized into a two-dimensional “emotion space”. Like previous theories, arousal theories posit a biphasic organization wherein stimuli are evaluated along a valence (i.e. appetitive vs aversive) dimension. Unlike the previous theories, arousal theories propose that emotions also vary along an arousal dimension which indexes the degree of activation of the appetitive and aversive systems (metabolically, neuronally, etc.). For example, a picture of a sunset may activate the appetitive system but may not be very arousing whereas an image of a large spider may activate the aversive system and may be very arousing (i.e. it activates the aversive system to a greater degree). Along these lines, Vogt and colleagues (2008) required participants to complete a spatial cueing paradigm in which the cues consisted of images that varied along both the valence and arousal dimensions. This study found that RTs were significantly slower for high-arousal images. Similarly, Schimack (2005) required participants to ignore affective images while completing a non-emotional primary task. Response times were slowest when the task was paired with a highly arousing image.

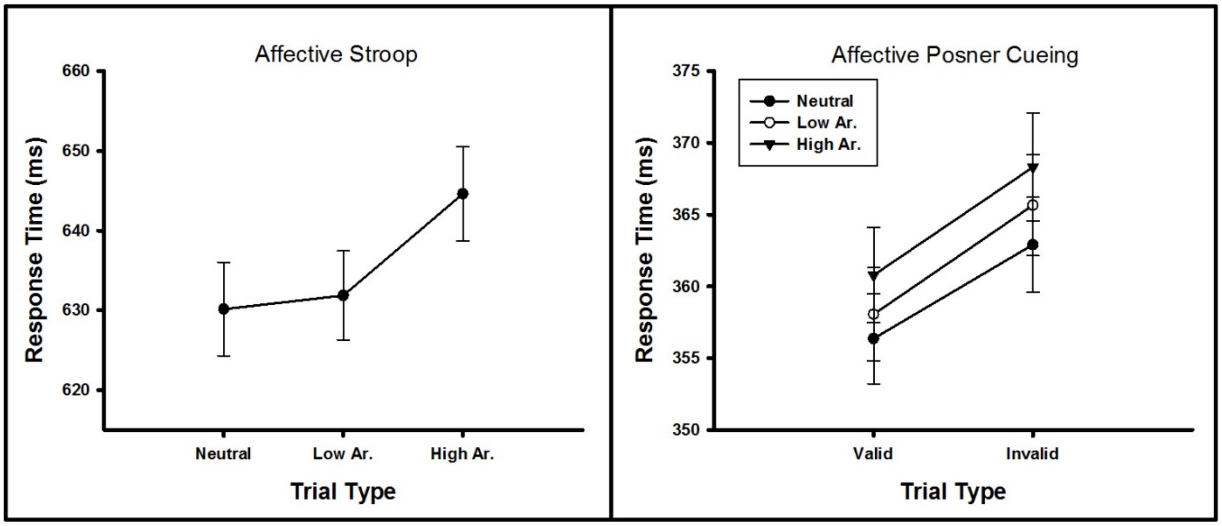
One possibility is that the ability of negative stimuli to capture attention is dependent on that stimulus’ arousal – the extent to which it activates the aversive system (Bradley et al, 2001). It may be that the stimuli in the current study were sufficiently arousing to capture attention to some degree (although stimulus salience almost certainly played a role as well as even the affective stimuli consisted of abrupt onsets and colors). Vogt et al (2008) reported that the mean subjective arousal rating for the negative/high-arousal images used in their study was $M = 6.84$

(out of 9). This is quite close to the mean arousal ratings for the negative words used in the Affective Stroop and Posner Cueing tasks used in the current study (*M* = 6.77 and *M* = 6.52, respectively)[2]. To explore this issue further, the negative words for the Stroop and Posner tasks were divided into high-arousal and low-arousal words based on a median split of the normative arousal ratings. For the Stroop, RTs were submitted to a single factor (Word Type: Neutral, Negative/Low-Arousal, Negative/High-Arousal) repeated measures ANOVA. The ANOVA was significant ($F(2, 398) = 8.44$, $p < .001$); an examination of the left panel of Figure 15 suggests that this was primarily due to high-arousal words. RTs from the Affective Posner were submitted to a 2(Cue Validity: Valid, Invalid) x 3(Word Type: Neutral, Negative/Low-Arousal, Negative/High-Arousal) repeated measures ANOVA. There was a main effect of validity ($F(1, 199) = 11.97$, $p = .001$) and a main effect of word type ($F(1, 199) = 3.74$, $p = .03$). As with the Stroop, the slowest RTs were observed on high-arousal trials (Figure 15, right panel). One can only speculate as to why a Validity x Word Type interaction was absent in the Affective Posner Cueing Task ($p = .9$). Fox and colleagues (1993; 2001; 2005) propose that increased RTs in affective cueing tasks actually stem from slower disengagement of attention from threat and not automatic orienting Perhaps participants required longer to disengage from representations of negative cues stored in memory than from representations of neutral stimuli. Alternately, Corbetta et al (Corbetta & Shulman, 2002; Corbetta et al, 2008; also see Mogg & Bradley, 1998) propose that a potentially relevant stimulus can elicited a fairly global interrupt signal that preempts ongoing processing. Perhaps the most arousing words were capable of interrupting task performance regardless of spatial location. The current dataset is not well-suited for explaining this lack of an interaction.

[2] The face stimuli for the Affective Theeuwes and Affective Landolt tasks could not be compared as the author is aware of no normative ratings for schematic faces.

Figure 15.

Left Panel: RTs from the Affective Stroop as a function of the type of word. Right Panel: RTs from the Affective Posner Cueing Task as a function of cue validity and word type



The Roles of Anxiety, WMC and Perceptual/Motor Speed

Attentional Control Theory. The findings related to WMC can only offer partial support for Eysenck and colleague's attentional control theory (Eysenck et al, 2007). As noted earlier, ACT attempts to parsimoniously account for the relationship between anxiety and cognition by proposing that anxiety influences fairly domain-general processes. That is, ACT proposes that worry is 1) an attentionally demanding activity (Paulesu et al, 2009) and that it 2) captures attention insofar as it is considered to be a form of internally-generated threat. Given that the control of attention in the face of distraction is known to be reliant on available WMC (Lavie, 2005; Lavie et al, 2004), Eysenck and colleagues attribute anxiety-related distractibility to reduced WMC.

To some extent, the current results are consistent with ACT. For example, anxiety was found to predict impaired WMC and the relationship between anxiety and attention does not seem to be reducible to speed alone. Additionally, a comparison of Figure 13 with Figure 14 reveals some support for the notion that anxiety predicts performance on attention tasks via reduced WMC. As shown in Figure 13, Anxiety scores account for approximately 14% of the variance in attention scores when considered in isolation. When WMC is included in the model (Figure 14), Anxiety only accounts for 8% of this variance. Thus, some of the effects of anxiety do appear to be mediated by WMC. However, it is also clear from Figure 14 that this relationship cannot be completely reduced to WMC as anxiety continued to predict significant variance in attentional performance even when WMC was accounted for. There would seem to be several possibilities to consider.

First, it is possible that problems of measurement can account for this lack of total mediation. WMC was measured using the OSPAN, change detection and N-Back tasks. This decision was made in order to maximize content validity. That is, these tasks were chosen in order to help ensure that all, or most, facets of working memory were represented in the current study. However, this may have come at the cost of an incoherent and difficult to interpret WMC factor. While it is generally assumed that WMC tasks measure the same underlying WM system (Shackman et al, 2006; Vytal et al, 2012; 2013; Robinson et al, 2013), mounting evidence suggests that this is not the case. For example, a recent meta-analysis found that performance on the OSPAN and N-Back was only weakly correlated (r = .2; Redick & Lindsey, 2013). Similarly, Kane and colleagues (2007) found that the OSPAN and N-Back predicted unique variance in fluid intelligence. With respect to the change detection task, less psychometric data are available. However, Snellenberg et al (2014) found the OSPAN and change detection tasks loaded on separate factors. Thus, it is not completely clear what the shared variance between these WM tasks represents and this combination of tasks may be poor indicators of the facets of WMC most relevant to anxiety-related attentional control deficits. It is possible that a set of tasks that were more precisely tailored to assess attentional control aspects of WMC would have yielded more support for the predictions of ACT.

However, it is also possible that WMC would not mediate this association even if measured in a more focused manner. For example, Moran (under review) found that the association between anxiety and WMC, while significant, was moderate in size (r = -.18, r^2 = .032, p < .001). Conversely, associations between anxiety and attentional capture have proven to be fairly robust. For example, Moser et al (2012) and Moran and Moser (2015) found fairly strong correlations between anxiety and performance in the Theeuwes task (rs = .44 and .49, respectively). Similarly, Derakshan and colleagues (2009) found that anxiety predicted performance in the anti-saccade task (r = .38). Finally, Esterman et al (2014) found a large association between symptom severity and Theeuwes task performance in PTSD patients (r = .60). I conducted a mini-meta-analysis with all studies examining attentional capture and anxiety. The combined effect size was r = .38 (r^2 = .144, p < .001). This suggests that the association between anxiety and WMC is simply too small to fully account for the association between anxiety and attentional deficits. That is, once the association between anxiety and WMC is accounted for, it is likely there will still be significant variance shared between anxiety and attentional task performance.

The second possibility stems from the composition of the Common attention factor. As noted earlier, it is possible that this factor does not represent domain-general executive attention – at least not purely. Instead, it may be that this factor represents an amalgam of executive attention, orienting/disengagement, perceptual/motor speed and other processes common to all of the tasks. With this in mind, one could suggest the following: 1) the anxiety-related variance that *was* accounted for by WMC represented the executive attention component of these tasks. This suggests that anxiety does in fact relate to increased distractibility via loaded WMC as posited by Eysenck and colleagues (1992; 2007). 2) Anxiety is also related to another process common to the tasks. For example, Fox and colleagues (e.g. 1993; 2001; 2005) have long argued that anxiety is associated with delayed disengagement from threat rather than impaired interference resolution or increased likelihood of capture. Previous work has considered these possibilities to be mutually exclusive. However, this need not be the case. It is possible that anxiety is related to multiple attention networks. If the second-order factor is in fact multi-dimensional, then the residual variance accounted for by anxiety may represent orienting/disengagement processes.

Models of NAB. The current results contribute to a growing literature which suggests that models of NAB (e.g. Williams et al., 1988; 1996; Öhman, 1996; 2005; Mogg & Bradley, 1998; Bar-Haim et al., 2007; Wells & Matthews, 1994) are insufficient to explain the relationship between anxiety and attention. As noted in the introduction, these models typically include a two-stage process. The first stage consists of a threat-detection mechanism which coarsely encodes incoming stimuli along a threat/non-threat (or negative/positive) dimension. In the second stage, stimuli that were tagged as negative/threatening in the first stage receive immediate attention in order to facilitate action. Anxiety is assumed to influence either the first stage – by increasing the likelihood of a stimulus being tagged as negative/threatening – or the second stage – by increasing the likelihood that attention will be allocated to negative/threatening stimuli. Some researchers (e.g. MacLeod et al, 2002; Mathews & MacLeod, 2005) have even hypothesized that individual differences in NAB may predispose individuals to later anxiety. That is, the tendency to attend to negative information, when paired with stressful events, puts individuals at risk for anxiety. Indeed, some work by Amir and colleagues (Amir et al, 2009a;

2009b) suggests that training clinically anxious individuals to focus on neutral information during a dot probe task can effectively treat anxiety. In these studies, anxious patients perform one of two versions of a dot probe. In one version (i.e. the treatment version) the probe always follows the neutral stimulus rather than negative stimulus. In the control version, the probe can follow either the negative or neutral stimulus. After eight sessions of the training procedure, patients in the treatment group were more likely to recover from anxiety. Thus, models of NAB posit that the tendency to focus on negative/threatening information is central to the development and maintenance of anxiety.

Mounting research suggests that anxiety is related to increased distraction by salient stimuli in the absence of threat. For example, anxiety predicts greater distraction in the standard Stroop task (Hochman, 1967; 1969; Pallak et al, 1975), the Posner cueing task (Poy et al, 2003), the anti-saccade task (Ansari et al, 2008; Derakshan et al, 2009) and Theeuwes' singleton search (Esterman et al, 2013; Moser et al, 2012; Moran & Moser, 2015). The current findings add to this literature in two main ways. First, the current findings replicate previous work insofar as they show that anxious individuals are more distractible across a number of different tasks. Second, these data extend the existing literature by challenging the notion that threatening and negative stimuli are "privileged" in anxiety in a way that previous studies do not. Previous work on anxiety has examined NAB and attentional capture in isolation without considering their interrelationships. This left open the possibility that anxiety was independently associated with both NAB and attentional capture. For example, it would be possible for NAB to be a key etiological mechanism and increased attentional capture to be 1) an independent risk factor for anxiety, 2) a tendency that develops alongside anxiety or 3) an effect of anxiety as Eysenck et al (1992; 2007) predicts. However, the current results found that anxiety is related to the variance that is shared between many types of attention tasks. This suggests that negative/threatening information is not uniquely privileged in anxiety. Rather, anxiety is related to attention at a fairly general level. Thus, existing models of NAB appear to be inadequate to fully account for the relationship between anxiety an attention.

While models of anxiety and attention currently disagree regarding whether increased distractibility is a cause or effect of anxiety (c.f. Amir et al, 2009a; 2009b; Eysenck et al, 1992; 2008; Hochman, 1967; 1969; MacLeod et al, 2002; Mathews & MacLeod, 2005; Pallak et al, 1975), one possibility that stems from the current findings is that attentional training programs aimed at reducing attentional capture by salient, but affectively neutral, stimuli may be a useful treatment for anxious pathology. For example, Leber and Egeth (2006) attempted to reduce attentional capture in a variant of Theeuwes' search paradigm. In this study, they trained participants to adopt either a feature-based search strategy – a strategy focused on locating target-specific features – or a singleton-based search strategy – a search strategy focused on locating salient, unique features. Participants who adopted a feature-based strategy no longer showed evidence of attentional capture by the singleton distracter. It is possible that an extended attentional training program, such as the one developed by Leber and Egeth (2006), might treat or reduce anxiety symptoms. This possibility will have to await future research.

Limitations and Future Directions

There are, of course, several limitations to the current study worth noting. The first is the use of raw RTs rather than difference scores. The current study avoided the use of difference scores as they are notoriously unreliable (e.g. Peter et al, 1993; Nunnally, 1978) and unreliable scores attenuate a variable's correlation with other variables (Nunnaly, 1978, Thorndike, 1949). Indeed, the difference scores for the attention measures used in the current study were quite unreliable ($\alpha s \leq .3$) which would have made detecting correlations very difficult. However, the use of raw scores is not without its problems. For example, it makes it difficult to disentangle distracter effects from more general speed. However, several steps were taken to attempt to mitigate this possibility. First, an additional CFA was conducted using RTs with perceptual/motor speed partialled out which also indicated acceptable fit (see Appendix B). It must also be noted that a general speed account would predict a single factor rather than a two factor solution. Second, and additional set of CFAs were conducted using corrected correlations for the difference scores (Appendix C). This analysis also produced the same two-factor structure. With respect to the SEM, Perceptual/Motor Speed was included along with Anxiety and WMC in order to show that both of these constructs predicted variance above-and-beyond speed. Additionally, Anxiety did not predict performance on the no-distracter/congruent trials (Appendix E). Nonetheless, future research will be aided by the development of more reliable tasks. Additionally, it must be borne in mind that reliability is subject to sampling error and other attempts to use these tasks could result in more reliable measures.

Second, future studies should determine whether a more coherent WMC factor is capable of accounting for the association between anxiety and attentional capture. For example, it is possible that WM tasks that are more relevant to attentional control aspects of WMC will show greater associations with both capture and anxiety. For example, a latent variable composed of complex span tasks may be a stronger mediator (Kane et al, 2004). Indeed, this is a possibility I will be pursuing in the upcoming semester. Alternately, the level at which anxiety relates to WMC is currently unclear (Moran, under review). It is possible that anxiety – or at least specific dimensions of anxiety – is associated with deficits in visuo-spatial maintenance specifically.

Future research, using a more comprehensive assessment of WMC, will be needed to answer this question.

Third, I have suggested that anxiety is independently related to at least two networks in Posner and Peterson's taxonomy of attention networks (Posner & Peterson, 1990; Peterson & Posner, 2012): orienting/disengagement and executive attention. However, there is currently very little direct evidence for this proposal. Anxiety does appear to be related to hyper-activation of the anterior cingulate cortex (e.g. Moser et al, 2013), a region involved in the executive attention network (Botvinick et al. 2001, Fan et al. 2005; Peterson & Posner, 2012). However, this has been inferred almost entirely from the study of errors rather than selective attention. The existing literature would benefit greatly from neuroimaging work examining regions involved in orienting/disengagement (the superior parietal lobe, frontal eye fields and, in particular, the temporal parietal junction; Corbetta & Shulman, 2002) and regions involved in executive attention (e.g. that anterior cingulate cortex and lateral prefrontal cortex; Botvinick et al. 2001, Fan et al. 2005) as a function of anxiety.

Fourth, in the structural equation models presented above, I have made certain assumptions regarding the directions of the causal pathways – most importantly: 1) that anxiety causally impacts WMC, 2) that WMC causally impacts attention and 3) that anxiety causally impacts attention. However, despite the causal models used in the present analysis, these data were fundamentally correlational. The present results would remain largely unchanged if the direction of the arrows were reversed. Nonetheless, the existing literature has provided good reasons to assume some of these particular causal relationships.

With respect to anxiety and WMC, theories have been somewhat inconsistent with respect to the direction of this relationship. For example, Eysenck et al (2007) proposes that worry acts as a dual-task and preempts WM processing resources (see Shackman et al [2006] for a similar account). Ouimet and colleagues (2009), on the other hand, propose that low WMC is a risk factor for the development of later anxiety. Theoretical disagreements notwithstanding, the empirical literature has been fairly clear. Shackman and colleagues (2006) demonstrated that a threat-of-shock design was capable of impairing performance in an N-Back. This has since been replicated several times (e.g. Vytal et al, 2012; 2013). Similarly, studies of ego-threat – i.e. studies in which stress is induced by threatening a participant's self-esteem or self-image – regularly find that digit span performance is reduced under threat conditions (e.g. Moldawsky & Moldawsky, 1952; Hodges & Spielberger, 1969; Hodges & Durham, 1972). Thus, the present article takes the view that anxiety interferes with WM operations and not necessarily vice versa.

With respect to WMC and attentional control, there is also some degree of theoretical disagreement. For example, Engle and colleagues have proposed that the ability to inhibit interference is reliant on available WMC (e.g. Engle, 2002; Engle et al, 1999a,b; see Lavie et al, 2004 for a related account). Hasher and Zacks (e.g. Hasher & Zacks, 1988; Zacks & Hasher, 1994), on the other hand, propose that individual differences in WMC can be attributed to individual differences in the ability to inhibit the no-longer-relevant contents of WMC. In this view, then, inhibition is the more fundamental ability. However, as with anxiety and WMC, the empirical literature is suggestive. Several studies have found that distracter interference is greater both for low-span individuals (Kane & Engle, 2003) and when WM is loaded (Lavie et al, 2004; Lavie & de Fockert, 2005). Similarly, high- and low-span individuals appear to be equally able to resist interference when placed under conditions of WM load (Kane & Engle, 2000; Rosen & Engle, 1997). That is, high-span individuals' ability to resist distraction is reliant on available

WMC. Thus, it seems reasonable to assume that attention task performance is reliant on WMC, rather than the other was around, in the current study.

With respect to anxiety and attention, the literature has been somewhat less clear. As noted earlier, anxiety is generally assumed to influence attentional processes. For example, anxiety is typically thought to influence a threat detection mechanism (e.g. Mogg & Bradley, 1998) or to interfere with executive attention (e.g. Eysenck et al, 2007). Mathews and MacLeod (2005), on the other hand, have suggested that individual differences in controlled attention may act as a risk factor for anxiety (see Ouimet et al [2009] for a related account). Unlike WMC, the empirical literature does not seem to provide a clear answer. For example, some research has found that anxiety inductions are capable of increasing RTs on incongruent trials in an affectively neutral Stroop task (Hochman, 1967; Hochman, 1969; Pallak et al, 1975). However, MacLeod et al (2002) found the opposite to be true as well. In this study participants completed one of two version of the dot probe task. In one version, the target always followed a threatening word cue. In the other version, the target always followed a neutral word cue. In a subsequent stress task, participants in the threat condition reported greater increases in negative affect. This suggests that allocating attention to threat can increase one's vulnerability to subsequent stress. To the author's knowledge, all studies that have demonstrated associations between anxiety and non-affective attentional capture have either examined individual differences in sub-clinical anxiety or have used anxiety diagnoses (Derakshan et al, 2009; Esterman et al, 2014; Moran & Moser, 2015; Moser et al, 2012). Moran and Moser (2015), using the Trier Social Stress Test, found that the anxiety induction did not affect performance in the Theeuwes task. However, the degree to which anxiety increased self-reported state anxiety was only significant at post-test (after the Theeuwes task). Additionally, some research suggests that the affect elicited by these manipulations is quite fleeting (see Shackman et al, 2006 for a review). Thus, whether or not anxiety can causally affect attentional capture – as is typically assumed (e.g. Eysenck et al, 2007) – appears to be an open question. Future research using more robust anxiety inductions will help settle this question. For example, threat-of-shock designs have proven to be robust and well-validated anxiety inductions (e.g. Davis et al, 2010; Schmitz & Grillon, 2012). In such a design, participants would complete a measure of attentional capture in a "safe" condition during which no shock would be delivered, and a "threat" condition during which participants would receive a randomly-timed electric shock. Similarly, as noted above, future research will benefit from exploring whether reducing attentional capture is capable of modulating anxiety.

Finally, the best fitting model was derived by means of an exploratory factor analysis and then more stringently evaluated with a confirmatory factor analysis (i.e. CFA 4). While this two-step procedure does not invalid the current results, it does suggest the need for replication. Exploratory factor analysis is a data-driven procedure that models the observed variables as the linear combination of unobserved variables that maximizes the explained variance. Submitting an exploratively obtained factor structure to a CFA is, in some sense, confirming a structure that is known to "work" beforehand. While this is not an invalid procedure, it is not as strong of a test as one that confirms an *a priori* model. This work would thus benefit from a replication attempt.

That being said, there are reasons to assume that the factor structure obtained in the current study is likely to replicate. Statistical research on factor-analytic methods has identified several factors that indicate a high likelihood of replicating a factor structure (e.g. Costello & Osborne, 2005; Osborne, et al., 2008; Osbourne, 2012). First, factor structures obtained with large sample sizes are more likely to replicate. As noted earlier, the present study meets most recommendations for absolute number of participants, for participant-to-variable ratios and for participant-to-number of parameters ratios (Hair, Anderson, Tatham, & Black, 1995; Nunnally, 1978; Gorsuch, 1983; Cattell, 1978; Kline, 1979; Lawley & Maxwell, 1971). Second, high initial communalities make replication more likely. The communalities in the EFA conducted in this study were quite reasonable and ranged between .41 and .8. Third, "clear" factor structure are more likely to replicate. The clarity of a factor structure refers the relative strengths of a variable's loading on each factor. A clear factor solution is one in which each variable loads strongly on its primary factor and the secondary loadings are near-zero. In the present study, the primary loadings were quite strong (ranging between .44 and .85; see Table 5) whereas the secondary loadings were generally lower than |.1| and all were lower than |.15|. Thus, it seems likely that the present results would be replicated in a new sample. Nonetheless, it would be useful for future research to attempt such a replication.

Conclusions

Overall, this thesis presents a novel, multivariate analysis designed to examine the interrelationships between measures of attentional capture as well as the role of individual differences in anxiety, WMC and Perceptual/Motor Speed in determining attentional capture at the level of individual differences. While some of the results were unexpected, this study was quite successful in achieving its aims. The present results suggest that attentional capture tasks are differentiated based on whether the distractor was an abruptly onsetting stimulus that appeared prior to the target or a static object that appeared with the target. There was no evidence that tasks could be differentiated based on whether the distracter was neutral or threatening in nature. Indeed, separating neutral and affective tasks produced the worst-fitting models in the entire study. As noted in previous studies, individual differences in anxiety predicted significant variance in attention task performance. In particular, anxiety predicted variance that was shared between all attention tasks rather than variance unique to any task or type of task. Finally, WMC and Perceptual/Motor Speed both predicted attention task performance but neither fully accounted for anxiety's association with attention. While anxiety was associated with decreased WMC, and the association between anxiety and attention was reduced when WMC was accounted for, anxiety and WMC still made independent contributions to attentional performance. Perceptual/Motor Speed, on the other hand, was not significantly related to anxiety.

The major limitations of the current study include low reliability of difference scores and well as the particular type of WMC tasks that were used. Future research would benefit from using a more focused battery of WMC tasks as well as developing attention tasks with more reliable difference scores. Additionally, future research will greater benefit from neuroimaging studies examining activation in attention networks as a function of anxiety. Finally, future studies should aim to replicate the current findings given that the best fitting CFA model was derived from an EFA.

APPENDICES

Appendix A

Copies of Self-Report Measures

This section includes copies of the self-reported measures of anxiety used in the current study. These include the State-Trait Anxiety Inventory (Trait; STAI; see Spielberger & Gorsuch, 1983 for more information), the Penn State Worry Questionnaire (PSWQ; see Meyer, Miller, Metzger, & Borkovec, 1990 for more information) and the Mood and Anxiety Symptom Questionnaire (MASQ; see Watson & Clark, 1991 for more information).

STAI-T

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you *generally* feel.

		Almost Never	Sometimes	Often	Almost Always
1.	I feel pleasant………………………………………..	1	2	3	4
2.	I feel nervous and restless…………………………...	1	2	3	4
3.	I feel satisfied with myself………………………….	1	2	3	4
4.	I wish I could be as happy as others seem to be…….	1	2	3	4
5.	I feel like a failure…………………………………	1	2	3	4
6.	I feel rested………………………………………….	1	2	3	4
7.	I am calm, cool, and collected………………………	1	2	3	4
8.	I feel that difficulties are piling up so that I cannot overcome them………………………………	1	2	3	4
9.	I worry too much over something that really doesn't matter……………………………………….	1	2	3	4
10.	I am happy…………………………………………..	1	2	3	4
11.	I have disturbing thoughts…………………………...	1	2	3	4
12.	I lack self-confidence………………………………..	1	2	3	4
13.	I feel secure………………………………………….	1	2	3	4
14.	I make decisions easily……………………………...	1	2	3	4
15.	I feel inadequate……………………………………..	1	2	3	4
16.	I am content…………………………………………	1	2	3	4
17.	Some unimportant thought runs through my mind and bothers me………………………………..	1	2	3	4
18.	I take disappointments so keenly that I can't put them out of my mind…………………………….	1	2	3	4
19.	I am a steady person…………………………………	1	2	3	4
20.	I get in a state of tension or turmoil as I think over my recent concerns and interests……………...	1	2	3	4

PSWQ

Rate each of the following statements on a scale of 1 ("not at all typical of me") to 5 ("very typical of me"). Please do not leave any items blank.

Not at all typical of me				Very typical of me
1	2	3	4	5

1.	If I do not have enough time to do everything, I do not worry about it.	1	2	3	4	5
2.	My worries overwhelm me.	1	2	3	4	5
3.	I do not tend to worry about things.	1	2	3	4	5
4.	Many situations make me worry.	1	2	3	4	5
5.	I know I should not worry about things, but I just cannot help it.	1	2	3	4	5
6.	When I am under pressure I worry a lot.	1	2	3	4	5
7.	I am always worrying about something.	1	2	3	4	5
8.	I find it easy to dismiss worrisome thoughts.	1	2	3	4	5
9.	As soon as I finish one task, I start to worry about everything else I have to do.	1	2	3	4	5
10.	I never worry about anything.	1	2	3	4	5
11.	When there is nothing more I can do about a concern, I do not worry about it any more.	1	2	3	4	5
12.	I have been a worrier all my life.	1	2	3	4	5
13.	I notice that I have been worrying about things.	1	2	3	4	5
14.	Once I start worrying, I cannot stop.	1	2	3	4	5
15.	I worry all the time.	1	2	3	4	5
16.	I worry about projects until they are done.	1	2	3	4	5

MASQ

Directions: *Below is a list of feelings, sensations, problems, and experiences that people sometimes have. Read each item and then fill in the appropriate number next to each statement. Use the choice that best describes* ***how much*** *you have felt or experienced things this way* ***during the past week, including today****. Use the scale below when answering each item.*

1 = Not at all
2 = A little bit
3 = Moderately
4 = Quite a bit
5 = Extremely

___1. Startled easily
___2. Felt cheerful
___3. Hands were shaky
___4. Felt optimistic
___5. Felt really happy
___6. Was short of breath
___7. Was proud of myself
___8. Felt faint
___9. Felt unattractive
___10. Had hot or cold spells
___11. Felt like I was having a lot of fun
___12. Hands were cold or sweaty
___13. Felt withdrawn from other people
___14. Felt like I had a lot of energy
___15. Was trembling or shaking
___16. Had trouble swallowing
___17. Felt really slowed down
___18. Felt dizzy or lightheaded
___19. Felt really "up" or lively
___20. Had pain in my chest
___21. Felt really bored
___22. Felt like I was choking
___23. Looked forward to things with enjoyment
___24. Muscles twitched or trembled
___25. Had a very dry mouth
___26. Felt like I had a lot of interesting things to do
___27. Was afraid I was going to die
___28. Felt like I had accomplished a lot
___29. Felt like it took extra effort to get started
___30. Felt like nothing was very enjoyable
___31. Heart was racing or pounding
___32. Felt like I had a lot to look forward to
___33. Felt numbness or tingling in my body
___34. Felt hopeful about the future
___35. Felt like there wasn't anything interesting or fun to do
___36. Seemed to move quickly and easily
___37. Felt really good about myself
___38. Had to urinate frequently

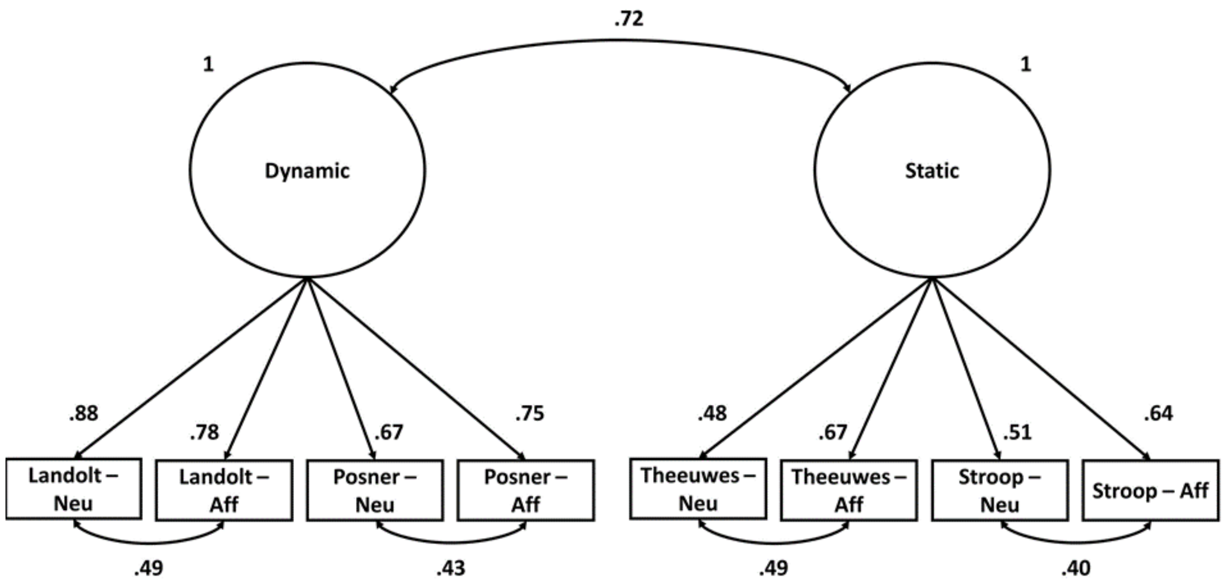
Appendix B

A Reanalysis of CFA 4 using Residualized Scores

Given that raw RTs, rather than difference scores, were used in the CFAs, one could argue that these factors represent more general processing speed instead of attentional capture. In order to attempt to mitigate this possibility, an additional CFA was conducted. First, a series of regression analyses were conducted in which scores on the various attention tasks were predicted using the measures of Perceptual/Motor Speed. This was done in order to "residualize" scores on the attention task – i.e. partition out variance associated with measures of Perceptual/Motor Speed. Then, CFA 4 was recomputed using these residual scores. The results of this analysis also indicated a well-fitting model ($\chi^2(15) = 26.29$; $\chi^2/df = 1.75$; SRMR = .03; RMSEA = .06; NFI = .97; TLI = .97; CFI = .99; AIC = -3.70). Additionally, all loadings and the between-factor correlation remained significant (*ps* $< .05$).

Figure 16.

A confirmatory factor analysis consisting of two factors: Dynamic distracter tasks and Static Distracter tasks. Curved paths connecting observed variables represent correlated error terms and curved paths between constructs represent correlations between the constructs. Scores were residualized for Perceptual/Motor Speed



APPENDIX C

A Reevaluation of CFA 4 using a Corrected Correlation Matrix

The confirmatory factor analyses presented in the primary text used RTs recorded on distracter trials only due to the low reliability of the difference scores. One method of avoiding the problem of unreliable measures is to correct the correlations for the reliability of the measures and then submit the corrected correlation matrix to confirmatory factor analyses. This is done by first dividing the observed correlations by the geometric mean of the reliabilities of the difference scores:

$$\boldsymbol{r_{x'y'}} = \frac{\boldsymbol{r_{xy}}}{\sqrt{\boldsymbol{\alpha_x \alpha_y}}}$$

where r_{xy} is the observed correlation between x and y, α_x is the reliability of measure x, α_y is the reliability of measure y and $r_{x'y'}$ is the corrected correlation coefficient. CFAs 1-4 from the main text were then reanalyzed using these corrected correlations. Difference scores computations are presented in Table 6.

Table 6.

Difference Score Computations

Task	**Difference Score Computation**
Theeuwes-Neutral	Distracter RT – No-Distracter RT
Theeuwes-Affective	Angry Face RT – Neutral Face RT
Stroop-Neutral	Incongruent RT – Congruent RT
Stroop-Affective	Negative Word RT – Neutral Word RT
Landolt-Neutral	Distracter RT – No-Distracter RT
Landolt-Affective	Angry Face RT – Neutral Face RT
Posner-Neutral	Invalid RT – Valid RT

Table 6 (cont'd)

Posner-Affective	Negative Word Invalid RT – Neutral Word Invalid RT

The results of these analyses are presented in Table 7. As in the primary text, CFAs 2b and 3b should be rejected. For CFA 2b, fit indices universally indicate poor fit. CFA 3b again resulted in an artifactual Heywood solution – that is the correlation between factors was $r = 1.09$. CFAs 1b and 4b both provided acceptable fit for the data. In order to compare these models, I conducted a χ^2 difference test. This test indicated that CFA 4b provided better fit than CFA 1b ($\chi^2(1)$ difference = 3.86, $p = .04$).

These findings broadly replicate the CFA presented in Appendix B insofar as they suggest that this factor structure cannot be attributed to the fact that all of the tasks involved speeded responses. However, it is also possible that the neutral and affective versions of each task loaded together because the affective tasks still involved some degree of physical salience (e.g. the angry face in the Landolt task was also an abruptly onsetting stimulus). The findings of Appendix B were unable to rule out this possibility.

The findings of this appendix, however, suggest otherwise. Because the difference scores in the affective tasks were computed as Affective Stimulus minus Neutral Stimulus (rather than Affective Stimulus minus No Distracter), it is unlikely that these findings can be attributed to physical salience alone.

Table 7.

Fit Statistics for the CFA Analyses Using Corrected Correlations

Model	**χ^2**	**χ^2/df**	**SRMR**	**RMSEA**	**NFI**	**TLI**	**CFI**	**PClose**	**AIC**
CFA 1b	10.62	1.21	.04	.04	.94	.96	.97	.87	1.31
CFA 2b	106.8***	6.67	.16	.17	.75	.53	.77	<.001	74.8
CFA 3b	8.75	.78	.04	.03	.95	.97	.98	.97	-1.58
CFA 4b	6.76	.53	.03	.03	.96	.98	.98	.98	-2.24

* $p < .05$, ** $p < .01$, *** $p < .001$

Appendix D

Measurement Invariance of the Attention Tasks

This section examines whether the resultant factor structure (CFA 4) is invariant across levels of anxiety. Measurement invariance methods test whether scores from a construct have the same meaning in different groups (Meade & Lautenschlager, 2004). The logic of measurement invariance is as follows: the model is freely estimated for each group (i.e. low- and high-anxiety). Then, parameters are gradually constrained to be equivalent across groups in order to determine if this constraint substantially affects the degree of fit.

Configural Invariance

Configural invariance tests whether the groups are characterized by the same number of factors and whether the factors correspond to the same indicators. This is accomplished by fitting the same model to both groups and allowing parameters to be freely estimated. First, a composite anxiety variable was generated by submitting the STAI, PSWQ and MASQ-Aar scales to an exploratory factor analysis (principal axis factoring). Then, low- and high-anxiety groups were created via a median split of this variable.

Finally, the model from CFA 4 was freely estimated for both groups. This resulted in a well-fitting model ($\chi^2(30) = 32.91$, $p = .33$; $\chi^2/df = 1.10$; SRMR = .04; RMSEA = .02; PClose = .87; NFI = .96; TLI = .99; CFI = .99; AIC = -27.09) indicating similar configurations across groups

Metric Invariance

Metric invariance tests whether the unstandardized factor loadings are invariant across groups. To test this, CFA 4 was re-estimated with the exception that factors loadings were constrained to be equivalent across groups. If this constraint significantly reduces fit, then one can conclude that the factor loadings are not invariant. However, a chi-square difference test revealed that this constraint did not significantly affect fit ($\chi^2(8)$ difference = 4.76, $p = .78$).

Factor Covariance Invariance

This determines whether covariances between latent variables are equivalent across groups. As with metric invariance, this is done by constraining covariances to be equivalent across groups. This also resulted in a non-significant chi-square difference test (χ^2(13) difference = 13.69, p = .40).

Error Term Invariance

Finally, error term invariance was tested. This determines whether the variances of the error terms were equivalent across groups. This too is done by constraining the error variances across anxiety groups. This also resulted in a non-significant chi-square difference test (χ^2(21) difference = 30.51, p = .09).

Overall, these findings suggest that the factor structure of the attention tasks used in this study is consistent across low- and high-anxiety groups. Therefore, scores on these constructs can be interpreted in much the same way regardless of anxiety level.

Appendix E

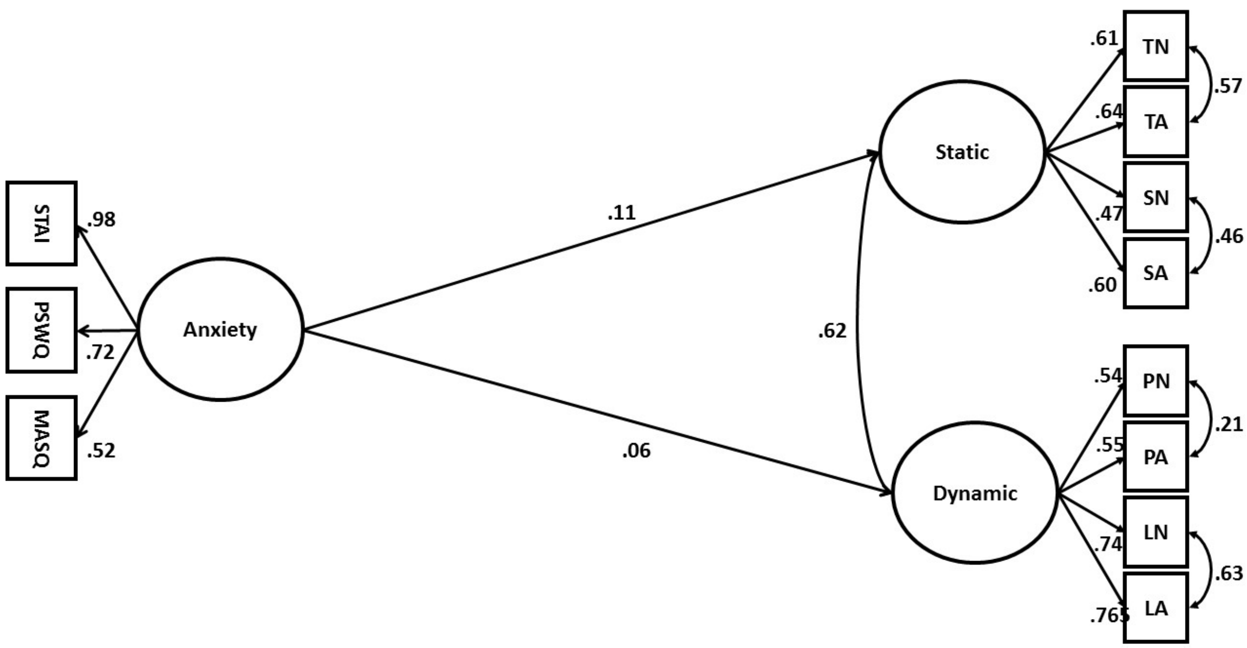
A Reanalysis of SEM 1 using No-Distracter/Baseline Trials

In SEM 1, anxiety was found to predict response times on distracter trials. While previous analyses suggest that this cannot be attributed to reduced Perceptual/Motor Speed (see Appendix B and SEM 2), it is nonetheless possible that anxiety actually predicts a more general slowdown to which the Perceptual/Motor Speed measures are insensitive. To evaluate this possibility, SEM 1 was recomputed using No-Distracter trials. That is, I conducted a structural equation model in which measures of anxiety were used to predict static tasks (No-Distracter trials for the Neutral/Affective Theeuwes tasks and Congruent trials for the Neutral/Affective Stroop tasks) and dynamic tasks (No-Distracter trials for the Neutral/Affective Landolt tasks and Valid trials for the Neutral/Affective Posner tasks). This analysis is shown in Figure 17.

As in the primary analyses, all loadings and correlations were significant ($ps < .05$). However, the paths leading from anxiety to the attention variables were not significant ($ps > .2$). This is quite consistent with previous research suggesting that anxiety only predicts performance on distracter trials. It also suggests that anxiety is not associated with a general slowdown; rather anxiety seems to predict some aspect of distracter interference or attentional disengagement.

Figure 17.

Structural equation model relating anxiety to No-Distracter trials. Curved paths connecting observed variables represent correlated error terms. The paths connecting latent variables are standardized regression coefficients linking these constructs. Key: TN = Theeuwes – Neutral; TA = Theeuwes – Affective; SN = Stroop – Neutral; SA = Stroop – Affective; PN = Posner – Neutral; PA = Posner – Affective; LN = Landolt – Neutral; LA = Landolt – Affective; STAI = State-Trait Anxiety Inventory; PSWQ = Penn State Worry Questionnaire; MASQ = Mood and Anxiety Symptom Questionnaire



REFERENCES

REFERENCES

Ahmed, L. & de Fockert, J.W. (2012). Focusing on attention: The effects of working memory capacity and load on selective attention. *PLoS One, 7(8)*: e43101.

Alting, T. & Markham, R. (1993). Test anxiety and distractibility. *Journal of Research in Personality, 27,* 134-137.

Amir, N., Beard, C., Taylor, C.T., Klumpp, H., Elias, J., Burns, M., & Chen, X. (2009a). Attention training in individuals with generalized social phobia: A randomized controlled trial. *Journal of Consulting and Clinical Psychology, 77,* 961-973.

Amir, N., Beard, C., Burns, M., & Bomyea, J. (2009b). Attention modification program in individuals with generalized anxiety disorder. *Journal of Abnormal Psychology, 118,* 28-33.

Ansari, T.L., Derakhshan, N., & Richards, A. (2008). Effects of anxiety on task switching: Evidence from the mixed antisaccade task. *Cognitive, Affective, & Behavioral Neuroscience, 8,* 229-238.

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M.J., & van IJzendoorn, M.H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin, 133,* 1-24.

Beck, A.T., (1976). *Cognitive Therapy and the Emotional Disorders*. New York: International Universities Press.

Bollen, K.A. (1987). Outliers and improper solutions: A confirmatory factor analysis example. *Sociological Methods and Research, 15,* 375-384.

Bollen, K.A. (1989). *Structural Equations with Latent Variables*. New York: Wiley.

Botvinick, M.M., Braver, T.S., Barch, D.M., Carter, C.S., & Cohen, J.D. (2001). Conflict monitoring and cognitive control. *Psychological Review, 108,* 624-652.

Bradley, M.M., Codispoti, M., Cuthbert, B.N., & Lang, P.J. (2001). Emotion and motivation I: Defensive and appetitive reactions in picture processing. *Emotion*, *1,* 276-298.

Bradley, M.M. & Lang, P.J. (2010). Affective Norms for English Words (ANEW): Instruction manual and affective ratings. Technical Report C-2. University of Florida, Gainesville, FL.

Broadbent, D.E., Cooper, P.F., FitzGerald, P., & Parkes, K.R. (1982). The cognitive failures questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology, 21,* 1-16.

Byrne, A. & Eysenck, M.W. (1995). Trait anxiety, anxious mood, and threat detection. *Cognition and Emotion, 9*, 549-562.

Calvo, M.G. & Carreiras, M. (1993). Selective influence of test anxiety on reading processes. *British Journal of Psychology, 84,* 375-388.

Calvo, M.G. & Castillo, M.D. (1995). Phonological coding in reading comprehension: The importance of individual differences. *European Journal of Cognitive Psychology, 7,* 365-382.

Calvo, M.G. & Eysenck, M.W. (1996). Phonological working memory and reading in test anxiety. *Memory, 4,* 289-305.

Cattell, R.B. (1978). *The Scientific Use of Factor Analysis*. New York: Plenum.

Cisler, J.M., Bacon, A.K., & Williams, N.L. (2009). Phenomenological characteristics of attentional biases towards threat: A critical review. *Cognitive Therapy and Research, 33,* 221−234.

Comrey, A.L. & Lee, H.B. (1992). *A first Course in Factor Analysis*. New Jersey: Erlbaum.

Constantine, R., McNally, R.J., & Hornig, C.D. (2001). Snake fear and the pictorial emotional Stroop paradigm. *Cognitive Therapy and Research, 25,* 757-764.

Conway, A.R.A, Cowan, N., Bunting, M.F., Therriault, D.J., & Minkoff, S.R.B. (2002). A latent variable analysis of working memory capacity, short-term memory capacity, processing speed, and general fluid intelligence. *Intelligence, 30*, 163-183.

Conway, A.R.A., Kane, M.J., Bunting, M.F., Hambrick, D.Z., Wilhelm, O., & Engle, R.W. (2005). Working memory span tasks: A methodological review and user's guide. *Psychonomic Bulletin & Review, 12*, 769-786.

Corbetta, M. Patel, G., & Shulman, G.L. (2008). The reorienting system of the human brain: Environment to theory of mind. *Neuron, 58,* 306-324.

Corbetta, M. & Shulman, G.L. (2002). Control of goal-directed and stimulus-driven attention in the brain. *Nature Reviews Neuroscience, 3,* 201-216.

Costello, A.B. & Osborne, J.W. (2005). Exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment, Research, and Evaluation, 10,* 1-9.

Davis, M., Walker,D.L., Miles,L., & Grillon, C. (2010). Phasic vs sustained fear in rats and humans: role of the extended amygdala in fear vs anxiety. *Neuropsychopharmacology, 35,* 105-135.

Dempster, F.N. (1991). Inhibitory processes: A neglected dimension in intelligence. *Intelligence, 15*, 157-173.

Dempster, F.N. (1992). The rise and fall of the inhibitory mechanism: Toward a unified theory of cognitive development and aging. *Developmental Review, 12,* 157-173.

Derakshan, N., Ansari, T.L., Hansard, M., Shoker, L., & Eysenck, M.W. (2009). Anxiety and inhibition: An investigation using the antisaccade task. *Experimental Psychology, 56*, 48–55.

Derryberry, D. & Reed, M.A. (2002). Anxiety-related attentional biases and their regulation by attentional control. *Journal of Abnormal Psychology, 111*, 225-236.

Desimone, R. & Duncan, J. (1995). Neural mechanisms of selective visual attention. *Annual Review of Neuroscience, 18*, 193-222.

Devue, C., Belopolsky A.V. & Theeuwes, J. (2011). The role of fear and expectancies in capture of covert attention by spiders. *Emotion, 11*, 768-775.

Dillon, W.R., Kumar, A. & Mulani, N. (1987). Offending estimates in covariance structure analysis: Comments on the causes and solutions to Heywood cases. *Psychological Bulletin, 101*, 126-135.

Duncan, J. (1985). Visual search and visual attention. In M.I. Posner & O.S.M. Marin (Eds.). *Attention and performance, Vol. XI*. (pp. 85-106). New Jersey: Erlbaum.

Downing, P.E. (2000). Interactions between visual working memory and selective attention. *Psychological Science, 11*, 467-473.

Engle, R.W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science, 11*, 19-23.

Engle, R.W., Kane, M.J., & Tuholski, S.W. (1999a). Individual differences in working memory capacity and what they tell us about controlled attention, general fluid intelligence and functions of the prefrontal cortex. In A. Miyake & P. Shah (Eds.), *Models of working memory: Mechanisms of active maintenance and executive control* (pp. 102-134). New York: Cambridge University Press.

Engle, R.W., Tuholski, S.W., Laughlin, J.E., & Conway, A.R.A. (1999b). Working memory, short-term memory and general fluid intelligence: A latent variable approach. *Journal of Experimental Psychology: General*, 128, 309-331.

Esterman, M., DeGutis, J., Mercado, R., Rosenblatt, A., Vasterling, J.J., Milberg, W., & Glinchey, R. (2013). Stress-related psychological symptoms are associated with increased attentional capture by visually salient distracters. *Journal of the International Neuropsychological Society, 19*, 1-6.

Eysenck, M.W. & Calvo, M.G. (1992). Anxiety and performance: The processing efficiency theory. *Cognition and Emotion, 6*, 409-434.

Eysenck, M.W. & Derakshan, N. (2011). New perspectives in attentional control theory. *Personality and Individual Differences, 50*, 955-960.

Eysenck, M.W., Derakshan, N., Santos, R., & Calvo, M.G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion, 7*, 336-353.

Fan, J., McCandliss, B.D., Fossella, J., Flombaum, J.I., & Posner, M.I. (2005). The activation of attentional networks. *NeuroImage, 26*, 471-479.

Fan, J., McCandiss, B.D., Sommer, T., Raz, A., & Posner, M.I. (2002). Testing the efficiency and independence of attentional networks. *Journal of Cognitive Neuroscience, 14*, 340-347.

Farah, M.J. (1985). Psychophysical evidence for shared representational medium for mental images and percepts. *Journal of Experimental Psychology: General, 114,* 91-103.

Folk, C.L., Remington, R.W., & Johnston, J.C. (1992). Involuntary covert orienting is contingent on attentional control settings. *Journal of Experimental Psychology: Human Perception and Performance, 18*, 1030-1044.

Folk, C.L., Remington, R.W., & Wright, J.H. (1994). The structure of attentional control: Contingent attentional capture by apparent motion, abrupt onset, and color. *Journal of Experimental Psychology: Human Perception and Performance, 20,* 317-329.

Fox, E. (1993). Attentional bias in anxiety: Selective or not? *Behaviour Research and Therapy, 31,* 487-493.

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General, 130,* 681-700.

Friedman, N.P. & Miyake, A. (2004). The relations among inhibition and interference control functions: A latent variable analysis. *Journal of Experimental Psychology: General, 133*, 101-135.

Fukuda, K. & Vogel, E. (2011). Individual differences in recovery time from attentional capture. *Psychological Science, 22*, 361-368.

Ganley, C.M. & Vasilyeva, M. (2014). The role of anxiety and working memory in gender differences in mathematics. *Journal of Educational Psychology, 106*, 105-120.

Georgiou, G., Bleakley, C., Hayward, J., Russo, R., Dutton, K., Eltiti, S., & Fox, E. (2005). Focusing on fear: Attentional disengagement from emotional faces. *Visual Cognition, 12*, 145-158.

Gorsuch, R.L. (1983). *Factor analysis* (2nd ed.). New Jersey: Erlbaum.

Guilford, J.P. (1954). *Psychometric methods* (2nd ed.). New York: McGraw-Hill.

Hair, J.F.J., Anderson, R.E., Tatham, R.L., & Black,W.C. (1995). *Multivariate data analysis* (4th ed.). New Jersey: Prentice Hall.

Hakamata, Y., Lissek, S., Bar-Haim, Y., Britton, J.C., Fox, N.A., Leibenluft, E., et al. (2010). Attention bias modification treatment: A meta-analysis towards the establishment of novel treatment for anxiety. *Biological Psychiatry, 68*, 982-990.

Hasher, L. & Zacks, R.T. (1988). Working memory, comprehension, and aging: A review and a new view. In G.H. Bower (Ed.). *The psychology of learning and motivation: Advances in research and theory, Vol. XI.* (pp 193-225). California: Academic Press.

Hickey, C., McDonald, J.J., & Theeuwes, J. (2006), Electrophysiological evidence of the capture of visual attention. *Journal of Cognitive Neuroscience*, 18, 604-613.

Hochman, S.H. (1967). The effects of stress on Stroop color-word performance. *Psychonomic Science, 9*, 475-476.

Hochman, S.H. (1969). Stress and response competition in children's color-word performance. *Perceptual and Motor Skills, 28,* 115-118.

Hodges, W.F. & Durham, R.L. (1972). Anxiety, ability, and digit span performance. *Journal of Personality and Social Psychology, 24*, 401-406.

Hodges, W.F. & Spielberger, C.D. (1969). Digit span: An indicant of trait or state anxiety? *Journal of Consulting and Clinical Psychology, 33*, 430-434.

Hu, L. & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods, 3,* 424-453.

Hu, L. & Bentler, P.M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 3*, 424-453.

Hutcheson, G. & Sofroniou, N. (1999). *The multivariate social scientist: Introductory statistics using generalized linear models*. California: Sage Publications.

Kane, M.J., Bleckley, M.K., Conway, A.R.A., & Engle, R.W. (2001). A controlled-attention view of working memory capacity. *Journal of Experimental Psychology: General, 130,* 169-183.

Kane, M.J. & Engle, R.W. (2000). Working-memory capacity, proactive interference, and divided attention: Limits on long-term memory retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,* 336-358.

Kane, M.J., Conway, A.R.A., Miura, T.K., & Colflesh, G.J.H. (2007). Working memory, attention control, and the *N*-Back task: A question of construct validity. *Journal of Experimental Psychology: Learning, Memory and Cognition, 33*, 615-622.

Kane, M.J., Hambrick, D.Z., Tuholski, S.W., Willhelm, O., Payne, T.W., & Engle, R.W. (2004). The generality of working memory capacity: A latent-variable approach to verbal and visuospatial memory span and reasoning. *Journal of Experimental Psychology: General, 133*, 189-217.

Kane, M.J. & Engle, R.W. (2003). Working-memory capacity and the control of attention: The contributions of goal neglect, response competition, and task set to Stroop interference. *Journal of Experimental Psychology: General, 132*, 47-70.

Kindt, M. & Brosschot, J.F. (1997). Phobia-related cognitive bias for pictorial and linguistic stimuli. *Journal of Abnormal Psychology, 106,* 644-648.

Kindt, M. & Brosschot, J.F. (1999). Cognitive bias in spider-phobic children: Comparison of a pictorial and a linguistic spider Stroop. *Journal of Psychopathology and Behavioral Assessment, 21,* 207-220.

Kline, P. (1979). *Psychometrics and psychology*. London: Academic Press.

Kolenikov, S. & Bollen, K.A. (2012). Testing negative error variances: Is a Heywood Case a symptom of misspecification? *Sociological Methods & Research, 41*, 124-167.

Lang, P.J. (1995). The emotion probe: Studies of motivation and attention. *American Psychologist, 50*, 372-385.

Lawley, D.N. & Maxwell, A.E. (1971). *Factor analysis as a statistical method*. London: Butterworth and Co.

Lavie, N. & de Fockert, J. (2005). The role of working memory in attentional capture. *Psychonomic Bulletin and Review, 12*, 669-674.

Lavie, N., Hirst, A., de Fockert, J.W., & Viding, E. (2004). Load theory of selective attention and cognitive control. *Journal of Experimental Psychology: General, 133*, 339-354.

Lavy, E.H., Van den Hout, M., & Arntz, A. (1993). Attentional bias and spider phobia: Conceptual and clinical issues. *Behaviour Research and Therapy, 31*, 17-24.

Leber, A.B. & Egeth, H.E. (2006). It's under control: Top-down search strategies can override attentional capture. *Psychonomic Bulletin & Review, 13*, 132-138.

LeDoux, J.E. (1995). Emotion: Clues from the brain. *Annual Review of Psychology, 46*, 209-235.

LeDoux, J.E. (1996). *The Emotional Brain*. New York: Simon & Schuster.

LeDoux, J.E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience, 23*, 155-184.

Luck, S.J. & Vogel, E.K. (1997). The capacity of visual working memory for features and conjunctions. *Nature*, *390*, 279-281.

MacCallum, R.C., Widaman, K.F., Preacher, K.J., & Hong S. (2001). Sample size in factor analysis: The role of model error. *Multivariate Behavioral Research, 36*, 611-637.

MacCallum, R.C., Widaman, K.F., Zhang, S., & Hong S. (1999). Sample size in factor analysis. *Psychological Methods, 4*, 84-99.

MacLeod, C., Campbell, L., Rutherford, E., & Wilson, E. (2004). The causal status of anxiety-linked attentional and interpretive bias. In J. Yiend (Ed.). *Cognition, Emotion and Psychopathology: Theoretical, Empirical and Clinical Directions.* Cambridge: Cambridge University Press.

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95*, 15-20.

Mathôt, S., Hickey, C., & Theeuwes, J. (2010). From reorienting of attention to biased competition: Evidence from hemifield effects. *Attention, Perception & Psychophysics, 72*, 651-657.

Mathews, A. & MacLeod, C. (1985). Selective processing of threat cues in anxiety states. *Behavior Research and Therapy, 23*, 563-569.

Mathews, A. & MacLeod, C. (2005). Cognitive vulnerability to emotional disorders. *Annual Review of Clinical Psychology, 1*, 167-195.

MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, G., & Holker, L. (2002). Selective attention and emotional vulnerability: Assessing the causal basis of their association through the experimental manipulation of attentional bias. *Journal of Abnormal Psychology, 111*, 107-123.

McCabe, D.P., Roediger, H.L., McDaniel, M.A., Balota, D.A., & Hambrick, D.Z. (2010). The relationship between working memory capacity and executive functioning: evidence for a Common executive attention construct. *Neuropsychology, 24*, 222-24.

Meade, A.W. & Lautenschlager, G.J. (2004). A comparison of item response theory and confirmatory factor analytic methodologies for establishing measurement equivalence/invariance. *Organizational Research Methods, 7,* 361-388.

Miltner, W.H.R., Krieschel, S., Hecht, H., Trippe, R., & Weiss, T. (2004). Eye movements and behavioral responses to threatening and nonthreatening stimuli during visual search in phobic and nonphobic subjects. *Emotion, 4*, 323-339.

Meyer, T.J., Miller, M.L., Metzger, R.L., & Borkovec, T.D. (1990). Development and validation of the Penn State Worry Questionnaire. *Behaviour Research and Therapy, 28,* 487-495.

Merckelbach, H., Kenemans, J.L., Dijkstra, A., & Schouten, E. (1993). No attentional bias for pictoral stimuli in spider-fearful subjects. *Journal of Psychopathology and Behavioral Assessment, 15,* 197-206.

Mogg, K. & Bradley, B.P. (1998). A cognitive–motivational analysis of anxiety. *Behaviour Research and Therapy, 36*, 809-848.

Mogg, K., Mathews, A., & Weinman, J. (1987). Memory bias in clinical anxiety. *Journal of Abnormal Psychology, 96*, 94-98.

Moser, J.S., Becker, M.W., & Moran, T.P. (2012). Enhanced attentional capture in trait anxiety. *Emotion, 12*, 213-216.

Moser, J.S., Moran, T.P., Schroder, H.S., Donnellan, M.B., & Yeung, N. (2013). On the relationship between anxiety and error-monitoring: A meta-analysis and conceptual framework. *Frontiers in Human Neuroscience, 7:466*.

Moldawsky, S. & Moldawsky, P.C. (1952). Digit span as an anxiety indicator. *Journal of Consulting Psychology, 16*, 115-118.

Moran, T.P. (under review). Anxiety ad working memory capacity: A meta-analysis and critical review of the literature. *Psychological Bulletin*.

Moran, T.P., & Moser. J.S. (2015). The color of anxiety: Neurobehavioral evidence for distraction by perceptually salient stimuli in anxiety. *Cognitive, Affective, & Behavioral Neuroscience, 15,* 169-179.

Nottelman, E.D. & Hill, K.T. (1977). Test anxiety and off-task behavior in evaluative situations. *Child Development, 48,* 225-231.

Nunnally, J.C. (1978). *Psychometric theory* (2nd Ed.). New York: McGraw-Hill

Öhman, A. (1996). Preferential preattentive processing of threat in anxiety: Preparedness and attentional biases. In R.M. Rapee (Ed.). *Current controversies in the anxiety disorders*. New York: Guilford Press.

Öhman, A. (2005). The role of the amygdala in human fear: Automatic detection of threat. *Psychoneuroendocrinology, 30*, 953-958.

Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General, 130*, 466-478.

Olivers, N.L., Meijer, F., & Theeuwes, J. (2006). Feature-based memory-driven attentional capture: Visual working memory content affects visual attention. *Journal of Experimental Psychology: Human Perception and Performance*, *32*, 1243-1265.

Osborne, J.W. (2012), Replication analysis in exploratory factor analysis: What it is and why it makes your analysis better. *Practical Assessment, Research & Evaluation, 17*, 1-8.

Osborne, J.W., Costello, A.B., & Kellow, J.T. (2008). Best Practices in Exploratory Factor Analysis. In J.W. Osborne (Ed.). *Best Practices in Quantitative Methods* (pp. 205-213). California: Sage Publishing

Ouimet, A.J., Gawronski, B., & Dozois, D.J.A. (2009). Cognitive vulnerability to anxiety: A review and an integrative model. *Clinical Psychology Review, 29*, 459-470.

Owens, M., Stevenson, J., Hadwin, J.A., & Norgate, R. (2012). When does anxiety help or hinder cognitive test performance? The role of working memory capacity. *British Journal of Psychology, 105*, 92-101.

Owens, M., Stevenson, J., Norgate, R., & Hadwin, J.A. (2008). Processing efficiency theory in children: Working memory as a mediator between trait anxiety and academic performance. *Anxiety, Stress, & Coping*, *21*, 417-430.

Pallak, M.S., Pittman, T.S., Heller, J.F., & Munson, P. (1975). The effect of arousal on Stroop color-word task performance. *Bulletin of the Psychonomic Society, 6*, 248-250.

Pashler, H. & Shiu, L.P. (1999). Do images involuntarily trigger search? A test of Pillsbury's hypothesis. *Psychonomic Bulletin & Review, 6*, 445-448.

Paulesu, E., Sambugaro, E., Torti, T., Danelli, L., Ferri, F., Scialfa, G., Sberna, G., Ruggiero, G.M., Bottini, G., & Sassaroli, S. (2009). Neural correlates of worry in generalized anxiety disorder and in normal controls: a functional MRI study. *Psychological Medicine, 40*, 117-124.

Peter, J.P., Churchill, G.A., & Brown, T.J. (1993). Caution in the use of difference scores in consumer research. *Journal of Consumer Research, 19*, 655-662.

Peterson, S.E. & Posner, M.I. (2012). The attention system of the human brain: 20 years after. *Annual Review of Neuroscience, 35*, 73-89.

Posner, M.I. (1980). Orienting of attention. *Quarterly Journal of Experimental Psychology, 32*, 3-25.

Posner, M.I. & Peterson, S.E. (1990). The attention system of the human brain. *Annual Review of Neuroscience, 13*, 25-42.

Posner, M.I. & Rothbart, M.K. (2000). Developing mechanisms of self-regulation. *Development and Psychopathology, 12*, 427-441.

Posner, M.I., Snyder, C.R., & Davidson, B.J. (1980). Attention and the detection of signals. *Journal of Experimental Psychology: General, 109*, 160-174.

Poy, R., Eixarch, M.D.C., & Avila, C. (2003). On the relationship between attention and personality: covert visual orienting of attention in anxiety and impulsivity. *Personality and Individual differences, 36*, 1471-1481.

Pratt, J., Sekuler, A.B., & McAuliffe, J. (2001). The role of attentional set on attentional cueing and inhibition of return. *Visual Cognition, 8*, 33-46.

Pratto, F. & John, O.P. (1991). Automatic vigilance: The attention grabbing power of negative social information. *Journal of Personality and Social Psychology, 61,* 380-391.

Redick, T.S. & Lindsey, D.R.B. (2013). Complex span and n-back measures of working memory: A meta-analysis. *Psychonomic Bulletin & Review, 20*, 1102-1113.

Rinck, M., Becker, E.S., Kellermann, J., & Roth, W. T. (2003). Selective attention in anxiety: Distraction and enhancement in visual search. *Depression and Anxiety, 18*, 18-28.

Rinck, M., Reinecke, A., Ellwart, T., Heuer, K., & Becker, E.S. (2005). Speeded detection and increased distraction in fear of spiders: Evidence from eye movements. *Journal of Abnormal Psychology, 114*, 235-248.

Rindskopf, D. (1984). Structural equation models: Empirical identification, Heywood cases, and related problems. *Sociological Methods and Research, 13*, 109-119.

Robinson, O.J., Vytal, K., Cromwell, B., & Grillon, C. (2013). The impact of anxiety upon cognition: Perspective from human threat of shock studies. *Frontiers in Human Neuroscience, 7:93*.

Rosen, V.M. & Engle, R.W. (1997). The role of working memory capacity in retrieval. *Journal of Experimental Psychology: General, 126*, 211-227.

Rouder, J.N., Morey, R.D., Morey, C.C., & Cowan, N. How to measure working memory capacity in the change detection paradigm. *Psychonomic Bulletin & Review, 18,* 324-330.

Salthouse, T.A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological Review, 103*, 403-428.

Sato, M. (1987). Pragmatic treatment of improper solutions in factor analysis. *Annals of the Institute of Statistics and Mathematics, part B, 39,* 443-455.

Schimmack, U. (2005). Attentional interference effect of emotional pictures: Threat, negativity, or arousal? *Emotion, 5,* 55-66.

Schmitz, A. & Grillon, C. (2012). Assessing fear and anxiety in humans using the threat of predictable and unpredictable aversive events (the NPU-threat test). *Nature Protocols, 7,* 527-532.

Shackman, A.J., Sarinopoulos, I., Maxwell, J.S., Pizzagalli, D.A., Lavric, A., & Davidson, R.J. (2006). Anxiety selectively disrupts visuospatial working memory. *Emotion, 6,* 40-61.

Snellenberg, J.X., Conway, A.R.A., Spicer, J., Read, C., & Smith, E.E. (2014). Capacity estimates in working memory: Reliability and interrelationships among tasks. *Cognitive, Affective, & Behavioral Neuroscience, 14,* 106-116.

Soto, D., Heinke, D., Humphreys, G.W., & Blanco, M.J. (2005). Early, involuntary top-down guidance of attention from working memory. *Journal of Experimental Psychology: Human Perception and Performance, 31,* 248-261.

Spielberger, C.D. & Gorsuch, R.L. (1983). *Manual for the state-trait anxiety inventory (form Y): Self-evaluation questionnaire.* Palo Alto, CA: Consulting Psychologists Press.

Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18,* 643-662.

Theeuwes, J. (1991). Cross-dimensional perceptual selectivity. *Perception & Psychophysics,* 50, 184-193.

Theeuwes, J. (1992). Perceptual selectivity for color and form. *Perception & Psychophysics,* 51, 599-606.

Theeuwes, J. (2010). Top–down and bottom–up control of visual selection. *Acta Psychologica, 135,* 77-99.

Theeuwes, J., Atchley, P., & Kramer, A.F. (2000). On the time course of top-down and bottom-up control of visual attention. In S.M.J. Driver (Ed.). *Attention & performance Vol. 18.* (pp. 105-125). Cambridge: MIT Press.

Thorndike, R.L. (1949). *Personnel selection: Test and measurement techniques*. Oxford: Wiley.

Thorpe, S.J. & Salkovskis, P.M. (1998). Studies on the role of disgust in the acquisition and maintenance of specific phobias. *Behaviour Research and Therapy, 36*, 877-893.

Torrubia, R., Avila, C., Molto, J., & Caseras, X. (2001). The sensitivity to punishment and sensitivity to reward questionnaire (SPSRQ) as a measure of Gray's anxiety and impulsivity dimensions. *Personality and Individual Differences, 31*, 837-862.

Van Driel, O.P. (1978). On various causes of improper solutions in maximum likelihood factor analysis. *Psychometrika, 43,* 225-243.

Velicer, W.F. & Fava, J.L. (1998). Effects of variable and subject sampling on factor pattern recovery. *Psychological Methods, 3*, 231-251.

Vogt, J., De Houwer, J., Koster, E.H.W., Van Damme, S., & Crombez, G. (2008). Allocation of spatial attention to emotional stimuli depends on arousal and not valence. *Emotion, 8*, 880-885.

Vuilleumier, P. (2005). How brains beware: Neural mechanisms of emotional attention. *Trends in Cognitive Sciences, 9*, 585-594.

Vukovic, R.K., Kieffer, M.J., Bailey, S.P., & Harari, R.R. (2012). Mathematics anxiety in young children: Concurrent and longitudinal associations with mathematical performance. *Contemporary Educational Psychology, 38*, 1-10.

Vytal, K., Cromwell, B., Arkin, N., & Grillon, C. (2012). Describing the interplay between anxiety and cognition: From impaired performance under low cognitive load to reduced anxiety under high load. *Psychophysiology, 49*, 842-852.

Vytal, K.E., Comwell, B.R., Letkiewicz, A.M., Arkin, N.E., & Grillon, C. (2013). The complex interaction between anxiety and cognition: Insight from spatial and verbal working memory. *Frontiers in Human Neuroscience, 7:93*.

Walter, W.G., Cooper, R., Aldridge, V.A. McCallum, W.C. & Winter, A.L. (1964). Contingent negative variation: An electric sign of sensorimotor association and expectancy in the human brain. *Nature, 203,* 380-384.

Watson, D., & Clark, L.A. (1991). The Mood and Anxiety Symptom Questionnaire. Unpublished manuscript. University of Iowa, Iowa City, IA.

Wells, A. & Matthews, G. (1994). *Attention and emotion: A clinical perspective*. New Jersey: Lawrence Erlbaum Associates.

Williams, J.M.G., Mathews, A. & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin, 120*, 3-24.

Williams, J.M.G., Watts, F. N., MacLeod, C., & Mathews, A. (1988). *Cognitive psychology and emotional disorders*. Chichester: Wiley.

Zacks, R.T. & Hasher, L. (1994). Directed ignoring: Inhibitory regulation of working memory. In D. Dagenbach & T.H. Carr (Eds.). *Inhibitory processes in attention, memory and language* (pp. 241-264). New York: Academic Press.