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The primary objective of the current study was to test the hypothesis that cognitive biases for negative and threatening social information mediate the effect of Behavioral Inhibition System (BIS) and Behavioral Approach System (BAS) sensitivity on social anxiety. To test this hypothesis, undergraduate participants (N = 207) were initially asked to complete measures of BIS, BAS, and trait social anxiety. Participants were then informed that they would be required to give a speech at the end of the study. This social-threat induction procedure was immediately followed by the administration of a counter-balanced battery of cognitive tasks. After the participants completed the cognitive battery, their level of state anxiety in response to the speech task was assessed via self-report. Participants were then asked to perform a brief impromptu speech. Latent variables were constructed for BIS, BAS, cognitive bias, and social anxiety. Structural equation modeling was used to test the hypothesis that cognitive biases mediate the effect of BIS and BAS sensitivity on social anxiety. As predicted, the fully-mediated model showed significantly better fit to the data than did several competing models. These results provide strong support for a mediated model of social anxiety and suggest that cognitive biases for negative and threatening social information may be the mechanism through which BIS and BAS sensitivity exert their influence upon social anxiety.

BIS, BAS, AND BIAS: THE ROLE OF PERSONALITY AND COGNITION IN SOCIAL ANXIETY

by

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Approved by

_____

Committee Chair

To Azure, Andrew, and Jack:

Thank you.

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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CHAPTER I

INTRODUCTION

Social anxiety refers to excessive fear and anxiety in response to one or more social or performance situations. Social phobia refers to the clinical diagnosis given to individuals whose social anxiety is so severe that it causes them significant distress or seriously impairs their functioning (American Psychiatric Association, 2000). Substantial evidence suggests that social phobia is essentially an extreme point on the dimension of social anxiety (e.g., Furmark, Tillfors, Stattin, Edselius, & Fredrikson, 2000; Rapee, 1995; Ruscio, Brown, Chiu, Sareen, Stein, & Kessler, 2008; Tillfors et al., 2001; Widiger, 2001). Accordingly, the current paper adopts the position taken by many in the field (e.g., McNeil, 2001; Rapee & Spence, 2004; Widiger, 2001) that social anxiety is a dimensional construct. The low end of the social anxiety dimension is proposed to be characterized by an absence of social anxiety and relative fearlessness, whereas the high end of the social anxiety dimension is proposed to be characterized by levels of social anxiety so high that they cause significant distress and impairment (McNeil, 2001). Most people are proposed to fall in between these two extremes and to experience “normal” levels of social anxiety in certain types of social situations. It is estimated, however, that approximately 7 - 13% of the population in Western societies will meet diagnostic criteria for social phobia at some point during their lifetimes (Furmark, 2002, Furmark et al., 1999; Kessler et al., 1994; Ruscio et al., 2008), making it the third most common

psychological disorder in Western societies (Kessler et al., 1994) and a major mental health concern (Wittchen et al., 1999, 2000).

Individuals suffering from social phobia frequently experience significant interference in several life domains, including academic functioning, career functioning, interpersonal relationships, and romantic relationships (APA, 2000; Manuzza et al., 1995; Rapee, 1995; Ruscio et al., 2008; Wittchen et al., 1999, 2000). Social phobia is also associated with high rates of unemployment, high rates of missed work, decreased work productivity, increased utilization of healthcare services, and decreased quality of life in terms of vitality and health (Wittchen et al., 1999, 2000). These problems are likely exacerbated by the chronicity of the disorder, as it appears to be moderately stable across the lifespan (Pine, Cohen, Gurley, Brook, & Ma, 1998; Rapee, 1995; Rapee & Spence, 2004). Moreover, individuals with social phobia are at increased risk for developing other anxiety disorders, mood disorders, and substance use disorders (Magee, Eaton, Wittchen, McGonagle, & Kessler, 1996; Rapee, 1995; Ruscio et al., 2008; Sanderson, Di Nardo, Rapee, & Barlow, 1990). After studying the prevalence and sociodemographic profile of individuals with social phobia in the general population, Furmark and colleagues (1999) concluded that "although the exact diagnostic boundaries for social phobia are difficult to determine, it can be concluded that social anxiety is a distressing problem for a considerable proportion of the population" (p. 416).

During the past three decades, researchers have begun to examine a variety of factors related to the development and maintenance of social anxiety, and a number of models have been put forth (e.g., Clark & Wells, 1995; Ollendick & Hirshfeld-Becker,

2002; Rapee & Heimberg, 1997; Rapee & Spence, 2004). Among the many models that have been proposed, Kimbrel's (2008) recently proposed model of social anxiety is unique because it: (a) it integrates a wide range of factors (i.e., genetic, biological, temperamental, environmental, and cognitive) into a unified model of the development and maintenance of social anxiety, (b) provides a biologically-based personality framework for understanding the cognitive biases observed among individuals with social anxiety, and (c) predicts the conditions under which these types of cognitive biases are most likely to emerge; however, to date, no studies have systematically tested this model of social anxiety. The goal of the current study was to provide the first direct test of Kimbrel's (2008) hypothesis that cognitive biases for negative and threatening social information mediate the effect of Behavioral Inhibition System (BIS) and Behavioral Approach System (BAS) sensitivity on social anxiety.

Reinforcement Sensitivity Theory

Kimbrel's mediated model of social anxiety is based largely upon Jeffrey Gray's Reinforcement Sensitivity Theory of personality (RST; Gray, 1970, 1982, 1991; Gray & McNaughton, 2000). RST is a biologically-based theory of personality that postulates three major subsystems of the brain underlie many of the individual differences seen in personality, psychopathology, and reinforcement sensitivity (Gray, 1991; Pickering & Gray, 1999). These brain systems are referred to as the BIS, BAS, and Fight-Flight-Freeze System (FFFS). Individual differences in BIS, BAS, and FFFS sensitivity are theorized to underlie two fundamental dimensions of personality—anxiety and

impulsivity. Furthermore, RST assumes that normal personality variation lies on a continuum with psychopathology. Thus, individuals at the far poles of the anxiety and impulsivity dimensions are hypothesized to be at increased risk for developing psychopathology (Pickering & Gray, 1999). The core idea underlying RST—the idea that anxiety involves the septo-hippocampal system—has remained intact since its inception by Gray in 1970 (McNaughton & Corr, 2004); however, the theory has undergone substantial revisions in recent years which are described below and are incorporated into the current study.

Subsystems of the Brain

Fight-flight-freeze system. The FFFS is now viewed as the defensive avoidance subsystem of the brain. As such, its primary responsibility is to motivate avoidance and escape behaviors in response to both conditioned and unconditioned aversive stimuli (Corr, 2004). The FFFS is also posited to be the neural substrate for the emotions of fear and panic. Several anxiety disorders, including panic disorder and specific phobia, are proposed to reflect hyperactivity in the FFFS (Gray & McNaughton, 2000). The major components of the FFFS from lowest neural and functional level to highest include the periaqueductal gray, medial hypothalamus, amygdala, anterior cingulate, and prefrontal ventral stream (McNaughton & Corr, 2004).

Behavioral approach system. The BAS continues to be viewed as the appetitive motivational subsystem of the brain. As such, its primary responsibility is to motivate approach behavior in response to both conditioned and unconditioned appetitive stimuli

(Corr, 2004). In addition, activity in the BAS is posited to be associated with the positive emotions of elation and relief, as well as the "high" associated with drugs of abuse (Gray, 1994). Hyperactivity in the BAS is proposed to underlie substance abuse (Gray, 1994) and mania (Gray, 1991), whereas hypoactivity in the BAS is proposed to underlie depression unaccompanied by anxiety (Gray, 1991, 1994). The major components of the BAS include the basal ganglia, the dopaminergic fibers ascending from the substantia nigra and ventral tegmental area to innervate the basal ganglia, and the motor, sensorimotor, and prefrontal cortices (Gray, 1994).

Behavioral inhibition system. The BIS is now viewed as the defensive approach subsystem of the brain. As such, its primary responsibility is to resolve conflicts among competing goals (e.g., approach-avoidance conflict) by inhibiting prepotent behavior, increasing attention, increasing emotional arousal, and by actively engaging in risk assessment behaviors in response to goal conflict (Gray & McNaughton, 2000; McNaughton & Corr, 2004). These risk assessment behaviors include both external (i.e., environmental) scanning for threat-relevant information and internal scanning of memory stores for threat-relevant information. The aim of these processes is goal resolution (Corr, 2004); however, presumably due to evolutionary pressures, the BIS is proposed to exhibit a bias for potentially threatening information so that avoidant responses are always favored (Gray & McNaughton, 2000). The major components of the BIS from lowest neural and functional level to highest include the periaqueductal gray, medial hypothalamus, amygdala, septo-hippocampal system, posterior cingulate, and prefrontal dorsal stream (McNaughton & Corr, 2004). Hyperactivity in the BIS has been proposed

to underlie several disorders, including generalized anxiety disorder (Gray & McNaughton, 2000), depression (Gray, 1991), and social phobia (Gray & McNaughton, 2000; Kimbrel, 2008).

Personality and its Inheritance

The foundation of RST is Gray's (1970, 1991) proposal that Eysenck's (1967) personality dimensions of Neuroticism and Extraversion should be rotated by 30-degrees to better reflect the underlying neurobiological systems. Gray (1991) termed his rotated personality dimensions "anxiety" and "impulsivity." The anxiety dimension was proposed to run from Eysenck's neurotic-introvert quadrant to the stable-extravert quadrant. Anxiety was proposed to be rotated closer to neuroticism and was said to reflect activity in the BIS. The impulsivity dimension was proposed to run from Eysenck's stable-introvert quadrant to the neurotic-extravert quadrant. Impulsivity was proposed to be closer to extraversion and to reflect activity in the BAS. Gray further proposed that individuals high on the BIS-anxiety dimension would be hypersensitive to punishing stimuli, whereas individuals high on the BAS-impulsivity dimension would be hypersensitive to rewarding stimuli. Experimental studies have supported this proposal (Derryberry & Reed, 1994; Gray, 1970, Gray & McNaughton, 2000; Wallace & Newman, 1990).

The relationship of the FFFS to personality has historically been more difficult to determine, although it was tentatively suggested to map onto Eysenck's psychoticism dimension at one time (e.g., Gray, 1991). More recently, however, Gray and

McNaughton (2000) revised and extended RST with respect to personality and its inheritance. Specifically, they have argued that "studies of the inheritance of both human neurotic disorders and rodent emotionality strongly suggest...that what is inherited is a broad propensity to display a variety of forms of emotional behaviour...spanning both the behavioural inhibition and the fight-flight systems" (p. 348). On this basis, they now postulate that the personality trait of neuroticism reflects the entire defense system's overall level of sensitivity to threat (i.e., the combined sensitivity of both the BIS and FFFS). Similarly, Corr (2004) has argued that it is likely that current self-reports of BIS sensitivity actually reflect combined activity in the overall defense system (i.e., combined BIS and FFFS functioning). The current paper takes this position as well. Accordingly, the term "BIS sensitivity" is used throughout the paper to refer to combined BIS and FFFS sensitivity.

BIS Sensitivity and Social Anxiety

There is now considerable support for the proposal that high levels of BIS sensitivity are associated with social anxiety. For example, Coplan, Wilson, Frohlick, and Zelenski (2006) examined the association between self-reported BIS and social anxiety symptoms in a community sample of children. As expected, BIS was positively associated with social anxiety. Similar results have been reported among non-clinical samples of adults using self-report measures of BIS (e.g., Kashdan & Roberts, 2006; Kimbrel, Cobb, Mitchell, Hundt, & Nelson-Gray, 2008). In addition, using the Eysenck Personality Inventory (Eysenck & Eysenck, 1968), Stemberger, Turner, Beidel, and

Calhoun (1995) reported that individuals with social phobia scored significantly higher on the personality trait of neuroticism than did a group of normal controls. Bienvenu and colleagues (2004) reported similar results using the Revised NEO Personality Inventory (Costa & McCrae, 1992).

Additional support for the proposal that heightened BIS sensitivity underlies social anxiety comes from neuroscience studies. For example, using functional magnetic resonance imaging (fMRI) and positron emission tomography (PET), several studies have reported increased regional cerebral blood flow (rCBF) in the amygdala, hippocampus, and prefrontal cortex (key components of the BIS) among social phobics during anticipation of a public-speaking task (Tillfors et al., 2001; Furmark et al., 2004; Tillfors, Furmark, Marteinsdottir, & Fredrikson, 2002). Etkin and Wager (2007) recently conducted a meta-analysis on studies that have used fMRI and PET to examine neurobiological deficits in social phobia. These authors concluded that, relative to matched control participants, patients diagnosed with social phobia consistently show hyperactivation in the amygdala. Additional evidence for the role of the BIS in social phobia comes from the finding that there is reduced rCBF in the amygdala, hippocampus, and prefrontal cortex following successful treatment with cognitive-behavioral therapy (Furmark et al., 2002). Taken together, these studies provide strong evidence that hypersensitivity in the BIS is associated with increased social anxiety.

Social Anxiety and Cognitive Bias

There is also considerable support for the idea that individuals experiencing high

levels of social anxiety exhibit cognitive biases for negative and threatening social information (Clark & Wells, 1995; Hirsch & Clark, 2004; Musa & Lepine, 2000; Rapee & Heimberg, 1997). In particular, there is growing evidence that socially-anxious individuals hold negative beliefs and expectancies about social situations (e.g., Leary, Kowalski, & Campbell, 1988; Lucock & Salkovskis, 1988) and exhibit attention and memory biases for threatening social information (e.g., Asmundson & Stein, 1994; Mansell & Clark, 1999). The evidence for these cognitive biases is reviewed in the following section of the paper.

Negative Beliefs and Expectancies Regarding Social Situations

A number of studies indicate that individuals experiencing high levels of social anxiety tend to hold negative beliefs about themselves and their ability to perform in social situations, tend to exhibit negative expectancies regarding the outcomes of potential social situations, and tend to perceive social experiences in a negative manner (e.g., Amir, Foa & Coles, 1998; Foa, Franklin, Perry, & Herbert, 1996; Leary et al., 1988; Lucock & Salkovskis, 1988; Stopa & Clark, 1993, 2000). For example, Leary et al. (1988) reported that individuals high on social anxiety tend to believe that other people will evaluate them negatively across a wide range of social situations—even if the contact is very brief. Similarly, Lucock and Salkovskis (1988) reported that individuals with social phobia were more likely than non-clinical control participants to expect negative social events to happen to them and were less likely to expect positive social events to happen to them.

Amir et al. (1998) found that individuals with social phobia were more likely to interpret ambiguous social scenarios in a negative manner in comparison to non-anxious controls and individuals with other anxiety disorders. Stopa and Clark (1993, 2000) also found that individuals with social phobia were more likely to interpret ambiguous social events in a negative manner than were non-anxious controls and controls with different anxiety disorders. In addition, they reported that individuals with social phobia were more likely to interpret mildly negative social events in a catastrophic manner than were control participants. Taken together, these findings provide strong support for the hypothesis that individuals experiencing high levels of social anxiety tend to hold negative beliefs about themselves, tend to expect negative outcomes to occur in social situations, and tend to perceive social situations as more threatening and negative than do others.

Attention Bias for Threatening Social Information

Socially-anxious individuals also tend to exhibit an attention bias for negative and threatening social information (e.g., Amir & Foa, 2001; Asmundson & Stein, 1994; Becker, Rinck, Margraf, & Roth, 2001; Hope, Rapee, Heimberg, & Dombeck, 1990; Lundh & Ost, 1996a; Mattia, Heimberg, & Hope, 1993), although some of the evidence has been mixed (e.g., Amir et al., 1996). For example, Hope et al. (1990) investigated attention bias among individuals with social phobia, panic disorder, and matched controls on the revised Stroop task. These researchers reported that individuals with social phobia exhibited longer response latencies for words that were associated with social threat (e.g.,

'embarrassed'), but did not exhibit longer response latencies for physical threat words or matched control words. In contrast, individuals with panic disorder exhibited longer response latencies for physical threat words, but did not exhibit longer response latencies for social threat words. Several other studies have reported similar results using the revised Stroop task (e.g., Becker et al., 2001; Lundh & Ost, 1996a; Mattia et al., 1993). Using the dot-probe paradigm, Asmundson and Stein (1994) reported that individuals with social phobia responded faster to probes following social threat words than to probes following physical threat or neutral words, whereas no differences in response times to the different stimuli were found among control participants. Thus, much of the available evidence suggests that individuals experiencing high levels of social anxiety exhibit an attention bias for threatening social information.

Memory Bias for Threatening Social Information

There is also some evidence that socially-anxious individuals exhibit a memory bias for negative and threatening social information (e.g., Breck & Smith, 1983; Lundh & Ost, 1996b; Mansell & Clark, 1999); however, there are also a number of studies that have failed to find evidence of a memory bias among socially-anxious participants (e.g., Cloitre, Cancienne, Heimberg, Holt, & Liebowitz, 1995; Rapee, McCallum, Melville, Ravenscroft & Rodney, 1994). For example, Rapee et al. (1994) investigated the possibility of a memory bias for threatening social information among individuals with social phobia in a series of four studies. These researchers failed to find any support for a memory bias among individuals with social phobia. The study used several different

tasks to assess for possible memory biases, including free recall, cued recall, recognition, and stem-completion tasks using socially threatening, physically threatening, and neutral words; however, in each case, there was no evidence for a memory bias. Cloitre and colleagues (1995) also failed to find a memory bias for social threat words using recognition and free-recall tasks.

In contrast, Breck and Smith (1983) reported a memory bias for negative social information among individuals reporting high levels of social anxiety using a free-recall task; however, this bias only occurred when socially-anxious individuals were led to believe that they would have to interact with a stranger at a later point in the experiment. Similarly, Mansell and Clark (1999) found that individuals high on social anxiety recalled fewer positive self-referent words than individuals low on social anxiety when they were told that they would have to give a speech prior to recall; however, the bias did not occur when the social threat induction procedure was not used.

Lundh and Ost (1996b) demonstrated a memory bias for threatening social information using a different social-threat induction procedure. They hypothesized that since "the basic fear in social phobia is about being negatively evaluated by others" (p. 787) that "a memory bias in social phobia may be most likely to appear with an encoding task which activates the social fears of negative evaluation in a more direct way" (p. 788). Accordingly, they asked participants to rate a series of 20 photographs of faces on the degree to which the faces appeared to be either "critical" or "accepting." Five minutes later, the participants were given a surprise recognition task in which they were asked to identify the 20 faces they had seen previously from among a group of 80 photographs

which also contained 60 distractor photographs. Lundh and Ost reported that the social phobia group recognized more of the critical faces than did the control group, whereas the control group recognized more of the accepting faces than did individuals with social phobia.

Taken together, these results suggest that under normal conditions, socially-anxious individuals may not exhibit a memory bias for negative social information; however, there is growing evidence that socially-anxious individuals may exhibit a memory bias for negative social information under conditions of imminent social threat (Breck & Smith, 1982; Hirsch & Clark, 2004; Lundh & Ost, 1996b; Mansell & Clark, 1999).

BIS, BAS, and Bias

The Role of BIS Sensitivity in Social Anxiety

Building upon the work of Gray (Gray, 1972, 1982, 1990, 1991, 1994) and McNaughton (Gray & McNaughton, 2000; McNaughton & Corr, 2004), Kimbrel (2008) has proposed that many of the cognitive biases observed among socially-anxious individuals are the direct result of heightened BIS sensitivity. Specifically, because the BIS is proposed to engage in external and internal scanning for threat-relevant information in response to threatening and potentially threatening situations (Gray & McNaughton, 2000), Kimbrel proposed that the BIS may be the personality/biological basis for the attention and memory biases that have been observed among individuals with high levels of social anxiety under conditions of social threat (e.g., Asmundson &

Stein, 1994; Breck & Smith, 1983; Lundh & Ost, 1996b; Mansell & Clark, 1999). Gray and McNaughton have also reported that the septo-hippocampal system, a major component of the BIS, sends simple feedback signals to other areas of the brain, including higher level goal processing areas, like the prefrontal cortex. According to Gray and McNaughton, the function of these feedback signals is to increase the valence of threatening information in these areas of the brain. Building upon this idea, Kimbrel proposed that this biasing process might be the biological basis for the conscious negative beliefs and expectancies that individuals with high levels of social anxiety frequently report (e.g., Leary et al., 1988) and hypothesized that:

> As a result of this biased information processing, [socially-anxious individuals] are predicted to perceive (i.e., interpret) novel and ambiguous social situations as highly threatening. The end result of this powerful biasing process should be consistent fear and avoidance of actual or potentially threatening social situations. Additionally, over time, it is expected that [socially-anxious individuals] will come to develop negative beliefs, schemas, and expectancies concerning social situations and their ability to perform in them as a result of their chronically-elevated perceptions of threat. Importantly, the proposed model provides a theoretical rationale for Hirsch and Clark's (2004) observation that memory biases among [socially-anxious individuals] are most likely to occur following a social threat induction procedure. From the perspective of the proposed model, potentially threatening social situations should produce the most pronounced

> information processing biases as these situations often entail goal conflict and should result in the BIS entering into "control mode," which should lead to increased external scanning for threat cues as well as increased internal scanning for threat cues (Kimbrel, 2008, p. 605).

Thus, this model proposes that cognitive biases for negative and threatening social information mediate the effect of BIS sensitivity on social anxiety under conditions of imminent social threat (see Figure 1).

To date, this model of social anxiety has not been tested directly; however, the existing research does provide some support for this proposal. For example, as mentioned above, BIS sensitivity and neuroticism have both been associated with increased social anxiety (Bienvenu et al., 2004; Coplan et al., 2006; Kashdan & Roberts, 2006; Kimbrel et al., 2008; Stemberger et al., 1995), and social anxiety has been consistently associated with cognitive biases for negative and threatening social information (e.g., Asmundson & Stein, 1994; Hirsch & Clark, 2004; Leary et al., 1988; Lundh & Ost, 1996b; Mansell & Clark, 1999; Musa & Lepine, 2000). In addition, BIS sensitivity has been associated with lower levels of control beliefs (Windsor, Anstey, Butterworth, & Rodgers, 2008), a cognitive tendency to focus on negative information (Noguchi, Gohm, & Dalsky, 2006), increased recall of negatively-valenced words in a free-recall task (Gomez & Gomez, 2006), a tendency to choose negative words to complete word fragments (Gomez & Gomez, 2006), and enhanced recognition of negatively-valenced words (Gomez & Gomez, 2006).

Research on the relationship between BIS-related personality traits and cognitive bias provides some additional support for this hypothesis. For example, Derryberry and Reed (1994) reported that neurotic introverts tended to exhibit an attention bias for negative cues relative to stable extraverts. Given that neurotic introverts should be high on BIS, whereas stable extraverts should be low on BIS (Gray, 1991), this finding provides additional support for the hypothesis that individuals high on BIS exhibit an attention bias for negative information. High levels of neuroticism have also been associated with a tendency toward recalling more negative memories and thoughts about oneself (e.g., Martin, Ward, & Clark, 1983; Mayo, 1983; Ruiz-Caballero & Bermudez, 2001), a tendency to hold negative beliefs and the world and ones ability to cope with it (Langston & Sykes, 1997), and a tendency to engage in rumination and dysfunctional beliefs (Lam, Smith, Checkley, Rijskijk, & Sham, 2003).

In sum, there is growing evidence that heightened BIS sensitivity is associated with social anxiety and with a cognitive bias for negative and threatening information. There is also substantial evidence that suggests that social anxiety is associated with cognitive biases for negative and threatening social information. Thus, while the hypothesis that cognitive biases mediate the effect of BIS sensitivity on social anxiety has not been tested directly, this proposal is consistent with the available evidence.

The Role of BAS Sensitivity in Social Anxiety

While Kimbrel's (2008) model primarily focuses on the role of BIS sensitivity in the development and maintenance of social anxiety, it also proposes that low BAS

sensitivity plays a significant, albeit modest, role in social anxiety due to the interdependent nature of the BIS and BAS systems. This proposal is based on Corr's (2002) joint-subsystems hypothesis, which posits that the BIS and BAS have antagonistic and facilitory effects upon behavior and are functionally interdependent. If Corr's (2002) joint-subsystems hypothesis is correct, then low levels of BAS sensitivity should facilitate high BIS sensitivity and should lead to more anxiety and avoidance in response to threatening social stimuli. Accordingly, Kimbrel (2008) proposed that low BAS sensitivity represented an additional risk factor for the development of social anxiety.

To date, research examining the role of low BAS sensitivity in social anxiety has been mixed (e.g., Coplan et al., 2006; Kashdan, 2002; Kashdan & Roberts, 2006; Kimbrel, Robertson, et al., 2007; Kimbrel et al., 2008). For example, consistent with the joint-subsystems hypothesis, Kashdan (2002) reported a negative correlation between self-reported BAS sensitivity and social anxiety among a large sample of college students. Similarly, Coplan et al. (2006) reported that BAS sensitivity was negatively associated with two of three measures of social anxiety among a community sample of children. In contrast, both Kashdan and Roberts (2006) and Kimbrel et al. (2008) failed to find a significant relationship between self-reported BAS sensitivity and social anxiety among non-clinical samples of adults; however, in both cases there was a trend toward a negative relationship between BAS and social anxiety symptoms.

Kimbrel and colleagues recently conducted the most comprehensive study to date on the relationship between low BAS and social anxiety (Kimbrel, Robertson, et al., 2007). In this study, two large independent samples of undergraduates (N = 181 and N =

543) completed multiple measures of BIS, BAS, and social anxiety symptoms. Principal component analysis was used to construct composite variables for BIS, BAS, and social anxiety, and hierarchical regression analyses were used to test the hypothesis that low BAS contributes uniquely to the prediction of social anxiety. As predicted, low BAS was a significant predictor of social anxiety symptoms in both samples after accounting for BIS sensitivity; however, the effect of low BAS sensitivity on social anxiety was modest in comparison to the effect of high BIS in both samples.

Given the growing evidence of a relationship between low BAS and social anxiety, the second objective of the current study was to gather additional evidence on the relationship between low BAS sensitivity and social anxiety. Consistent with Corr's (2002) joint-subsystems hypothesis and Kimbrel's (2008) mediated model of social anxiety, it was hypothesized that the effect of low BAS sensitivity on social anxiety would also be mediated by cognitive biases for negative and threatening social information. While no previous study has directly examined the relationship between BAS sensitivity, cognitive bias, and social anxiety, this hypothesis was consistent with current RST theory (e.g., Corr, 2002; Gray, 1990, 1991, 1994; Gray & McNaughton, 2000). For example, referring to both the BIS and BAS, Gray (1990) argued that "neurobiological research with animals suggests that the brain systems mediating emotion overlap with those mediating cognition to such a degree that it is difficult to maintain any clear distinction between them" (p. 269).

This hypothesis is also consistent with previous research. For example, high BAS sensitivity has been associated with positive expectancies (Beevers & Meyer, 2002),

increased approach goals (Jones, Shams, & Liversidge, 2007), higher levels of perceived control (Windsor, Anstey, Butterworth, & Rodgers, 2008), and a cognitive tendency to focus on positive information (Noguchi et al., 2006). A study conducted by Gomez and Gomez (2002) found that high BAS sensitivity was associated with increased recall of positively-valenced words in a free-recall task, a tendency to choose positive words to complete word fragments, enhanced recognition of positively-valenced words, and decreased recall of negatively-valenced words in a free-recall task. In addition, Beevers and Meyer (2002) reported that decreased positive experiences and decreased positive expectancies mediated the effect of low BAS sensitivity on symptoms of depression. Thus, while no previous study has directly examined the relationship between low BAS sensitivity, cognitive bias, and social anxiety, the hypothesis that cognitive biases would mediate the effect of low BAS on social anxiety was consistent with both current theory and research.

Study Objective

The primary objective of the current study was to test the hypothesis that cognitive biases for negative and threatening social information mediate the effect of BIS and BAS sensitivity on social anxiety. To test this hypothesis, participants were initially asked to complete measures of BIS, BAS, and trait social anxiety. A social-threat induction procedure was employed next. Specifically, participants were told that they would be asked to give a short speech at the end of the study. This procedure was immediately followed by a counter-balanced battery of cognitive tasks assessing memory

bias, belief bias, expectancy bias, attention bias, and perception of threat. After the participants completed the cognitive battery, their level of state anxiety was assessed via self-report immediately before they began the speech task. Participants were then randomly selected and asked to give a brief impromptu speech. After each speech, the speaker's level of anxiety during the speech was rated by the audience members. Correlational analyses were used to examine the relationships among the study variables, and structural equation modeling (SEM) was used to test the hypothesized model (Figure 2) against other alternative models.

CHAPTER II

METHOD

Participants

Two-hundred and nineteen undergraduate students were recruited from the University of North Carolina at Greensboro subject pool to participate in the study. Age and fluency in English were the only exclusionary criteria for participation in the study. Specifically, since personality is typically not viewed as fully formed until 18 years of age (APA, 2000), and since personality was an integral part of the current study, only participants who were 18 years of age or older and fluent in English were eligible to participate. All of the participants received course credit for their participation in the study.

Twelve participants (approximately 5%) scored above the recommended cut-off score of three or higher on the Infrequency Scale (IFS; Chapman & Chapman, 1986), which suggests that it is likely that these participants used a random response style while completing the initial battery of questionnaires. Accordingly, these participants were excluded from all of the statistical analyses, yielding a final sample of 207 participants. Of the remaining sample of 207 participants, 50 (24%) scored at or above the clinical cut-off score of 24 on the Social Phobia Scale (Heimberg, Mueller, Holt, Hope, & Liebowitz, 1992), which suggests that approximately one-fourth of the final sample was experiencing clinically-significant levels of social anxiety at the time of the study. Sixty-

seven percent of the final sample was female, and 70% of the final sample was Euro-American, both of which were consistent with the University's demographic profile. The participants' mean age was 19.1 years (*SD* = 5.8) and their mean cumulative grade point average was 3.3 (*SD* = .59). Table 1 provides a summary of the participants' demographic information.

Materials

Demographic Form – Participants were asked to provide basic demographic information about their age, gender, ethnicity, college standing, and cumulative grade point average on a demographic form at the beginning of each study session.

Sensitivity to Punishment and Sensitivity to Reward Questionnaire – The Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Avila, Molto, & Caseras, 2001) is a 48-item binary response self-report measure used to assess individual differences in BIS and BAS sensitivity. The SPSRQ contains a 24-item sensitivity to punishment subscale that assesses BIS sensitivity and a 24-item sensitivity to reward subscale that assesses BAS sensitivity. The SPSRQ has demonstrated good internal consistency and test-retest reliability in several previous studies (e.g., Torrubia et al., 2001; Torrubia, Avila, Molto, & Grande, 1995). The SPSRQ has also demonstrated good convergent validity with laboratory measures (Avila, 2001), self-report measures (Brebner & Martin, 1995; Caseras, Avila, & Torrubia, 2003), and with relevant brain structures (i.e., the hippocampal formation and amygdala) using voxel-based morphometry (Barrós-Loscertles et al., 2006).

Infrequency Scale – The Infrequency Scale (IFS; Chapman & Chapman, 1986) is a 13-item scale designed to assess random responding. IFS items were intermixed among the SPSRQ items to provide an index of random responding. Sample items include "On some mornings do you get out of bed when you wake up?" and "Can you remember a time when you talked with someone who wore glasses?" Scores of three or higher indicate a random response style. Consequently, participants who scored three or higher on the IFS (N = 12) were not used in any of the statistical analyses.

Social Phobia Scale – The Social Phobia Scale (Mattick & Clarke, 1998) is a 20-item self-report measure that was administered to participants to assess their trait levels of social anxiety. Respondents rated the level of expected anxiety they would experience while performing a variety of different activities in public settings, such as eating and speaking in public. The Social Phobia Scale is a well-established measure of social anxiety symptoms that has demonstrated excellent reliability and validity in previous research studies (e.g., Heimberg et al., 1992; Herbert, Rheingold, & Brandsma, 2001; Orsillo, 2001; Osman, Gutierrez, Barrios, Kopper, & Chiros, 1998). A score of 24 or higher on the Social Phobia Scale indicates that a diagnosis of social phobia is likely and that social anxiety symptoms are clinically significant (Heimberg et al., 1992). In the current study, the Social Phobia Scale was used only to validate the social threat manipulation and the state anxiety measures. Specifically, it was assumed that if the social-threat manipulation was successful, that there would be a positive correlation between scores on the Social Phobia Scale and scores on the state anxiety measures.

State-Trait Anxiety Inventory – The state version of the State-Trait Anxiety

Inventory (Spielberger, Lushene, Vagg, & Jacobs, 1983) is a 20-item self-report measure designed to assess levels of state anxiety. The state version of the State-Trait Anxiety Inventory has been widely used in clinical and research settings, and it has demonstrated good reliability and validity in previous research applications (Spielberger et al., 1983). In the current study, the State-Trait Anxiety Inventory was used as a measure of state anxiety in response to the speech task.

Positive and Negative Affect Schedule – The Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) is a 20-item self-report measure used to assess positive and negative affect. The 10-item Positive Affect scale is used to assess positive affect, whereas the 10-item Negative Affect scale is used to assess negative affect. The PANAS has consistently demonstrated good reliability and validity in previous research studies (e.g., Watson et al., 1988; Watson & Clark, 1994; Watson & McKee Walker, 1996). Indeed, Thompson (2007) notes that the PANAS has been "exceptionally well-validated" and has been cited in over 2,000 scholarly papers (Thompson, 2007, p. 228). In the current study, the Negative Affect scale was used as a measure of state anxiety in response to the speech task.

Beck Anxiety Inventory – The Beck Anxiety Inventory (Beck, Epstein, Brown, & Steer, 1988) is a 21-item self-report measure of physiological anxiety symptoms. The Beck Anxiety Inventory has been widely used in both research and clinical settings, and it has demonstrated good reliability and validity in previous research applications (e.g., Beck et al., 1988; Osman, Kopper, Barrios, Osman, & Wade, 1997). In the current study, the directions of the Beck Anxiety Inventory were altered so that participants were asked

to rate the degree to which they were currently experiencing the symptoms listed in response to the impending speech task. Thus, in the current study, the Beck Anxiety Inventory was used as a measure of state anxiety in response to the speech task.

Audience Rating of Anxiety – Participants' level of state anxiety during the speech task was also rated by the audience members on the Audience Rating of Anxiety scale. Specifically, each of the audience members (i.e., all of the participants and experimenters present in each study session) was provided with a copy of the Audience Rating of Anxiety scale and was instructed to rate "how anxious or nervous the speaker appeared while giving the speech" immediately after each speaker finished the speech task. The speakers were rated on a five-point Likert scale that ranged from 1 = "not nervous at all" to 5 = "very nervous." The Audience Rating of Anxiety scores for each participant were averaged across all available raters to produce an average Audience Rating of Anxiety score for each participant that gave a speech. The Audience Rating of Anxiety scale was included in the current study so that a latent variable for social anxiety in response to the speech task could be created that included both self-report data and independent behavioral observations.

Self-Statements During Public-Speaking Scale – The Self-Statements During Public-Speaking Scale (Hofmann & DiBartolo, 2000) is a 10-item self-report measure designed to assess beliefs related to public speaking. The Self-Statements During Public-Speaking Scale contains two subscales—the Positive Self-Statements subscale and the Negative Self-Statements subscale. Both of the subscales have demonstrated good internal consistency, good test-retest reliability, and good convergent and discriminant

validity in clinical and non-clinical samples (Hofmann & DiBartolo, 2000). The wording of the Self-Statements During Public-Speaking Scale was modified in the current study so that participants were asked to endorse whether the self-statements were indicative of their current thoughts as they anticipated giving the speech, rather than their thoughts during the past two weeks.

Speech Expectancies Scale – The Speech Expectancies Scale is a simple self-report measure that was designed for the current study to assess participants' expectations regarding the speech task. The Speech Expectancies Scale was created for the current study because of the lack of available instruments to assess speech expectancies regarding an impending speech task. The scale consisted of six items and two subscales—the Positive Speech Expectancies scale and the Negative Speech Expectancies scale. Participants rated each item on a 5-point Likert scale ranging from "1 = not at all" to "5 = very." The Positive Speech Expectancies scale consisted of three items: "Please rate how likely you think it is that your peers will evaluate you positively during the speech," "Please rate how likely you are to perform well during the speech task," and "Please rate how likely you think it is that giving this speech will be an enjoyable experience." The Negative Speech Expectancies scale consisted of the following three items: "Please rate how likely you think it is that your peers will evaluate you negatively during the speech," "Please rate how likely you are to perform poorly during the speech task," and "Please rate how likely you think it is that giving this speech will be a terrible experience." Both scales exhibited good internal consistency in the current study (see Table 5).

Perception of Threat Rating – Because Kimbrel (2008) hypothesized that socially-anxious individuals would perceive social and performance situations as more threatening than individuals who were not socially anxious, the participants were also asked to provide Perception of Threat ratings regarding the speech task on a five-point Likert scale at the end of the Speech Expectancies Scale. Specifically, each of the participants was asked to rate "How threatened do you feel by the prospect of having to give a speech in front of your peers?" on a five-point Likert scale that ranged from "Not at all" to "Very." This rating scale was administered along with the other cognitive measures in the cognitive task battery that participants completed before beginning the speech task.

Incidental Free Recall Task – An incidental free recall task was used to assess memory bias for negative and threatening social information. During the encoding phase of this task, participants were asked to rate whether or not a list of 38 trait words described how others would view them during the speech task. Table 2 provides the complete list of stimulus words used in the free recall task. Half of the words were negative words associated with social anxiety and poor social performance (e.g., nervous, tense), whereas the other half were positive words associated with social success (e.g., confident, composed). The majority of these words were selected from previous studies examining cognitive biases for threatening and non-threatening social words among socially-anxious individuals (e.g., MacLeod, Matthews, & Tata, 1986; Mansell & Clark, 1999; Matthew et al., 1989).

The first and last four words in the word list served as primacy and recency

buffers and were not included in the statistical analysis of memory bias (Mansell & Clark, 1999). The test set of 30 words (15 negative words and 15 positive words) in the middle of the word list was equated on word length and word frequency with the ratings provided by Balota et al. (2002). The Hyperspace Analogue to Language (HAL) norms (Lund & Burgess, 1996) for word frequency were used to determine word frequency. The HAL norms for word frequency were chosen because they are the most recent word frequency norms available and because they have been shown to be stronger predictors of lexical decision time than the Kucera and Francis (1967) norms (Balota, Cortese, Sergent-Marshall, Spiegler, & Yap, 2004). To control for serial position effects, three versions of the word list were produced. In each list, the primacy and recency buffers remained the same; however, three randomly-generated versions of the 30 test items were created with the stipulation that there be no more than two positive or two negative words in a row (Mansell & Clark, 1999).

Following the encoding task, participants were cognitively distracted for two minutes with the distraction procedure used by Breck and Smith (1983). Specifically, participants were asked to cross out the letter "E" from a page of random letters for 2 minutes. Afterwards, participants were asked to write down as many of the traits as they could remember from the list of traits they rated during the encoding task. Following the recall task, participants completed a second cognitive distraction task to ensure that the recalled words were not primed while they completed the other cognitive tasks. The second cognitive distraction task used a different grid of letters than the first; however, it was identical to the first in all other respects.

Embedded Word Task – The Embedded Word Task (Wenzlaff et al., 2001) was used to assess attention bias for threatening social information. This task is essentially the same as a "word search" game. Thus, participants were instructed to search a letter grid for hidden words and to write down all of the words that they were able to find during a four-minute time period. Three different versions of the Embedded Word Task were created using the commercial software program, 1-2-3 Word Search Maker ®, to control for the position and arrangement of words across participants. Each of the three versions of the Embedded Word Task was visually inspected to ensure that there were no readily apparent solutions (e.g., the word "awkward" being readily apparent in the middle of the puzzle).

Three different valence categories of words were used: negative social words (e.g., awkward), positive social words (e.g., achieve), and neutral words (e.g., lawn). The neutral words were included to divert participants' attention away from the social nature of the words. All stimulus words were between 3 and 7 letters in length. Negative social words, positive social words, and neutral words were chosen from previous studies examining cognitive biases for threatening and non-threatening social words among individuals with high levels of social anxiety (e.g., MacLeod et al., 1986; Mansell & Clark, 1999; Matthew et al., 1989); however, all of the words used in the Embedded Word Task were different from those that were used in the free recall task. Positive and negative words that appeared to be particularly relevant to self-presentational concerns about giving a speech (e.g., "stupid," "calm") were selected when available. Neutral words were drawn from the same studies as well as other studies examining cognitive

biases with other types of clinical populations (e.g., Wenzlaff et al., 2001). As with the free-recall task, each set of ten words was equated on word length and word frequency with the ratings provided by Balota et al. (2002). The HAL norms (Lund & Burgess, 1996) were used to determine word frequency. Table 3 provides the complete list of stimulus words that were used in the Embedded Word Task.

The Embedded Word Task was conducted in the same way that it had been conducted in previous research with one important exception. In previous studies, participants were given a lengthy number to remember while they were completing the task to put them in a state of "cognitive load." However, the current study did not use a cognitive load procedure because Kimbrel (2008) hypothesized that social threat alone should be sufficient to induce a cognitive bias for negative and threatening social information. Accordingly, the cognitive load procedure was not used in order to provide the most stringent test of Kimbrel's social threat hypothesis.

Behavioral Assessment Test – At the end of the study, participants were asked to participate in a Behavioral Assessment Test (BAT). Specifically, participants were asked to prepare and give a short speech on a controversial topic in front of the other participants. Approximately half way through the study, all of the participants were given a Speech Topics Form and were instructed to choose a speech topic from among five different controversial speech topics, including "Should gay marriage be legalized?," "Should drugs be legalized?," "Should animal research be made illegal?," "Should tobacco be outlawed?," and "Wrestling and football: Should females be allowed to compete?" This portion of the study served as the main social threat induction procedure.

The speech topics were chosen for inclusion in this study on the basis that they be both relevant to college students and at least somewhat controversial in nature. Controversial topics were chosen to ensure that there was a possibility of negative evaluation from other participants in the study.

At the beginning of the social threat induction procedure, the Speech Topics Form was passed out, and all of the participants were given three-minutes to collect their thoughts about the speech topic. They were also asked to circle which speech topic they would speak about, and they were allowed to make notes on Speech Topics Form. This form was then collected from the participants after the three minute period was over to ensure that the speeches were impromptu in nature. Participants then completed the cognitive tasks in counter-balanced order. After the cognitive tasks were completed, the participants completed the state anxiety measures in counter-balanced order. After all of the state anxiety measures had been completed, the Public-Speaking Performance Rating Scale (PSPRS) was passed out to participants. A random numbers table was used to randomly select participants for the BAT.

Once selected, participants were asked to go to the front of the classroom and to give their speech. Most of the speeches were less than a minute and none of the speeches lasted longer than 3 minutes. After each speaker completed the speech task, the research assistants and other participants rated the speaker on the PSPRS. Participants were instructed to not rate themselves on the PSPRS and to instead skip that section and move on to the next participant. All participants were asked to complete the speech task until each participant had gone or until the 2-hour mark had been reached, at which time the

BAT was discontinued. Of the 207 participants, four participants refused to participate in the BAT. In addition, 40 participants were unable to complete the task because the 2-hour time mark was reached before they were called. Thus, a total of 163 participants (79%) completed the BAT.

Public Speaking Performance Rating Scale – The PSPRS was a modified version of the Social Performance Rating Scale (SPRS; Fydrich, Chambless, Perry, Buergner, & Beazley, 1998) that was used by the participants and the experimenters to rate the participants' public speaking ability during the speech task. The primary purpose of including the PSPRS in the current study was to enhance the social-threat induction procedure by making participants more aware of the fact that they would be evaluated by the audience members during the speech task. A secondary purpose for including the PSPRS in the current study was to collect pilot data for future studies concerning the manner in which audience members perceive individuals with social anxiety while they are speaking in public.

The SPRS, which is the measure that the PSPRS was derived from, has demonstrated good reliability and validity in two previous studies (Fydrich et al., 1998; Harb, Eng, Zaider, & Heimberg, 2003); however, since the SPRS was originally developed to assess behavior during a one-on-one role play procedure, the original version of the SPRS was unsuitable for use in the current study. Accordingly, the PSPRS was created to allow untrained audience members to rate their perceptions of the speakers' public-speaking abilities. The six items on the PSPRS asked audience members to rate each of the speakers' performance on several key dimensions of public-speaking

(e.g., gaze, vocal quality, enthusiasm) using a 5-point Likert scale. Internal consistency for the six-item PSPRS in the current study was excellent ($\alpha = .97$), indicating that it may be possible in the future to reliably measure perception of public-speaking performance with untrained observers; however, because public-speaking performance was not the variable of interest in the current study, and because approximately 20% of the participants did not complete the speeches, the data collected from this measure were viewed as exploratory in nature and were not included in the statistical analyses.

Procedure

Recruiting procedure and group size. Participants signed up for the study through the Momentum™ website in small groups. In all, 24 separate sessions were conducted. The mean number of participants per group was 9.1 (*SD* = 5.4). The number of participants per group ranged from two to nineteen participants. All of the sessions were conducted in two identical classrooms that contained approximately 25 seats each.

Protocol. A detailed research protocol was developed for the study to ensure that the study was conducted in a consistent manner. The protocol specified all of the procedures that the research assistants (RAs) were to follow while conducting the study. The protocol also included written instructions for all aspects of the study which were read verbatim by the RAs. There were at least two RAs present for every session. The first RA was designated as Experimenter 1, and the primary job of this RA was to communicate to the participants and to read the protocol verbatim. Only graduate students and senior-level undergraduate students who had been trained by the principal

investigator were allowed to serve as Experimenter 1. The primary responsibility of the Experimenter 2 position was to quickly pass out and collect measures from the participants. Typically, undergraduate RAs with less research experience served in the role of Experimenter 2. All RAs received extensive training from the PI and other trained RAs prior to conducting the study.

Consent procedure and the initial battery of measures. Upon arrival, participants were asked to sit at desks. On top of each desk there was a copy of the consent form, a packet of questionnaires, and a Post-It © note in the upper right corner that contained the ID number that corresponded to the packet of questionnaires. The consent form explained the basics of the study and stated that all participants would be asked to give a short speech at the end of the study. All participants were asked to read and sign the consent form before going any further. In addition, all participants were given an opportunity to ask questions about the consent form and to withdraw if they so chose. No participants withdrew from the study during the consent procedure; however, four participants did choose to discontinue at later points in the study because they did not want to participate in the BAT. After the consent forms were signed and collected, the participants were instructed to complete the initial packet of questionnaires as carefully as possibly and then to sit quietly until the other participants had completed their packets. The initial packet of questionnaires contained the demographic form, the SPSRQ, and the Social Phobia Scale.

Social-threat induction procedure. After all of the initial packets of measures had been completed and collected, Experimenter 2 handed out the Speech Topics Form to the

participants while Experimenter 1 instructed them as follows:

> "As I said before, in this study, we are interested in examining how well personality predicts performance and psychological functioning. Accordingly, in this part of the study, you will be asked to perform a variety of tasks, including completing a variety of word problems and preparing and performing an impromptu speech in front of the other participants on a controversial topic. I would like to state right away that unlike some other studies you may have heard about or may have participated in, we are in no way deceiving you about the speech task. It is a critical part of this study, and each of you will be required to give a speech at the end of the study. In addition, you should know that your speeches will be evaluated by the other participants on the Speech Performance Evaluation Sheets that we will provide to you. We have structured the study so that the speech task is the last phase of the study because the length of the speech task depends entirely on the number of participants present for a particular study. Thus, after we complete the remaining performance tasks, we will proceed to the speech task. Does anyone have any questions about the speech task before we go any further?"

After Experimenter 1 answered participant questions, the participants were provided with the following instructions:

> "Please look at the form we just provided you with. Now, look at the participant ID

number that is written down on the piece of paper in the upper right hand corner of the desk. Please write that number clearly and neatly on the form we just gave you where it says ID Number in the upper right hand corner. You will need to do this for each measure that you are given for the remainder of the study. Thank you. Now, as I said before, we are interested in how personality predicts performance, and you will be asked to perform a variety of performance tasks today. The last task, which will be approximately 20 minutes from now, involves giving an impromptu speech in front of the other participants. At this time, we would like to give you a few minutes to determine your speech topic and to collect your thoughts. You may choose to speak on one of the following topics: 'Should gay marriage be legalized?', 'Should animal research be illegal?', 'Should tobacco be outlawed?', 'Should prayer be allowed in school?', and 'Wresting and football: Should women be allowed to compete?' Please circle the topic that you will speak on and then take the next 3 minutes to write down the main points that you want to make. You may write down your thoughts on this paper if you choose; however, we will be collecting these pieces of paper in a few minutes as the goal of this task is to asses your ability to perform an *impromptu* speech. You may begin now."

Experimenter 2 used a stopwatch to time this portion of the study. After 3 minutes, the Speech Topics Forms were collected from the participants. After the social threat induction procedure was completed, the cognitive tasks (i.e., memory, attention, beliefs, expectancies, perception of threat rating) were administered to the participants in

counter-balanced order to control for order effects.

Memory task. During the memory task portion of the cognitive battery, participants were given the Word Rating Form and were told the following:

> "In front of you is a list of words that can be used to describe people while they are performing speeches. Please rate whether or not you think each of the following words describes how you will look while you are giving your speech. If you think that a word describes how you will look while you're giving your speech, place a checkmark next to it."

After the word rating forms had been collected, the participants were given a page of random letters and were instructed to cross out every letter "E" they saw as quickly as they could for two minutes. Participants were then provided with the Memory for Words Form and were instructed to write down as many of the traits as they could remember from the Word Rating Form they had seen during the encoding task. Participants were given four minutes to complete this task. Afterwards, participants completed a second cognitive distraction task that was identical to the first with the exception that the letter grid was different. The second cognitive distraction procedure was included to ensure that the recalled words were not primed while participants completed the other cognitive tasks.

Attention task. During the attention task portion of the cognitive battery, the Embedded Word Task was passed out to participants, and they were instructed as

follows:

> "In front of you is a word search puzzle. Please try to find as many words as you can during the next four minutes. Words can go forward, backward, horizontally, vertically, and diagonally in all eight directions. When you find a word, circle it, then write it down immediately. You may begin now."

After four minutes, the Embedded Word Tasks were collected.

Beliefs, expectancies, and perception of threat battery. To save time, the Speech Expectancies Scale, the modified version of the Self-Statements during Public-Speaking Scale, and the Perception of Threat rating scale were administered to participants within the same packet; however, within this packet, the measures were counter-balanced to control for order effects. In addition, this battery of questionnaires was counter-balanced with the attention and memory tasks. After the packets of questionnaires were given to the participants, they were instructed as follows:

> "These questionnaires assess different beliefs and expectations that people have regarding speaking in public. Please read the directions carefully and then complete each questionnaire as carefully as you can. You can raise your hand when you are done, and we will come around to collect them from you."

State anxiety battery. After the cognitive battery was finished, the participants

were given the state anxiety battery. This battery of questionnaires contained the Beck Anxiety Inventory, State-Trait Anxiety Inventory, and PANAS in randomized order. After receiving the packets, the participants were instructed as follows:

> "In front of you are three measures that assess how you are feeling RIGHT NOW as you anticipate getting ready to give your speeches, which will be the next and final part of the study. Please take your time and complete the measures in front of you as *carefully* as you can. The instructions for each measure are written at the top of the page; please read these instructions carefully and be sure to fill in the bubbles completely so that they will scan correctly. Please raise your hand when you are done, and we will come around to check your packets and collect them if you are done. You may begin now."

Behavioral assessment task. After all of the participants had completed the state anxiety battery, the PSPRS forms were passed out to the participants, and the following instructions were provided to the participants:

> "Please write down your ID number in the top right corner and enter in today's date. As each speaker announces their ID number, write it down. Then rate each speaker using the scale provided. Continue doing this until all of the speakers are done. Also, please do not rate yourself. Instead, just skip that one and move on to the next one when it is your turn to speak."

A random numbers table was used to determine the order in which speakers would be announced prior to beginning the speech task. When called, each speaker walked to the front of the room, announced their ID number, announced the topic of their speech, and proceeded to give their speech. Most of the speeches were short and less than one minute. After each speaker finished, the audience applauded briefly and then rated the speakers on the PSPRS and the Audience Rating of Anxiety scale. This process continued until all of the participants had given their speech or until the two-hour time limit was reached. Once either of these occurred, the speech task was discontinued. Participants were then debriefed and given experimental credits commensurate with the amount of time they had spent in the study. Table 4 provides a summary of the procedures and measures employed in the current study.

CHAPTER III

RESULTS

Preliminary Statistical Analyses

Means, standard deviations, and alphas were calculated for all of the measures used in the current study (Table 5). The internal consistency for the self-report measures ranged from .78 (Sensitivity to Reward scale) to .96 (State-Trait Anxiety Inventory), which indicates that the internal consistency reliability for the measures employed in the current study ranged from adequate to excellent (Kline, 2005). Due to the correlational nature of the hypotheses, the negative bias scoring procedure used by Matthews, Mogg, May, and Eysenck, (1989) was used, and negative bias scores were created for the four cognitive variables that contained both positive and negative scores (i.e., the beliefs, expectancies, attention, and memory variables). These scores were computed by subtracting positive scores from negative scores so that a single negative bias index score could be used in the primary statistical analyses. The resulting negative bias scores are interpreted as follows: high negative bias scores reflect a disproportionately high number of negative cognitions relative to positive cognitions and reflect a cognitive bias for negative information; low negative bias scores (i.e., negative scores) reflect a disproportionately low number of negative cognitions relative to positive cognitions and reflect a cognitive bias for positive information. The minimum and maximum values, means, and standard deviations for the four negative cognitive bias scores are displayed

in Table 6.

A correlation matrix was generated to examine if the primary predictors were related to one another as hypothesized (Table 7). As expected, BIS sensitivity correlated positively with belief bias, expectancy bias, memory bias, and perceived threat, whereas BAS sensitivity correlated negatively with belief bias, expectancy bias, and perceived threat. Contrary to predictions, BAS was unrelated to memory bias, and both BIS and BAS were unrelated to attention bias. BIS and BAS were also unrelated to one another, although there was a non-significant trend toward a negative relationship (r = -.11, *ns)*, which is consistent with current theory (i.e., Corr, 2002's joint-subsystems hypothesis).

Memory bias, belief bias, and expectancy bias were all positively correlated with each other. In contrast, attention bias was not significantly related to any of the other predictor variables. To assess if attention bias was related to any of the study variables, a correlation matrix containing the three attention task variables (i.e., negative words found, positive words found, negative attention bias score), the other primary predictor variables, and the criterion variables was generated (Table 8). This analysis revealed that the three attention variables were unrelated to all other study variables. Accordingly, the attention bias variable was dropped from all of the remaining analyses.

To better examine the relationship between BIS, BAS, and the measures of cognition, a correlation matrix containing, BIS, BAS, and the negative and positive cognition scores was generated (Table 9). Analysis of this matrix revealed that BIS sensitivity correlated positively with each of the negative cognition scores (i.e., number of negative words recalled on the memory task, total negative beliefs score, total negative

expectancies score, perceived threat) and negatively with each of the positive cognition scores. Conversely, BAS sensitivity correlated positively with the positive beliefs score and with the positive expectancies score. BAS also correlated negatively with the negative beliefs score, the negative expectancies score, and with perceived threat. BAS sensitivity was unrelated to both positive and negative memory scores, although there was a non-significant trend (r = .10, *ns)* toward a positive relationship between BAS sensitivity and total number of positive words recalled.

Next, a correlation matrix was generated to examine the relationships among the criterion variables (Table 10). The relationships among the criterion variables were all as expected. The three self-report measures of state anxiety correlated positively with one another, with the Social Phobia Scale, and with Audience-Rated Anxiety. These findings suggest that the social threat manipulation was successful and that individuals high on social anxiety did experience increased state anxiety in response to the social-threat induction procedure. In addition, the positive correlation between Audience-Rated Anxiety and the three self-report state anxiety measures suggests that audience members were able to accurately perceive the speakers' levels of state anxiety during the speech.

A final correlation matrix containing all of the remaining predictor and criterion variables was generated in order to provide initial tests of the study hypotheses at the zero-order level (Table 11). As expected, BIS sensitivity correlated positively with the cognitive bias measures and with the social anxiety measures. The cognitive bias measures correlated positively with the social anxiety measures. BAS sensitivity was correlated negatively with scores on the Social Phobia Scale (trait social anxiety) and

with scores on the State-Trait Anxiety Inventory (state social anxiety); however, the correlations between BAS and the Beck Anxiety Inventory and the Negative Affect scale were non-significant, although they were in the predicted direction (i.e., negative). With respect to the zero-order relationship between BAS sensitivity and cognitive bias, as expected, BAS sensitivity correlated negatively with belief bias, expectancy bias, and perceived threat; however, BAS sensitivity was unrelated to memory bias.

Structural Equation Modeling

To assess the fit of the hypothesized model to the data, SEM based on maximum likelihood estimation was conducted using version 7.0 of AMOS (Analysis of Moment Structures; Arbuckle, 2006). SEM is essentially a combination of factor analysis and path analysis (Kline, 2005). This type of statistical analysis was chosen to test the hypothesized model because it has several advantages over traditional statistical techniques. Specifically, SEM corrects for measurement error, allows both latent and observed variables to be evaluated within the same model, enables users to conduct tests of entire models in a single analysis, and it allows for entire models to be tested against other competing models (Kline, 2005). Given that the primary goal of the current study was to provide the first direct test of Kimbrel's (2008) mediated model of social anxiety, SEM appeared to be the most appropriate type of statistical analysis to employ.

The original version of the hypothesized SEM model is presented in Figure 2; however, because it was necessary to drop the attention bias variable from all of the remaining statistical analyses, it was necessary to modify the hypothesized SEM model.

Specifically, the attention bias variable, which had been an indicator for the cognitive bias latent variable, was removed from the hypothesized SEM model because the correlational analyses indicated that this variable was unrelated to all other study variables. A graphical representation of the revised version of the hypothesized model is presented in Figure 3.

Measurement portions of the hypothesized model. The hypothesized model (Figure 3) contained four latent variables—BIS Sensitivity, BAS Sensitivity, Cognitive Bias, and Social Anxiety. Structural equation models that include item parcels as indicators are referred to as partial disaggregation models, whereas structural equation models that include all of the individual items from a particular scale are referred to as total disaggregation models (Bagozzi & Heatherton, 1994; Leone, Perugini, Bagozzi, Pierro, & Mannetti, 2001; Mitchell, 2008). Partial disaggregation models are often preferred over total disaggregation models because they require smaller sample sizes, are less vulnerable to measurement error and sample specificity, and because the score reliability for parcels tends to be higher than the score reliability of individual items (Kline, 2005; Leone et al., 2001).

Since latent variables have a number of advantages over using a total item score as a manifest variable (Coffman & MacCullum, 2005), and since partial disaggregation models have a number of advantages over total disaggregation models (Bagozzi & Heatherton, 1994; Leone et al., 2001; Kline, 2005), the current paper followed Mitchell's (2008) procedure and used item parcels from the SPSRQ to create latent variables for BIS and BAS Sensitivity. The BIS Sensitivity latent variable (see Figure 4) was created from

four six-item Sensitivity to Punishment item parcels. Parcel one contained items 1, 3, 5, 7, 9, and 11 from the SPSRQ (i.e., the first six items of the Sensitivity to Punishment scale), parcel two contained items 13, 15, 17, 19, 21, and 23, parcel three contained items 25, 27, 29, 31, 33, and 35, and parcel four contained items 37, 39, 41, 43, 45, and 47. Similarly, the BAS Sensitivity latent variable was created from four six-item Sensitivity to Reward item parcels. Parcel one contained items 2, 4, 6, 8, 10, and 12 (i.e., the first six items of the Sensitivity to Reward scale); parcel two contained items 14, 16, 18, 20, 22, and 24; parcel three contained items 26, 28, 30, 32, 34, and 36; parcel four contained items 38, 40, 42, 44, 46, and 48. This parceling procedure is identical to the one used by Mitchell (2008). It should also be noted that Mitchell demonstrated that randomly and non-randomly selected 6-item parcels from the SPSRQ performed equally well in a confirmatory factor analysis.

Since multiple measures of cognitive bias and state social anxiety were available, the total scores from the relevant cognitive bias and social anxiety measures were used as the indicators for these latent variables. Specifically, the Cognitive Bias latent variable was constructed from the negative expectancy bias score, negative beliefs bias score, negative memory bias score, and the perception of threat score. The Social Anxiety latent variable was constructed from the total scores of the state anxiety measures, which included the State-Trait Anxiety Inventory, the Negative Affect scale, the Beck Anxiety Inventory, and the Audience Rating of Anxiety score. Graphical representations of the measurement models are presented in Figures 4, 5, 6, and 7.

Confirmatory factor analysis was used to assess the fit of the proposed

measurement models to the data. Because "there is no single 'magic index' that provides a gold standard for all models" (Kline, 2005, p. 134), Kline has recommended that researchers always report the chi-square statistic, the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), and standardized root mean residual (SRMR) when reporting SEM results. Accordingly, these fit indices are reported for each of the measurement models evaluated (Table 12). Two other well-known fit indices—the Goodness-of-Fit Index (GFI) and the Normed Fit Index (NFI)—are also reported in Table 12 to provide a more comprehensive summary of the measurement models' fit.

Models that exhibit adequate fit to the data should have CFI, NFI, and GFI values that are greater than .90, RMSEA values that are below .08, and SRMR values that are below .10 (Kline, 2005). Theoretically, the p-values for the chi-square statistic should be above .05 (i.e., non-significant) for well-fitting models; however, the chi-square statistic is problematic because of its extreme sensitivity to sample size (Kline, 2005). Thus, it is common for the chi-square statistic to be well below .05 in large samples for models that would be considered to have good fit by all other standards. As can be seen in Table 12, using Kline's (2005) suggested guidelines, each of the measurement models exhibited excellent fit to the data ($p > .05$, RMSEA < .06, SRMR < .03, GFI > .99, NFI > .98, CFI > .99 for each model). Accordingly, no adjustments were made to the measurement portion of the model.

Structural portion of the model. Kline's (2005) guidelines for interpreting goodness-of-fit indices were also used to evaluate the overall fit of the hypothesized

model and several competing models; however, in addition to reporting the fit statistics noted above (i.e., chi-square statistic, RMSEA, CFI, GFI, NFI), the 90% confidence intervals for the RMSEA values were also reported, as both Byrne (2001) and Kline (2005) have advocated that these statistics convey important information as well. Specifically, Kline (2005) has argued that models should not be rejected if the lower bound of the 90% RMSEA confidence interval is less than or equal to .05 and the upper bound of the 90% RMSEA confidence interval is less than or equal to .10. The Aikeke Information Criterion (AIC) index is also reported for each of the structural models, as this and other predictive fit indices can be used to compare nonhierarchical models that have been estimated with the same data. In these types of situations, models with lower AIC values should be preferred over models with higher AIC values (Kline, 2005).

The hypothesized model, which was constructed to test the hypothesis that Cognitive Biases for negative and threatening social information fully mediate the effect of BIS and BAS Sensitivity on Social Anxiety under conditions of imminent social threat, is shown in Figure 8 with the standardized maximum likelihood estimates. As can be seen in Table 13, with the exception of the chi-square statistic, all of the fit indices for the hypothesized model suggested good to adequate fit (Chi-Square = 173.82 (100), $p < .001$; RMSEA = .060; CFI = .954; NFI = .900; GFI = .900; SRMR = .064). In contrast, the null model of independence (Figure 9), which is a model that assumes that there are no correlations among the observed variables of interest, exhibited very poor fit to the data (RMSEA > .08; SRMR > .10; GFI, NFI, and CFI < .90). Because the null model of independence exhibited poor fit to the data, it was rejected in favor of the better-fitting

hypothesized model.

The hypothesized model (Figure 8) was compared to a latent model of independence next (Figure 10). In the latent model of independence, all of the structural relationships among the latent variables were constrained to be zero. As can be seen in Table 13, the fit indices for the latent model of independence also indicated poor fit to the data (RMSEA > .08; SRMR > .10; GFI, NFI, CFI < .90). Consequently, the latent model of independence was also rejected in favor of the better-fitting hypothesized model. Taken together, the poor fit statistics for the null model of independence and the latent model of independence strongly suggest that more elaborate models that take into account the structural relationships among the latent variables are required to adequately account for the data.

Accordingly, the hypothesized model (Figure 8) was compared to an independent main effects model next. The independent main effects model (Figure 11) tested the competing hypothesis that BIS Sensitivity, BAS Sensitivity, and Cognitive Bias all exhibit direct effects upon Social Anxiety, but do so independently of one another. As can be seen in Table 13, the independent main effects model showed poor overall fit to the data (Chi-Square = 284.213 (101), $p < .001$; RMSEA = .094; CFI = .887; NFI = .837; GFI = .860; SRMR = .194) and in comparison to the hypothesized model (Chi-Square = 173.82 (100), $p < .001$; RMSEA = .060; CFI = .954; NFI = .900; GFI = .900; SRMR = .064). Since the hypothesized model and the independent main effects model were not hierarchically related to one another, the chi-square difference test could not be used to directly compare the two models, as the chi-square difference test is not a valid test

statistic in these types of cases (Kline, 2005). Instead, AIC values should be compared when evaluating non-hierarchical models, and models with lower AIC values should be preferred over models with higher AIC values (Kline, 2005). As can be seen in Table 13, the AIC value for the hypothesized model (AIC = 245.82) was substantially smaller than the AIC value for the independent main effects model (AIC = 345.21). Accordingly, the independent main effects model was rejected in favor of the better-fitting hypothesized model.

Next, the hypothesized model was compared to a partially-mediated model of social anxiety (Figure 12), which was constructed to test the competing hypothesis that Cognitive Bias only partially mediates the effect of BIS and BAS Sensitivity on Social Anxiety. As can be seen in Table 13, the fit statistics for the hypothesized model and the partial mediation model were nearly identical, despite the fact that the partial mediation model involved adding direct paths from BIS and BAS Sensitivity to Social Anxiety. Since the hypothesized model and the partial mediation model were hierarchically related to one another, a chi-square difference test was conducted to determine if adding the direct paths from BIS and BAS Sensitivity to Social Anxiety significantly improved the fit of the model. The chi-square difference statistic (χ^2_D) was calculated by subtracting the chi-square statistic of the partial mediation model [χ^2 = 171.40 (98)] from the chi-square statistic of the hypothesized model [χ^2 = 173.82 (100)]. The resulting chi-square difference statistic (χ^2_D = 2.72 (2), *ns*) indicated that adding direct paths from BIS and BAS Sensitivity to Social Anxiety did not significantly improve the overall fit of the model. Accordingly, the partial mediation model was rejected in favor of the more

parsimonious hypothesized model. Additional support for the hypothesized model comes from the finding that both of the direct paths that were added in the partial mediation model (BIS → Social Anxiety, β = .13, *ns*; BAS → Social Anxiety, β = -.03, *ns*) were non-significant (α = .05).

A final model comparison was made between the hypothesized model and a competing model in which the path from BAS Sensitivity to Cognitive Bias was constrained to be zero. The BAS constrained model (Figure 13) was constructed to determine if estimating the direct path from BAS Sensitivity to Cognitive Bias significantly added to the overall fit of the model. This model seemed particularly relevant given the fact that the path coefficients for the direct paths leading from BAS Sensitivity to Social Anxiety in both the independent main effects model (β = -.06, *ns*) and the partial mediation model (β = -.03, *ns*) had been non-significant.

As can be seen in Table 13, the fit statistics for the Constrained BAS model (Chi-Square = 182.89 (101), $p < .001$; RMSEA = .063; CFI = .949; NFI = .895; GFI = .895; SRMR = .073) were slightly worse than the fit statistics for the hypothesized model (Chi-Square = 173.82 (100), $p < .001$; RMSEA = .060; CFI = .954; NFI = .900; GFI = .900; SRMR = .064), although they still suggested good fit to the data. Of note, whereas BIS and BAS had combined to account for 58% of the variance in Cognitive Bias in the hypothesized model, in the Constrained BAS model, BIS alone accounted for 55% of the variance in Cognitive Bias. This finding indicates that the effect of BIS on Cognitive Bias is substantially larger than the effect of BAS on Cognitive Bias.

A chi-square difference test was conducted to determine if adding a path from

BAS Sensitivity to Cognitive Bias (i.e., the hypothesized model) significantly improved model fit. The chi-square difference statistic (χ^2_D) was calculated by subtracting the chi-square statistic of the hypothesized model [χ^2 = 173.82 (100)] from the chi-square statistic of the BAS constrained model [χ^2 = 182.89 (101)]. The resulting chi-square difference statistic (χ^2_D = 9.07 (1), $p > .005$) indicated that the hypothesized model showed significantly better fit to the data. Accordingly, the BAS constrained model was rejected in favor of the better-fitting hypothesized model.

In sum, the hypothesized model exhibited better overall fit to the data than did the null model of independence, the latent model of independence, the independent main effects model, the partial mediation model, and the BAS constrained model. Accordingly, each of these models was rejected in favor of the better-fitting hypothesized model (Figure 8), and only the hypothesized model was considered in the remaining analyses.

Parameter estimates for the hypothesized model. Table 14 provides a summary of the factor loadings for the four latent variables in the hypothesized model, and Table 15 provides a summary of the direct and indirect effects, variances, and covariances for the hypothesized model. As can be seen in Table 14, the factor loadings for the four latent variables were generally high (i.e., $\beta > .50$). The lone exception to this pattern of results was the Social Anxiety → Audience-Rated Anxiety coefficient, which was moderate in size ($\beta = .35$, $p < .001$). With respect to the structural relationships among the latent variables, as predicted, both BIS ($\beta = .71$, $p < .001$) and BAS Sensitivity ($\beta = -.20$, $p < .001$) had significant direct effects upon Cognitive Bias, combining to account for 58% of the variance in this variable. In turn, Cognitive Bias had a substantial direct effect upon

Social Anxiety (β = .86, p < .001), accounting for 74% of the variance in this variable. In addition, as predicted by Kimbrel's (2008) mediated model of social anxiety, both BIS (β = .61) and BAS Sensitivity (β = -.17) had substantial indirect effects upon Social Anxiety via Cognitive Bias.

To determine if these indirect path coefficients were statistically significant, Sobel's (1982) products of coefficients test was calculated for each. As predicted, the indirect path from BIS Sensitivity → Cognitive Bias → Social Anxiety was statistically significant (z = 4.41, p < .001), providing the first direct support for Kimbrel's (2008) hypothesis that cognitive biases for negative and threatening social information mediate the effect of BIS sensitivity on social anxiety under conditions of imminent social threat. The indirect path from BAS Sensitivity → Cognitive Bias → Social Anxiety was also statistically significant (z = -2.57, p = .01), providing the strongest evidence to date that low BAS sensitivity also plays a significant role in social anxiety.

CHAPTER IV

DISCUSSION

Overall, the results from the current study were highly consistent with the hypothesis that cognitive biases for negative and threatening social information mediate the effect of BIS and BAS sensitivity on social anxiety. Thus, as predicted, BIS sensitivity had a significant direct effect upon cognitive bias. In turn, cognitive bias was shown to be a robust predictor of social anxiety symptoms in response to a threatening social situation. A Sobel's (1982) test confirmed that the indirect path from BIS to cognitive bias to social anxiety was significant, providing direct support for the hypothesis that cognitive biases for negative and threatening social information mediate the effect of BIS sensitivity on social anxiety symptoms.

A secondary purpose of the current study was to explore whether low BAS sensitivity also played a significant role in social anxiety. As predicted, low BAS sensitivity also had a significant indirect effect upon social anxiety via cognitive bias, even after accounting for shared variance with BIS sensitivity. This finding is important because it provides direct support for the hypothesis that low BAS sensitivity represents an additional risk factor for social anxiety (Corr, 2002; Kimbrel, 2008) and because it suggests that the effect of low BAS on social anxiety is also mediated by a cognitive bias for negative and threatening social information.

Taken together, these results suggest that personality and cognition are strongly

related to one another, and they highlight the need for more interdisciplinary research in this emerging area of study. The findings are also important because they provide the first direct support for Kimbrel's (2008) mediated model of social anxiety and suggest that cognitive biases for negative and threatening social information may be the mechanism through which BIS and BAS sensitivity exert their influence upon social anxiety. While more research is needed to replicate these findings, the current results are exciting because they suggest a personality/neurobiological basis for both social anxiety and the cognitive biases associated with this condition. The findings are also of broad interest because they suggest that biased information processing may be the mechanism through which personality influences behavioral responses to specific situations.

Research Implications

The current findings help to extend the existing literature in a number of important ways. First, this study adds to the growing literature concerning the relationship between BIS sensitivity and social anxiety by demonstrating that BIS sensitivity is predictive of state social anxiety within the context of an ecologically-valid social situation. Given that public-speaking situations are the most commonly feared situations among individuals diagnosed with social phobia (e.g., Cox, Clara, Sareen, & Stein, 2008; Ruscio et al., 2008), the current study helps to extend previous work on BIS sensitivity and trait social anxiety (e.g., Coplan et al., 2006; Kashdan & Roberts, 2006; Kimbrel et al., 2008) by establishing a relationship between BIS and state social anxiety within the context of a realistic and relevant social situation. An additional strength of the

study is its inclusion of the Audience-Rated Anxiety scale within the social anxiety latent variable. The inclusion of this variable adds to the validity of the findings by demonstrating that the results are unlikely to be due to self-report bias.

The current study also adds to the large body of work examining the relationship between social anxiety and cognitive bias (e.g., Amir et al., 1998; Asmundson & Stein, 1994; Breck & Smith, 1983; Leary et al., 1988; Lucock & Salkovskis, 1988, Mansell & Clark, 1999; Stopa & Clark, 1993, 2000) by demonstrating a cognitive bias for negative and threatening social information among socially-anxious individuals in response to a public-speaking situation. This finding is consistent with previous research and provides additional support for the cognitive model of social anxiety (e.g., Clark & Wells, 1995; Rapee & Heimberg, 1997).

The current study also adds to our understanding of the nature of cognitive bias by demonstrating that some forms of cognitive bias (i.e., beliefs, expectancies, memory bias, perception of threat) load onto a more general cognitive bias factor. This finding is consistent with Gray and McNaughton's (2000) proposal that there is a major biasing system in the brain (i.e., the BIS) that underlies many forms of cognitive bias. In addition, the more general finding that there is a strong relationship between personality, cognition, and emotion is consistent with Gray's (1990) observation that "the brain systems mediating emotion overlap with those mediating cognition to such a degree that it is difficult to maintain any clear distinction between them" (p. 269).

The current findings also add to our understanding of the differential relationships among biologically-based personality traits and cognitive bias. Specifically, as predicted,

BIS sensitivity was shown to be the RST-based personality trait most strongly associated with negative cognitive bias. Indeed, while the results of the SEM analyses indicated that both BIS and BAS uniquely contributed to the prediction of negative cognitive bias, the results also clearly indicated that BIS was the stronger predictor of the two. For example, in the model in which the effect of BAS on cognitive bias was constrained to be zero, BIS sensitivity alone accounted for 55% of the variance in the cognitive bias factor. Adding the path from BAS to bias in the hypothesized model only increased the total amount of variance accounted for in the cognitive bias factor by about 3%; however, this path was significant and it did improve the overall fit of the model. Thus, it appears that while BIS sensitivity is the primary RST-based personality trait that underlies negative cognitive bias, BAS sensitivity also plays a significant role.

The correlational analyses also revealed differences between BIS and BAS in relation to the cognitive measures. For example, BIS sensitivity was correlated more highly with each of the nine cognitive measures than was BAS, providing additional evidence that BIS sensitivity is the RST-based personality trait most strongly associated with negative cognitive bias. The results concerning the differential relationships between BIS, BAS, and the different types of cognitive bias are also of interest. For example, whereas the relationship between BAS sensitivity and negative memory bias was non-significant (r = -.08, *ns*), BIS demonstrated a significant positive correlation with this variable (r = .42, p < .01). While this pattern of results could simply be a reflection of the more general pattern of stronger relationships between BIS sensitivity and negative bias scores, it is also consistent with the idea that heightened BIS activation—especially

hypersensitivity in the hippocampus—is the primary neural basis for negative memory bias (Gray & McNaughton, 2000).

It is also worth noting that the current study is one of the few to demonstrate an explicit memory bias for negative and threatening social information among socially-anxious participants. Equally important is the finding that most of the previous studies that have found a memory bias among socially-anxious participants have also employed a social-threat manipulation (e.g., Breck & Smith, 1983; Lundh & Ost, 1996b; Mansell & Clark, 1999). In contrast, the majority of studies that have failed to find a memory bias (e.g., Cloitre et al., 1995; Rapee et al., 1994) have not. Thus, the findings from the current study are highly consistent with previous research and with Hirsch and Clark's (2004) observation that memory biases are most likely to occur among socially-anxious participants following a social threat manipulation. The current findings are also consistent with the hypothesis that potentially-threatening social situations should produce the most pronounced information-processing biases because these types of situations should engage the BIS and force it into control mode (Gray & McNaughton, 2000). Once in control mode, the BIS should begin to engage in both internal (i.e., memory bias) and external scanning (i.e., attention bias) for threat cues. While the results are consistent with this hypothesis, experimental research that includes a control condition in which some participants do not receive a social threat manipulation is needed to provide the most stringent test of this hypothesis.

An additional point of interest is the finding that both BIS and BAS sensitivity were associated with the "higher-level" cognitive biases (i.e., expectancy and belief bias)

that were measured in the current study. As noted in the introduction, Gray and McNaughton (2000) have reported that the septo-hippocampal system (a major component of the BIS) sends simple feedback signals to other areas of the brain, including higher level goal processing areas, like the prefrontal cortex. Furthermore, Gray and McNaughton (2000) have proposed that the function of these feedback signals is to increase the valence of threatening information in these areas of the brain. Building upon this idea, Kimbrel (2008) proposed that this biasing process might be the neural substrate underlying negative beliefs and expectancies. Interestingly, the prefrontal cortex is proposed to be a major component of both the BIS and BAS (Corr, 2004; Gray & McNaughton, 2000; McNaughton & Corr, 2006). Thus, one explanation for the observed relationship between BAS sensitivity and negative expectancies and beliefs is that this component of the BAS overlaps substantially with the BIS and would be most likely to be affected by this biasing process. In contrast, since the hippocampus is not proposed to play a substantial role in the BAS (Corr, 2004; Gray, 1994), BAS sensitivity would be expected to have little or no relationship with negative memory bias. While highly speculative at the current time, this explanation is consistent with current theory and should be addressed in future research.

Finally, the differential relationships between BIS, BAS, and the positive and negative measures of cognition are of interest. Specifically, the current findings indicate that BIS sensitivity is associated with increased negative thinking (as evidenced by the positive correlations among BIS and the negative cognitive scores) and decreased positive thinking (as evidenced by the negative correlations between BIS and positive

cognitive scores). Conversely, BAS sensitivity appears to be associated with increased positive thinking and decreased negative thinking. While previous studies have demonstrated that BIS sensitivity is associated with more negative thinking (e.g., Noguchi et al., 2006; Gomez & Gomez, 2006), the current study is one of the first to demonstrate that BIS sensitivity is also associated with less positive thinking. Similarly, while previous studies have demonstrated a relationship between BAS and positive thinking (e.g., Noguchi et al., 2006; Gomez & Gomez, 2006), the current study is one of the first to demonstrate that heightened BAS sensitivity is also associated with less negative thinking.

These results suggest the presence of strong antagonistic and facilitory relationships between BIS and BAS at the cognitive level. Given that the current study also demonstrates a strong relationship between negative cognition and social anxiety, it is reasonable to infer that the proposed facilitory effect of low BAS sensitivity on social anxiety is ultimately due to the facilitory effect of low BAS sensitivity on negative cognitive bias. Taken together, these results provide additional support for Kimbrel's (2008) mediated model of social anxiety and for a modified version of the joint-subsystems hypothesis (Corr, 2002) in which the proposed antagonistic and facilitory effects of BIS and BAS on behavior are mediated via cognitive bias. While Corr (2002) did not specify a mediating role for cognitive biases when he argued that BIS and BAS have antagonistic and facilitory effects upon behavior, this modified version of the joint-subsystems hypothesis may be a more accurate description of the interplay that occurs between BIS and BAS in response to threatening stimuli.

Clinical Implications

There are also a number of important clinical implications that emerge from the current study. First, a number of researchers have noted that the emotional disorders (i.e., anxiety disorders and unipolar depression) exhibit considerable overlap with one another (e.g., Brown, Campbell, Lehman, Grisham, & Mancill, 2001; Wittchen et al., 1999). For instance, Brown et al. (2001) reported that 76% of individuals diagnosed with an anxiety disorder also met lifetime criteria for at least one additional anxiety or depressive disorder. One explanation for the high rates of comorbidity among the emotional disorders is that there may be a more general "negative affect syndrome" that encompasses all of the emotional disorders (Barlow, 2002; Moses & Barlow, 2006). Given the results of the current study, as well as the consistent findings concerning the relationship between BIS sensitivity and emotional disorders in the literature (e.g., Johnson et al., 2003), a competing explanation for these findings is that high BIS sensitivity is the biological/personality basis for the emotional disorders in general and the cognitive biases that are associated with these types of disorders.

The latter explanation has several advantages. First, it provides a theoretical rationale for the development of emotional disorders and for the cognitive biases that underlie these disorders (e.g., Gray & McNaughton, 2000; Kimbrel, 2008) that can be used to help clinicians and researchers alike to conceptualize the development and treatment of emotional disorders at multiple levels of analysis. This explanation is also consistent with the growing evidence that the emotional disorders are associated with BIS

sensitivity (e.g., Hundt, Nelson-Gray, Kimbrel, Mitchell, & Kwapil, 2007; Johnson, Turner, & Iwata, 2003; Kimbrel, Nelson-Gray, & Mitchell, 2007; Kimbrel et al., 2008) and other closely-related measures of personality, such as neuroticism (e.g., Bienvenu et al., 2004; Marteinsdottir, Tillfors, Furmark, Anderberg, & Ekselius, 2003; Stemberger et al., 1995; Watson, Gameza, & Simms, 2005).

The proposal that heightened BIS sensitivity is the basis for the emotional disorders in general is also consistent with previous research demonstrating that the emotional disorders share a common genetic basis with one another and with the personality trait of neuroticism (e.g., Andrews, Stewart, Allen, & Henderson, 1990; Hettema et al., 2006). It is also consistent with the evidence gathered from this study and others like it (e.g., Derryberry & Reed, 1994; Gomez & Gomez, 2006; Lam et al., 2003; Langston & Sykes, 1997; Windsor et al., 2008) demonstrating that both BIS and neuroticism are associated with a cognitive bias for negative and threatening information.

A final advantage of this proposal is that it does not require the development of new categories, new diagnostic criteria, or new assessment devices. Moreover, clinicians could easily inform their assessment and conceptualization efforts by simply including basic RST measures like the SPSRQ in their assessment batteries. An additional advantage is that the two most widely-used RST measures (i.e., Carver & White, 1994; Torrubia et al., 2001) are in the public domain and are free to anyone. In contrast, most of the personality measures currently used in clinical settings cost a significant amount of money to buy and administer.

Another clinical implication that emerges from the current paper concerns the

cognitive mediation hypothesis. As noted by Garratt, Ingram, Rand, and Sawalani (2007), two of the primary assumptions that underlie cognitive therapy are that: (a) cognitive changes are associated with therapeutic improvement, and that (b) changes in cognition are specific to cognitive therapy. In contrast, Kimbrel's (2008) model proposes that cognitive changes are not specific to cognitive therapy. Instead, this model proposes that cognitive therapy, behavior therapy, and pharmacological therapy are all capable of decreasing cognitive biases because each of these forms of treatment is proposed to be capable of decreasing BIS sensitivity. While each form of treatment was proposed to decrease BIS sensitivity through a different mechanism (see Kimbrel, 2008, for a more thorough discussion), in each case, successful treatment was ultimately proposed to be a function of change in BIS sensitivity to social stimuli.

While the results from the current study are unable to provide direct support for this hypothesis, they do clearly demonstrate a link between heightened BIS sensitivity, cognitive bias, and social anxiety. Additional support for this proposal comes from the finding that both behavior therapy and pharmacological treatment are capable of decreasing cognitive bias in social phobia (Gould, Buckminster, Pollack, Otto, & Yap, 1997; Harmer, Shelley, Cowen, & Goodwin, 2004; Stravynski, Bond, & Amado, 2004) and depression (DeRubeis et al., 1990; Jacobsen et al., 1996; McKnight, Nelson-Gray, & Barnhill, 1992; Simons, Garfield, & Murphy, 1984). Moreover, successful treatment change in social phobia has been shown to be associated with decreased activation in core components of the BIS (i.e., amygdala, hippocampus, prefrontal cortex), regardless of whether patients were treated with cognitive-behavioral therapy or citalopram (Furmark

et al., 2002). Thus, while the results in the current study do not provide direct support for the hypothesis that decreased social anxiety symptoms are ultimately the result of decreased BIS sensitivity, they are consistent with this proposal.

Finally, the findings from the current study highlight the prevalence of social anxiety among "non-clinical" populations. Indeed, 24% of the undergraduate participants in the current study scored at or above the established clinical cut-off score of 24 on the Social Phobia Scale (Heimberg et al., 1992). Because the current study did not employ formal diagnostic procedures and did not assess for functional impairment, it is impossible to determine the exact percentage of participants who met full criteria for social phobia. Nevertheless, these findings strongly suggest that social anxiety is widespread, even among relatively high-functioning populations.

Given the increased emphasis on public-speaking and other oral communication skills in both academic and occupational settings (e.g., Becker & Eckdom, 1980; Emanuel, 2007; Harrell & Harrell, 1984; Morreale, Osborne, & Pearson, 2000; Winsor, Curtis, & Stephens, 1997), the potential for significant distress and functional impairment among socially-anxious individuals is obvious. For example, Becker and Eckdom (1980) reported that there is considerable evidence that speaking skills are more important than specific technical skills in terms of overall job success. Similarly, the results of a 20-year longitudinal study of graduates from the Stanford MBA program indicate that no skill is more important to a successful business career than good communication skills (Emanuel, 2007; Harrell & Harrell, 1984).

Taken together, these findings suggest that while public-speaking and other oral

communication skills are critical for long-term success, a substantial proportion of individuals experience significant anxiety and distress when asked to perform these very same skills. These findings highlight the need for increased research into treatment and prevention programs for individuals with both clinical and sub-clinical levels of social anxiety. These findings also provide additional support for Furmark et al.'s (1999, p. 416) conclusion that "although the exact diagnostic boundaries for social phobia are difficult to determine, it can be concluded that social anxiety is a distressing problem for a considerable proportion of the population."

Study Limitations

The current study had a number of limitations that should be acknowledged. First, it employed a non-clinical sample. While this type of approach does reduce the confounds associated with current psychopathology, it also limits the generalizability of the results. Future studies should consider including clinical participants as well. Given that the results of the current study clearly indicate that social anxiety, personality, and cognitive bias are all dimensional constructs, future studies might consider using mixed samples that include clinical participants with formal diagnoses and non-clinical participants from community samples. This type of approach would allow for the testing of dimensional models while also enhancing the generalizability of the results. The current study also relied heavily upon self-report measures. Future studies might consider including physiological and behavioral measures in addition to self-report measures in order to overcome this limitation.

The current study was also correlational in nature. While the study design (e.g., establishing temporal priority of BIS before bias and social anxiety) was consistent with the hypothesis that cognitive biases mediate the effect of BIS sensitivity on social anxiety, the absence of an experimental manipulation precludes any causal inferences. Similarly, the lack of a control group for the social threat manipulation prevents direct examination of the effect of this variable on cognitive bias. Kimbrel (2008) predicted that cognitive biases (especially memory and attention bias) would be most pronounced under conditions of imminent social threat because these conditions should activate both the BIS and FFFS. While this study confirms that cognitive biases can occur under these conditions, the design of the study prevents a direct test of the hypothesis that cognitive biases are more pronounced under these conditions than under conditions of no threat. Experimental research is needed to fully address this question.

Finally, while the overall findings from the current study support the role of cognitive biases in social anxiety, it is important to note that the attention measure scores were not related to any of the other study variables and could not be used as planned in the hypothesized model. This finding could be interpreted as evidence that an attention bias for negative and threatening social information does not exist among socially-anxious individuals. However, as noted in the introduction, there is substantial evidence that such a bias does exist (e.g., Amir & Foa, 2001; Asmundson & Stein, 1994; Becker, et al., 2001; Hope et al., 1990; Lundh & Ost, 1996a; Mattia et al.,1993) and that it is related to hypersensitivity in the amygdala (Fox, Hane, & Pine, 2007; Hariri et al., 2005), a primary component of the BIS; however, none of the previous studies that have found an

attention bias among socially-anxious participants used the Embedded Word Task. In fact, the current study appears to have been the first to have used the Embedded Word Task in relation to social anxiety. The current study also used a modified version of the Embedded Word Task. Whereas previous studies (Wezlaff et al., 2001) that have employed this task instructed participants to remember a lengthy number while they completed the task in order to put them in a state of cognitive load, the current study did not use the cognitive load procedure because Kimbrel (2008) specifically hypothesized that social threat alone should be sufficient to induce a cognitive bias for negative and threatening social information.

Given these facts, a competing explanation for the attention task's null results is that the modified version of the Embedded Word Task may have simply been an invalid measure of attention bias. Another potential explanation for the null results is that cognitive load, but not social threat, induces attention bias for negative and threatening social information; however, given that attention biases have been reported among social phobics under conditions of no social threat and no cognitive load (e.g., Hope et al., 1990), a more likely explanation is that the modified Embedded Word Task used in the current study was simply not a valid measure of attention bias. Unfortunately, the null findings and the modified procedure are confounded within the same study, which makes it impossible to determine the true cause of these results. These findings highlight the importance of using reliable and well-validated measures whenever possible. In addition, they suggest the need for additional research aimed at developing a reliable and valid attention-bias measure that can be administered quickly and used with socially-anxious

participants in a group format.

Future Directions for Research

The current findings point to a number of important directions for future research. First, given the novelty of the current findings, future studies are needed to replicate these results using different samples and different methodologies. In particular, it is recommended that different types of memory tasks (e.g., facial recognition tasks), attention tasks (e.g., dot-probe tasks), and social-threat manipulations (e.g., one-on-one interactions with a stranger) be used in future research. Future research would also benefit from multi-method assessment of BIS sensitivity. For instance, in addition to self-reports, neuroimaging and/or behavioral tasks could be used to enhance the validity of the current findings. Future studies might also consider using a pre-post design in which BIS sensitivity, cognitive bias, and social anxiety symptoms are assessed before and after some form of treatment (e.g., cognitive-behavioral therapy or medication) to determine if decreases in social anxiety and cognitive bias are a direct function of decreases in BIS sensitivity. Finally, additional research examining the relationship between BIS sensitivity, other forms of cognitive bias (e.g., rumination), and other types of psychological disorders is needed, as the available data suggest that heightened BIS sensitivity is associated with a wide range of psychological problems (e.g., Hundt et al., 2007; Johnson et al., 2003; Kane, Loxton, Staiger, & Dawe, 2004; Kimbrel, Nelson-Gray, et al., 2007; Kimbrel et al., 2008).

Conclusion

In sum, the results from the current study provide strong support for Kimbrel's (2008) mediated model of social anxiety. As predicted, high BIS and low BAS both had significant direct effects upon cognitive bias, which, in turn, was a robust predictor of state anxiety in response to a threatening social situation. Additional support for this model comes from the finding that the indirect paths from BIS and BAS sensitivity to social anxiety were both statistically significant. Moreover, the hypothesized model showed significantly better fit to the data than did several alternative models. Taken together, these results provide strong support for a mediated model of social anxiety and suggest that cognitive biases for negative and threatening social information may be the mechanism through which BIS and BAS sensitivity exert their influence upon social anxiety.

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Appendix A

TABLES

Table 1

Summary of the Sample Demographic Information

Variable	Classification	Frequency	Percentage
Gender			
	Male	69	33%
	Female	138	67%
Ethnicity			
	Euro-American	145	70%
	African-American	39	19%
	Asian-American	9	4%
	Hispanic-American	3	2%
	Other	9	4%
	Missing	2	1%
College Standing			
	Freshman	153	74%
	Sophomore	38	18%
	Junior	8	4%
	Senior	6	3%
	Other	1	<1%

Variable	Mean	SD
Age	19.1	5.8
GPA	3.3	.59

Note: GPA = grade point average; SD = standard deviation.

Table 2

Word Lists used in the Free Recall Task

NEGATIVE WORDS	**POSITIVE WORDS**	**BUFFER WORDS**
DULL	ARTICULATE	POISED
FRIGHTENED	ATTRACTIVE	SUCCESSFUL
INADEQUATE	BRILLIANT	EFFICIENT
INSECURE	CALM	VIVACIOUS
NERVOUS	CHEERFUL	IMMATURE
PATHETIC	COMPETENT	INEPT
RIDICULOUS	COMPOSED	UNINSPIRING
SCARED	CONFIDENT	OBNOXIOUS
SILLY	DYNAMIC	
STRESSED	EAGER	
SWEATY	HUMOROUS	
TENSE	INTELLIGENT	
UGLY	PLEASANT	
UNCOMFORTABLE	RELAXED	
WORRIED	WITTY	

Table 3

Word Lists used in the Embedded Word Task

NEGATIVE WORDS	**POSITIVE WORDS**	**NEUTRAL WORDS**
AWKWARD	ACHIEVE	SHIP
BAD	CAPABLE	STORE
BLUSH	CLEVER	VOTE
BORING	FUN	TRACK
REJECT	GLAD	UNCLE
DUMB	GRIN	CARPET
FOOL	HAPPY	CHERRY
FAIL	PRAISE	OPERA
INSULT	PROUD	MARBLE
STUPID	SMART	PURPLE

Table 4

Summary of the Procedures and Measures

Time Point	Procedure	Corresponding Measures and Tasks
1	Overview of the study and consent procedure	a. Consent form
2	Completion of the initial packets (counter-balanced)	b. Demographic form c. Sensitivity to Punishment and Sensitivity to Reward Questionnaire d. Social Phobia Scale
3	Social-threat induction procedure	e. Speech topics form
4	Cognitive battery (counter-balanced)	f. Incidental free-recall task g. Embedded-word task h. Speech Expectancies Scale i. Self-Statements During Public-Speaking Scale j. Perception of threat rating
5	State anxiety battery (counter-balanced)	k. State-Trait Anxiety Inventory l. Beck Anxiety Inventory m. Negative Affect scale
6	Speech task	n. Audience Rated Anxiety Scale o. Public-Speaking Performance Rating Scale
7	Debriefing procedure	p. Debriefing form provided to participants to take with them q. Copy of consent form provided to participants to take with them

Table 5

Means, Standard Deviations, and Cronbach's Alphas

Measure	Mean	SD	Alpha
1. Sensitivity to Punishment subscale (BIS sensitivity)	10.7	5.5	.85
2. Sensitivity to Reward subscale (BAS sensitivity)	12.2	4.4	.78
3. Social Phobia Scale	17.4	13.4	.93
4. Beck Anxiety Inventory	14.9	13.2	.95
5. Negative Affect	20.2	7.7	.88
6. State-Trait Anxiety Inventory (State Version)	47.1	15.1	.96
7. Negative Self-Statements	11.4	6.4	.85
8. Positive Self-Statements	13.3	4.3	.80
9. Negative Speech Expectancies	8.6	2.9	.80
10. Positive Speech Expectancies	7.9	2.7	.82
11. Audience-Rated Anxiety (Average)*	2.4	.65	
12. Perceived Threat*	2.9	1.3	
13. Negative Words Recalled*	3.4	1.6	
14. Positive Words Recalled*	3.3	1.9	
15. Negative EWT Words Found*	2	1.2	
16. Positive EWT Words Found*	1.6	1.2	
17. Neutral EWT Words Found*	1.6	1.2	

Note: *Measures 11 – 17 are not appropriate for the calculation of internal consistency because they contain only one score. Accordingly, only means and standard deviations are reported for these measures. EWT = Embedded word task.

Table 6

Descriptive Statistics for Cognitive Bias Scores

Measure	Minimum	Maximum	Mean	SD
1. Negative Belief Bias Score	-20	25	-1.8	9.7
2. Negative Expectancy Bias Score	-12	12	.68	5.3
3. Negative Memory Bias Score	-6	7	.05	2.5
4. Negative Attention Bias Score	-4	4	.36	1.4

Table 7

Correlations among the Primary Predictor Variables

Measures	2	3	4	5	6	7
1. BIS sensitivity	-.11	.57**	.49**	.42**	.00	.54**
2. BAS sensitivity	--	-.23**	-.28**	-.08	-.06	-.15*
3. Negative Belief Bias		--	.74**	.41**	.03	.68**
4. Negative Expectancy Bias			--	.38**	.07	.62**
5. Negative Memory Bias				--	.10	.42**
6. Negative Attention Bias					--	-.06
7. Perceived Threat						--

Note: * $p < .05$; ** $p < .01$

Table 8

Correlations with the Attention Task Variables

Measures	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Negative EWT Words Found	.29**	.62**	.03	-.05	-.03	-.01	.04	-.02	.07	-.01	-.01	.04	-.07
2. Positive EWT Words Found	--	.58**	.04	.04	-.07	-.10	-.08	.05	.04	-.01	-.02	.00	-.08
3. Attention Bias Score		--	.00	-.06	.04	.07	.10	-.06	.03	-.01	.00	.03	.01
4. BIS Sensitivity			--	-.11	.59**	.50**	.43**	.55**	.64**	.59**	.53**	.61**	.32**
5. BAS Sensitivity				--	-.23**	-.28**	-.08	-.15*	-.15*	-.10	-.13	-.28**	-.13
6. Beliefs Bias Score					--	.77**	.43**	.70**	.53**	.59**	.73**	.77**	.37**
7. Expectancy Bias Score						--	.39**	.63**	.38**	.45**	.59**	.72**	.41**
8. Memory Bias Score							--	.44**	.40**	.38**	.40**	.44**	.29**
9. Perceived Threat								--	.53**	.53**	.57**	.65**	.34**
10. Social Phobia Scale									--	.63**	.58**	.60**	.27*
11. Beck Anxiety Inventory										--	.77**	.71**	.28**
12. Negative Affect											--	.87**	.31**
13. State-Trait Anxiety Inventory												--	.36**
14. Audience-Rated Anxiety													--

Note: * $p < .01$, ** $p < .001$; EWT = Embedded word task.

Table 9

Correlations among Personality and Cognitive Bias Variables

Measures	1	2	3	4	5	6	7	8	9
1. BIS Sensitivity	--	-.11	.28**	.56**	.43**	.54**	-.31**	-.46**	-.49**
2. BAS Sensitivity		--	-.02	-.17*	-.23**	-.15*	.10	.27**	.30**
3. Negative Memory Score			--	.29**	.17*	.24**	.01	-.23**	-.24**
4. Negative Beliefs Score				--	.68**	.65**	-.33**	-.62**	-.62**
5. Negative Expectancy Score					--	.61**	-.30**	-.55**	-.73**
6. Perceived Threat						--	-.35**	-.56**	-.55**
7. Positive Memory Score							--	.16*	.29**
8. Positive Beliefs Score								--	.61**
9. Positive Expectancy Score									--

Note: * $p < .01$, ** $p < .001$;

Table 10

Correlations among the Criterion Variables

Measures	1	2	3	4	5
1. Social Phobia Scale	--	.63**	.58**	.60**	.27**
2. Beck Anxiety Inventory		--	.77**	.71**	.28**
3. Negative Affect			--	.87**	.31**
4. State-Trait Anxiety Inventory				--	.36**
5. Audience-Rated Anxiety					--

Note: ** $p < .01$.

Table 11

Correlations among the Predictor and Criterion Variables

Measures	2	3	4	5	6	7	8	9	10	11
1. BIS Sensitivity	-.11	.57**	.49**	.42**	.54**	.63**	.58**	.49**	.57**	.28**
2. BAS Sensitivity	--	-.23**	-.28**	-.08	-.15*	-.15*	-.10	-.13	-.28**	-.13
3. Negative Belief Bias		--	.74**	.41**	.68**	.49**	.57**	.66**	.71**	.34**
4. Negative Expectancy			--	.38**	.62**	.35**	.43**	.54**	.67**	.37**
5. Negative Memory Bias				--	.42**	.37**	.37**	.35**	.41**	.26**
6. Perceived Threat					--	.51**	.51**	.54**	.62**	.31**
7. Social Phobia Scale						--	.58**	.51**	.54**	.23*
8. Beck Anxiety Inventory							--	.68**	.67**	.26**
9. Negative Affect								--	.81**	.26**
10.State-Trait Anxiety									--	.32**
11.Audience-Rated Anx.										--

Note: * $p < .01$, ** $p < .001$.

Table 12

Fit Statistics for the Measurement Models

Model	Chi-Square	($p > .05$) p-value	df	(<.08) RMSEA	(<.10) SRMR	(>.90) GFI	(>.90) NFI	(>.90) CFI
BIS Sensitivity Measurement Model	3.41	.18	2	.058	.018	.992	.984	.993
BAS Sensitivity Measurement Model	3.41	.18	2	.058	.023	.992	.984	.993
Cognitive Bias Measurement Model	2.75	.25	2	.043	.020	.993	.992	.998
State Anxiety Measurement Model	2.46	.29	2	.034	.022	.994	.994	.999

Note: Cut-offs for acceptable fit are listed above the respective goodness-of-fit indices in parentheses. These cut-offs are based on Kline's (2005) recommendations; df = degrees of freedom; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; GFI = Goodness-of-Fit Index; NFI = Normed Fit Index; CFI = Comparative Fit Index.

Table 13

Summary of the Fit Statistics for the Models

Model	Chi-Square	df	(<.08) RMSEA	Low 90%	High 90%	(<.10) SRMR	(>.90) GFI	(>.90) NFI	(>.90) CFI	AIC
Hypothesized Model	173.82	100	.060	.045	.075	.064	.900	.900	.954	245.82
Null Model of Independence	1740.33	120	.256	.245	.267	.3584	.314	.000	.000	1772.33
Latent Model of Independence	475.99	104	.132	.120	.144	.2783	.782	.726	.770	539.992
Independent Main Effects Model	284.213	101	.094	.081	.107	.1941	.860	.837	.887	354.21
Partial Mediation Model	171.40	98	.060	.045	.075	.063	.902	.902	.955	247.40
BAS Constrained Model	182.89	101	.063	.048	.077	.0725	.895	.895	.949	252.89

Note: Cut-offs for acceptable fit are listed above the respective goodness-of-fit indices in parentheses. These cut-offs are based on Kline's (2005) recommendations; df = degrees of freedom; RMSEA = Root Mean Square Error of Approximation; Low 90% = Lower confidence interval for RMSEA; High 90% = Higher confidence interval for RMSEA; SRMR = Standardized Root Mean Square Residual; GFI = Goodness-of-Fit Index; NFI = Normed Fit Index; CFI = Comparative Fit Index; AIC = Akaike Information Criterion.

Table 14

Summary of the Factor Loadings for the Hypothesized Model

Parameter	Unstandardized	SE	Standardized	p-value
BIS → sp1	1.000	--	.695	***
BIS → sp2	1.281	.126	.815	***
BIS → sp3	1.101	.119	.729	***
BIS → sp4	1.341	.137	.774	***
BAS → sr1	1.000	--	.620	***
BAS → sr2	1.202	.175	.630	***
BAS → sr3	1.126	.152	.709	***
BAS → sr4	1.511	.197	.769	***
Cognitive Bias → memory bias	1.000	--	.499	***
Cognitive Bias → perceived threat	.818	.116	.771	***
Cognitive Bias → expectancy bias	3.448	.477	.807	***
Cognitive Bias → belief bias	6.806	.911	.883	***
Social Anxiety → BAI	1.000	--	.740	***
Social Anxiety → NA	.663	.052	.867	***
Social Anxiety → STAI	1.465	.109	.931	***
Social Anxiety → ARA	.021	.004	.351	***

Note: *** $p < .001$; SE = Standard error; sp1 – sp4 = Sensitivity to Punishment parcels; sr1 – sr4 = Sensitivity to Reward parcels; BAI = Beck Anxiety Inventory; STAI = State-Trait Anxiety Inventory, State Version; NA = Negative Affect; ARA = Audience Rated Anxiety.

Table 15

Summary of the Parameter Estimates for the Hypothesized Model

Parameter	Unstandardized	SE	Standardized	p-value
	Direct Effects			
BIS → Cognitive Bias	.810	.137	.706	***
BAS → Cognitive Bias	-.298	.107	-.195	.006
Cognitive Bias → Social Anxiety	6.704	1.013	.863	***
	Indirect Effects			
BIS → Social Anxiety	5.433	--	.609	***
BAS → Social Anxiety	-1.998	--	-.168	.010
	Covariances			
BIS ←→ BAS	-.131	.074	-.154	.079
	Variances			
BIS	1.126	.210	--	***
BAS	.636	.145	--	***
d1	.625	.182	--	***
d2	22.929	4.887	--	***
e1	1.203	.139	--	***
e2	.933	.134	--	***
e3	1.204	.145	--	***
e4	1.355	.175	--	***
e5	1.018	.121	--	***
e6	1.399	.168	--	***
e7	.797	.109	--	***
e8	1.003	.165	--	***
e9	4.484	.457	--	***
e10	.677	.078	--	***
e11	9.447	1.146	--	***
e12	19.413	2.970	--	***
e13	73.990	8.096	--	***
e14	12.974	1.765	--	***
e15	29.686	6.357	--	***
e16	.287	.029	--	***

Note: *** $p < .001$; SE = Standard error; d1 = disturbance term 1; d2 = disturbance term 2; e1 – e16 = error terms 1 – 16.

Appendix B

FIGURES

Figure 1

Kimbrel's (2008) Mediated Model of Social Anxiety

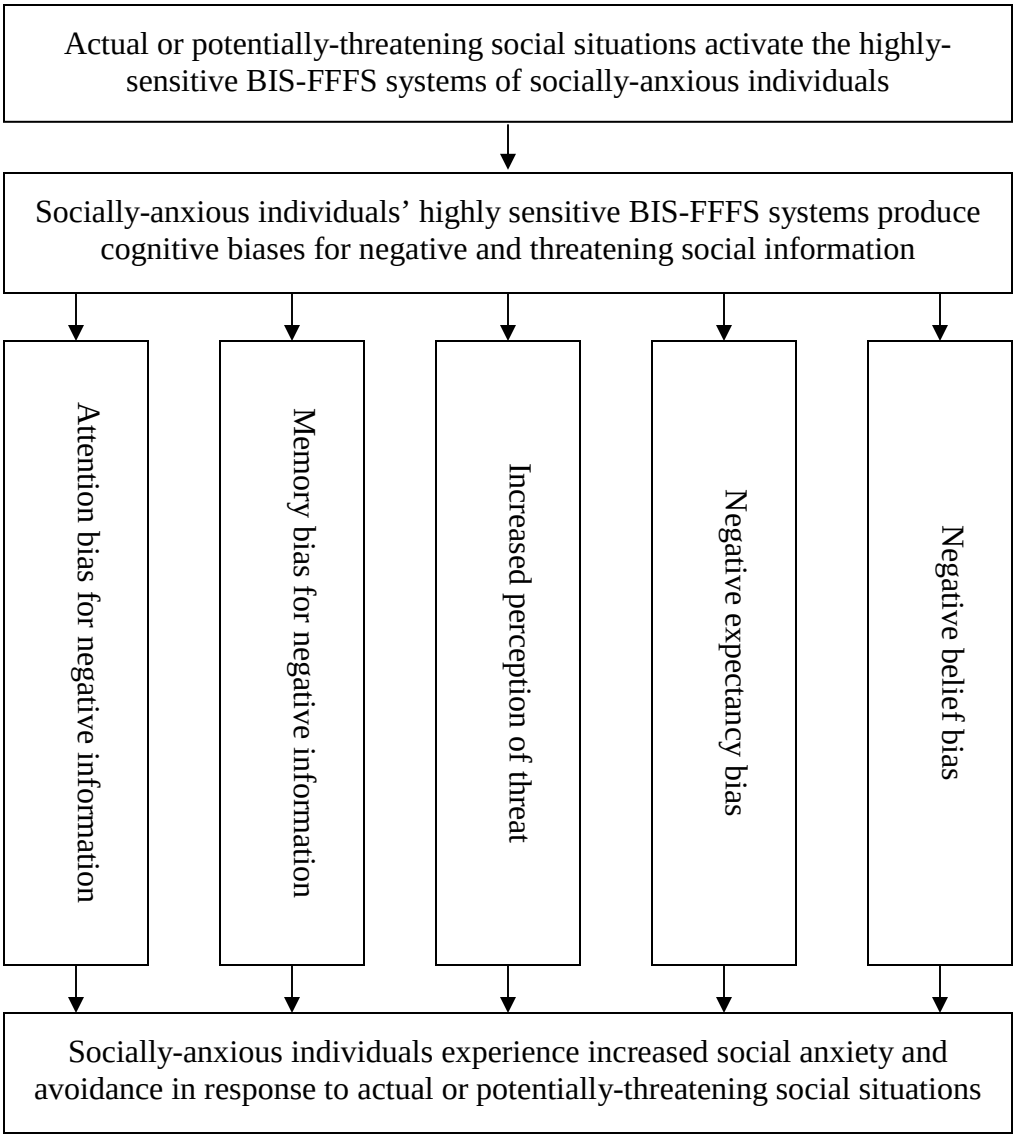
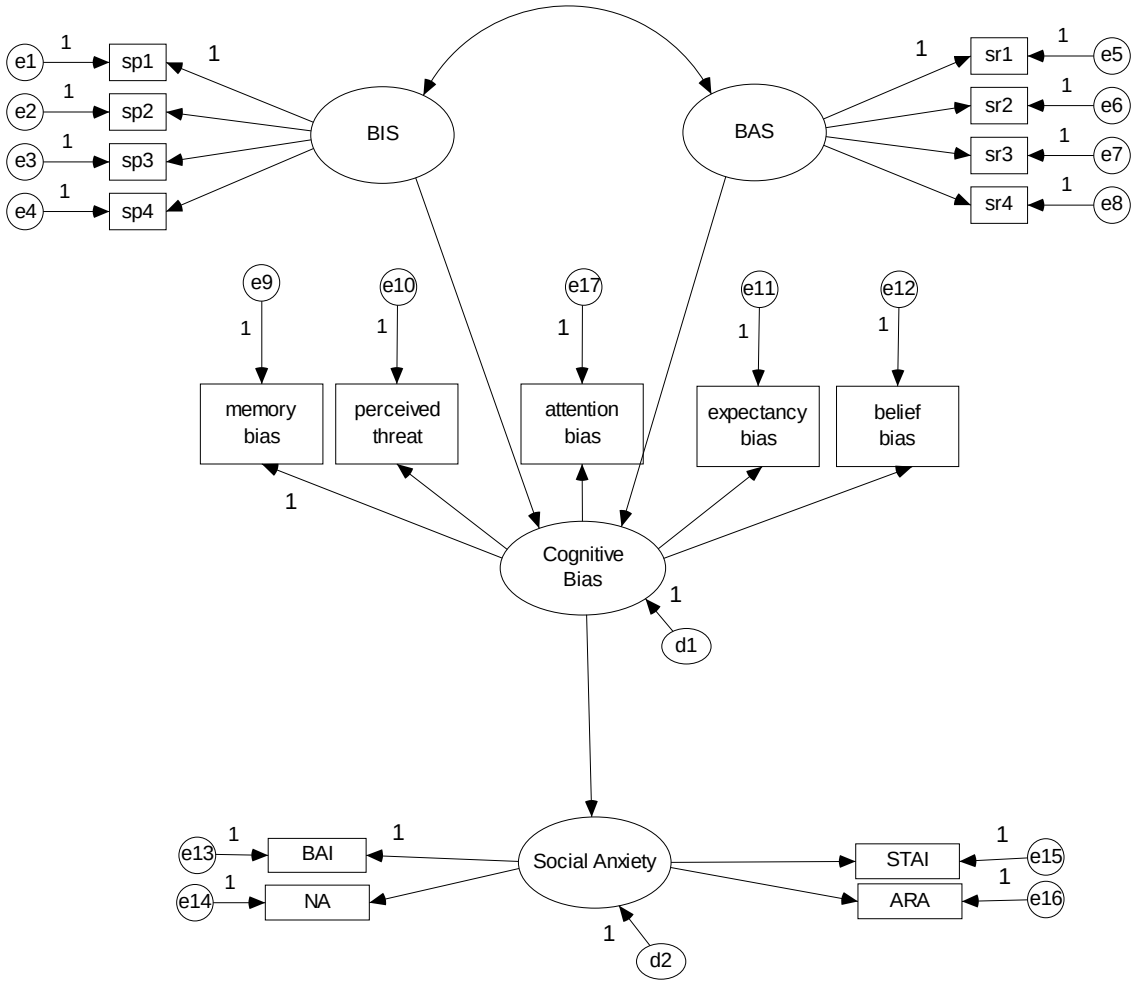


Figure 2

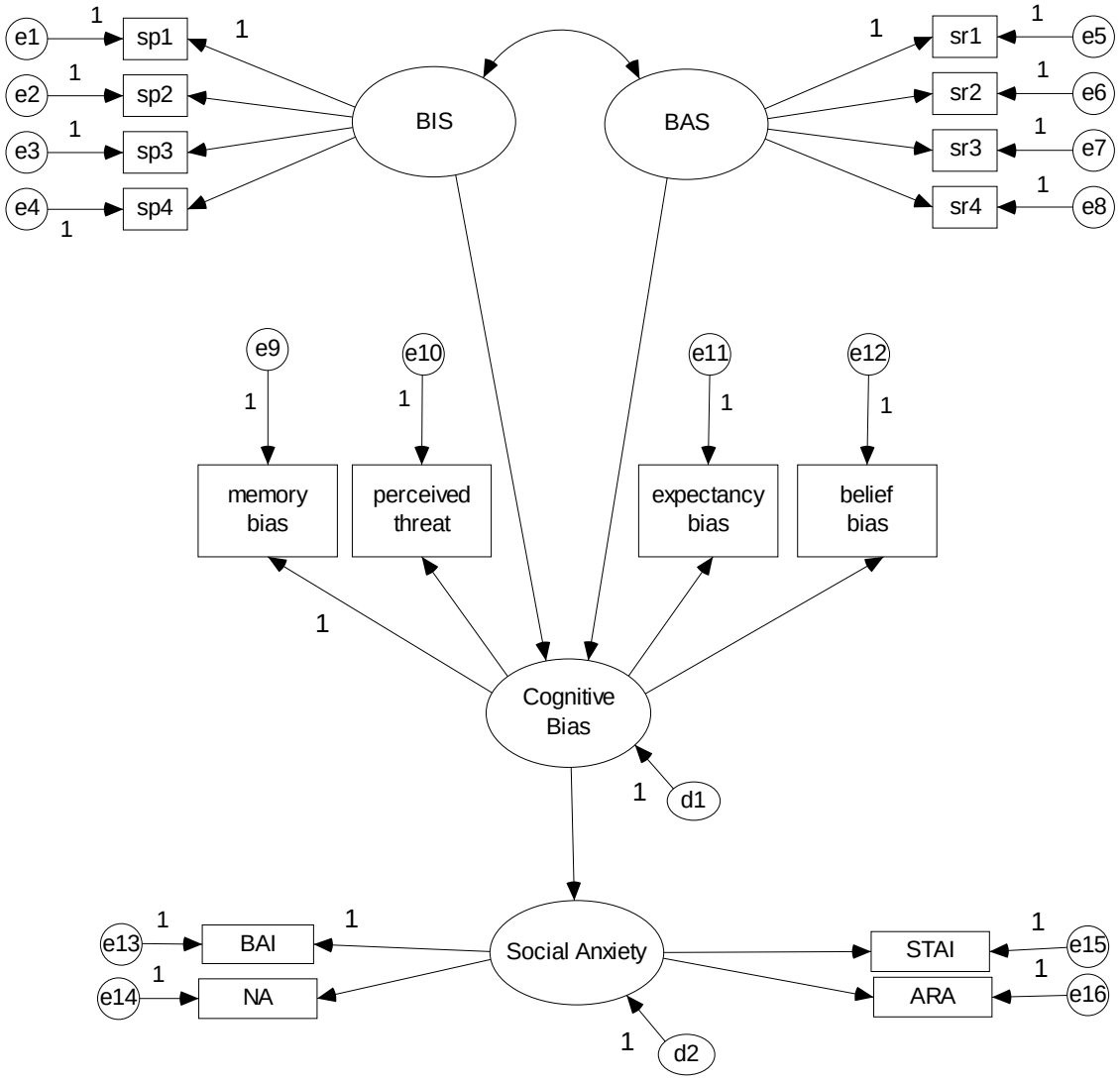
Hypothesized Model with the Attention Bias Variable Included



Note: sp1 – sp4 = Sensitivity to Punishment parcels 1 – 4; sr1 – sr4 = Sensitivity to Reward parcels 1 – 4; BAI = Beck Anxiety Inventory; STAI = State-Trait Anxiety Inventory, State Version; NA = Negative Affect; ARA = Audience Rated Anxiety; e1 – 17 = error terms; d1 = disturbance term for cognitive bias; d2 = disturbance term for social anxiety.

Figure 3

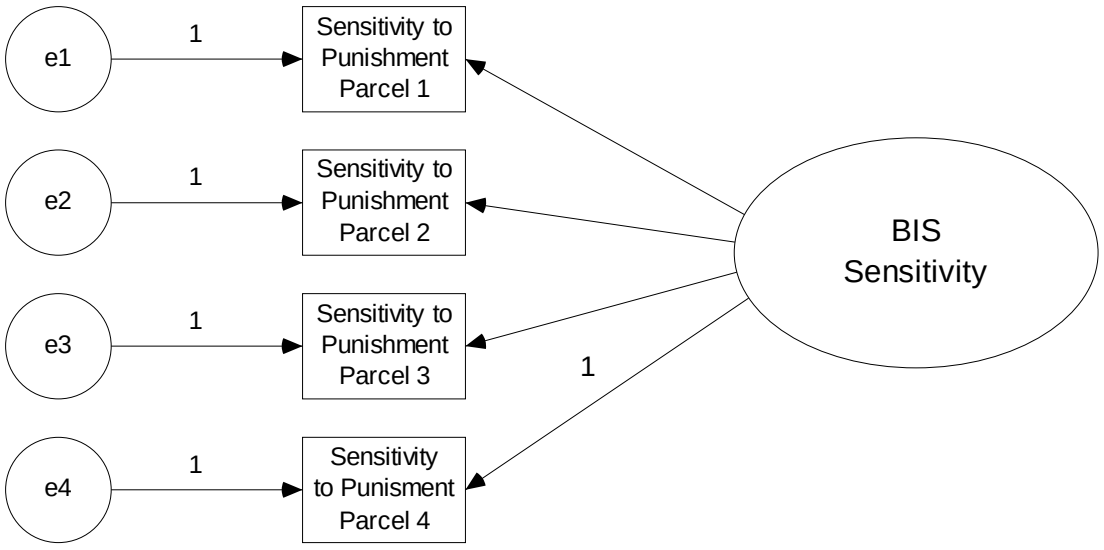
Hypothesized Model after Removing the Attention Bias Variable



Note: sp1 – sp4 = Sensitivity to Punishment parcels 1 – 4; sr1 – sr4 = Sensitivity to Reward parcels 1 – 4; BAI = Beck Anxiety Inventory; STAI = State-Trait Anxiety Inventory, State Version; NA = Negative Affect; ARA = Audience Rated Anxiety; e1 – 17 = error terms; d2 = disturbance term for social anxiety.

Figure 4

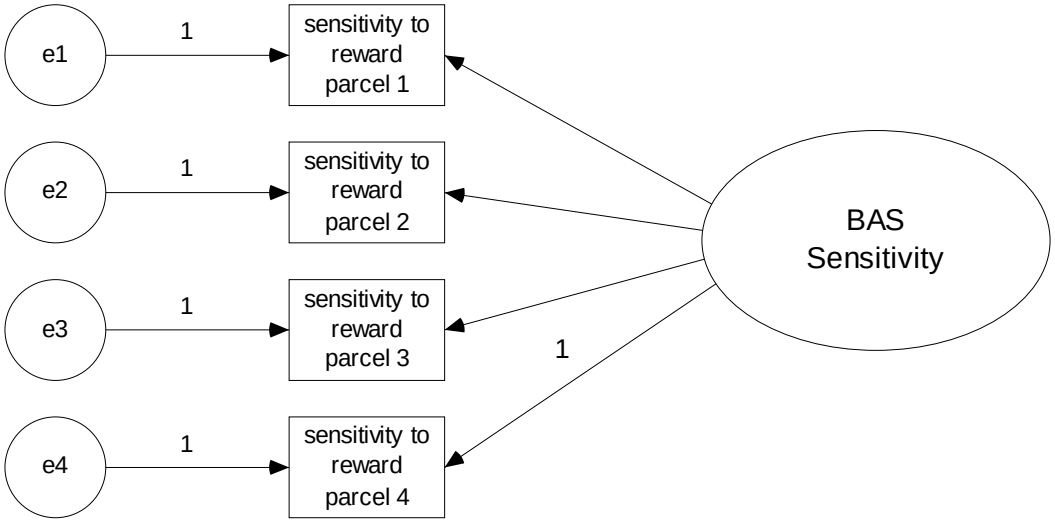
Measurement Model for BIS Sensitivity Latent Variable



Note: e1 – e4 = error terms 1 – 4.

Figure 5

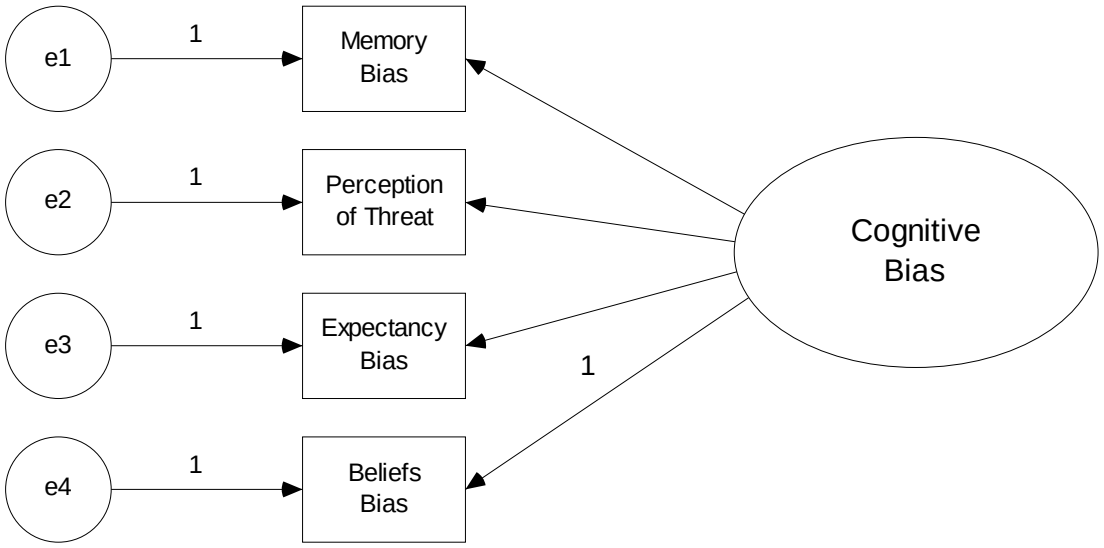
Measurement Model for BAS Sensitivity Latent Variable



Note: e1 – e4 = error terms 1 – 4.

Figure 6

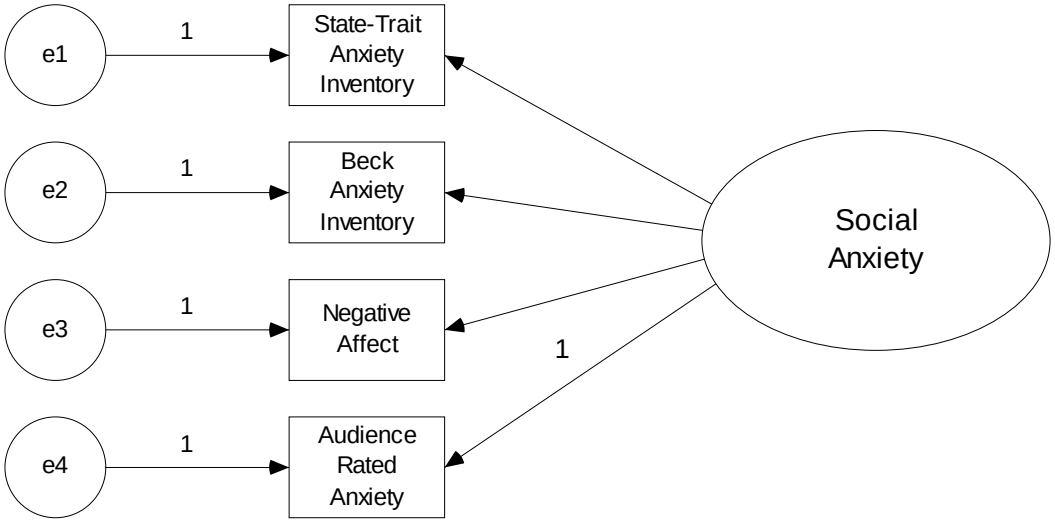
Measurement Model for Cognitive Bias Latent Variable



Note: e1 – e4 = error terms 1 – 4.

Figure 7

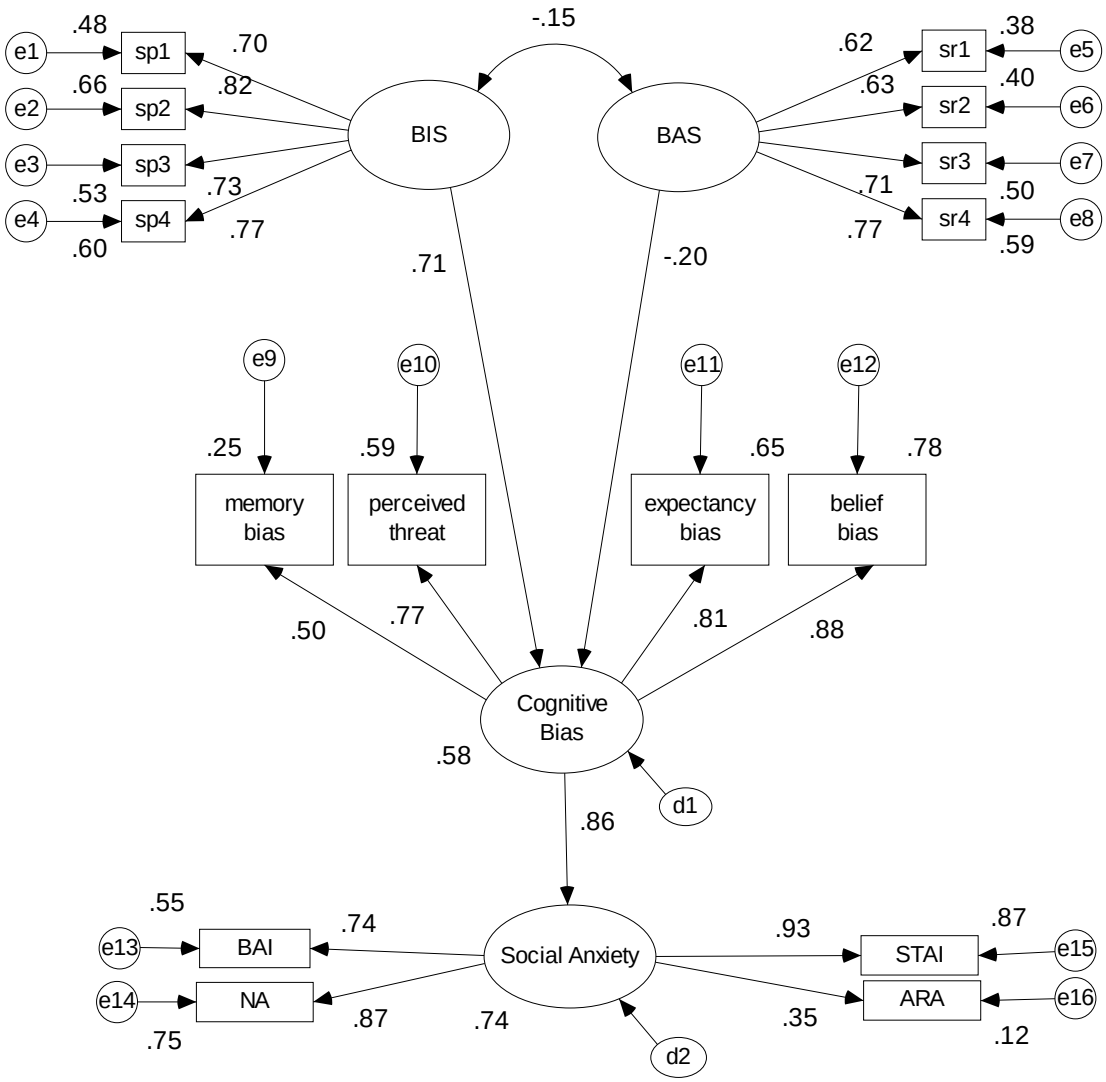
Measurement Model for Social Anxiety Latent Variable



Note: e1 – e4 = error terms 1 – 4.

Figure 8

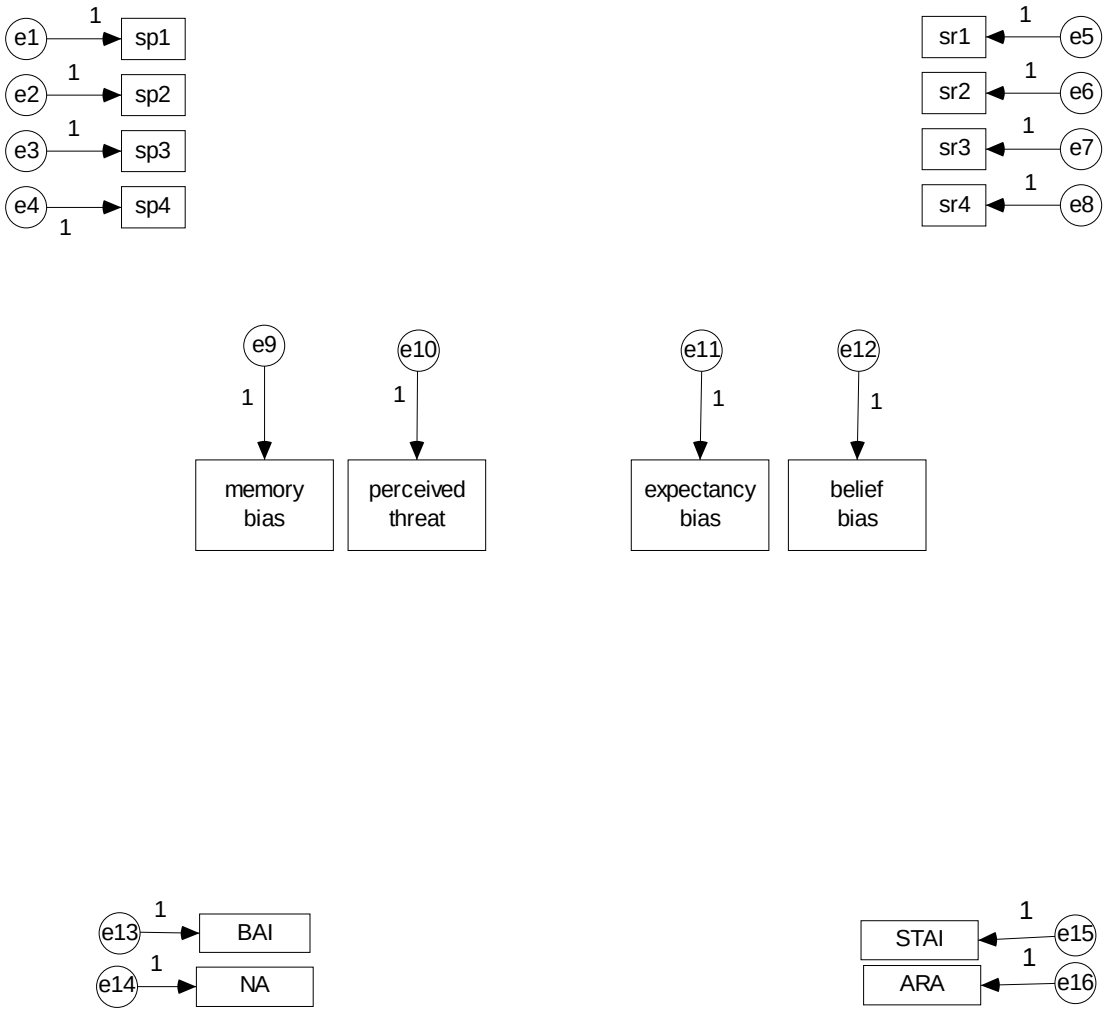
Hypothesized Model with Standardized Estimates Shown



Note: sp1 – sp4 = Sensitivity to Punishment parcels 1 – 4; sr1 – sr4 = Sensitivity to Reward parcels 1 – 4; BAI = Beck Anxiety Inventory; STAI = State-Trait Anxiety Inventory, State Version; NA = Negative Affect; ARA = Audience Rated Anxiety; e1 – 17 = error terms; d2 = disturbance term for social anxiety.

Figure 9

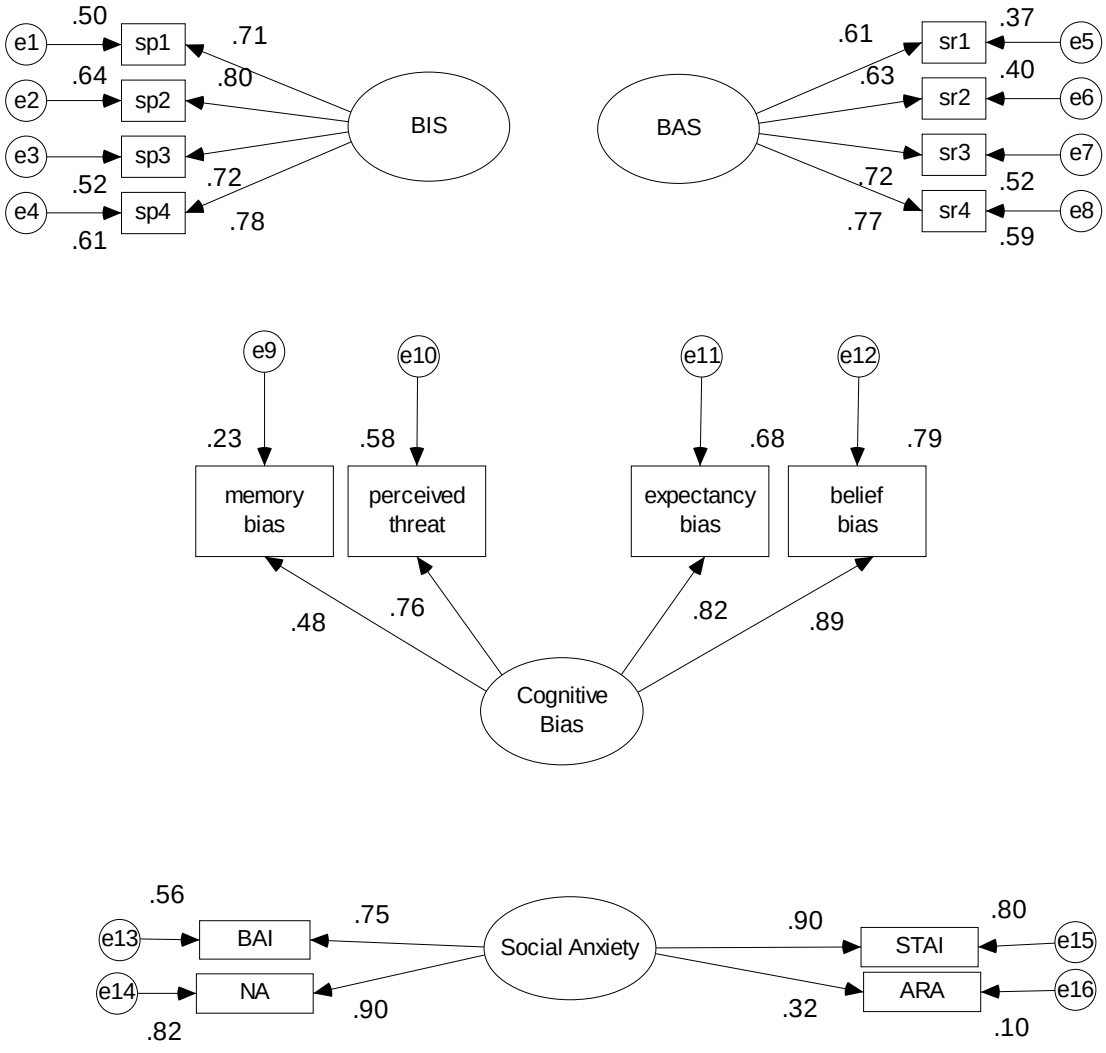
Null Model of Independence



Note: sp1 – sp4 = Sensitivity to Punishment parcels 1 – 4; sr1 – sr4 = Sensitivity to Reward parcels 1 – 4; BAI = Beck Anxiety Inventory; STAI = State-Trait Anxiety Inventory, State Version; NA = Negative Affect; ARA = Audience Rated Anxiety; e1 – 17 = error terms; d2 = disturbance term for social anxiety.

Figure 10

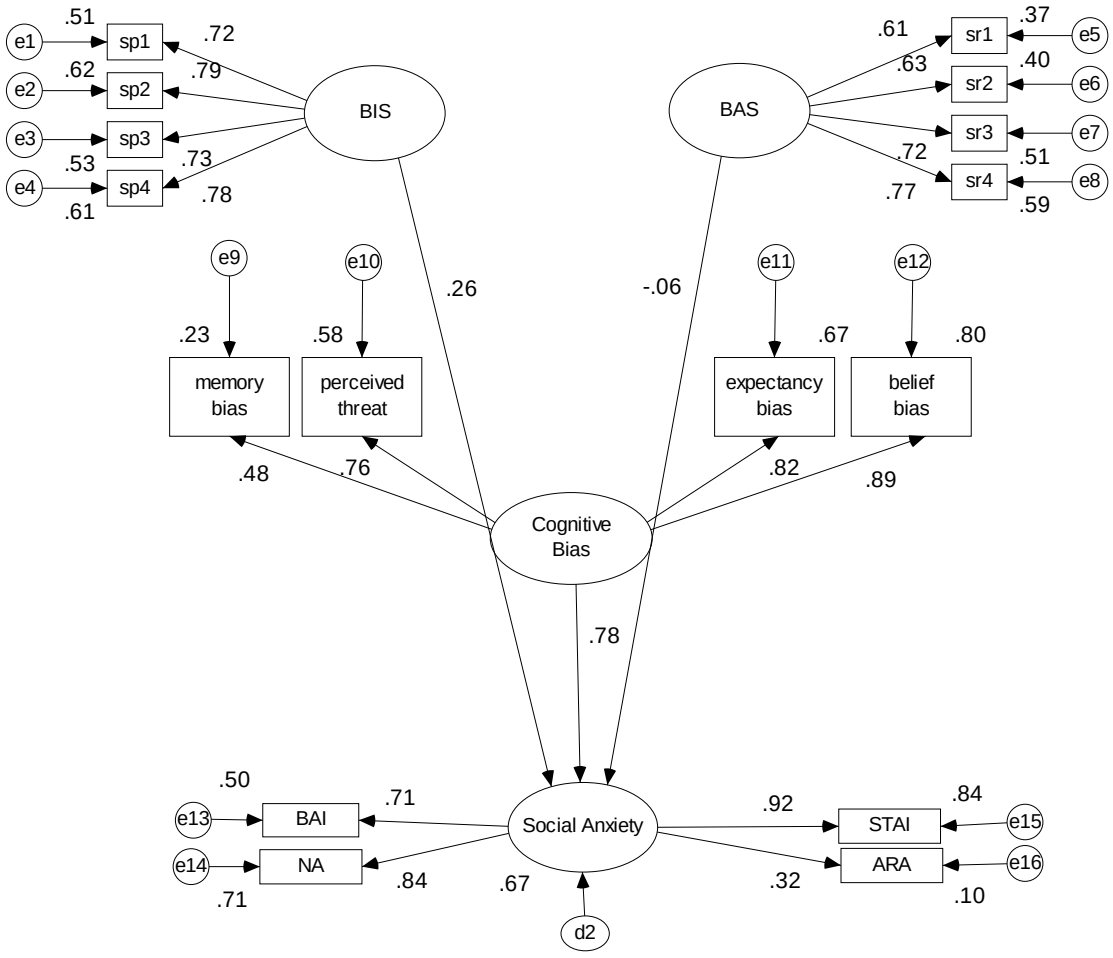
Latent Model of Independence



Note: sp1 – sp4 = Sensitivity to Punishment parcels 1 – 4; sr1 – sr4 = Sensitivity to Reward parcels 1 – 4; BAI = Beck Anxiety Inventory; STAI = State-Trait Anxiety Inventory, State Version; NA = Negative Affect; ARA = Audience Rated Anxiety; e1 – 17 = error terms; d2 = disturbance term for social anxiety.

Figure 11

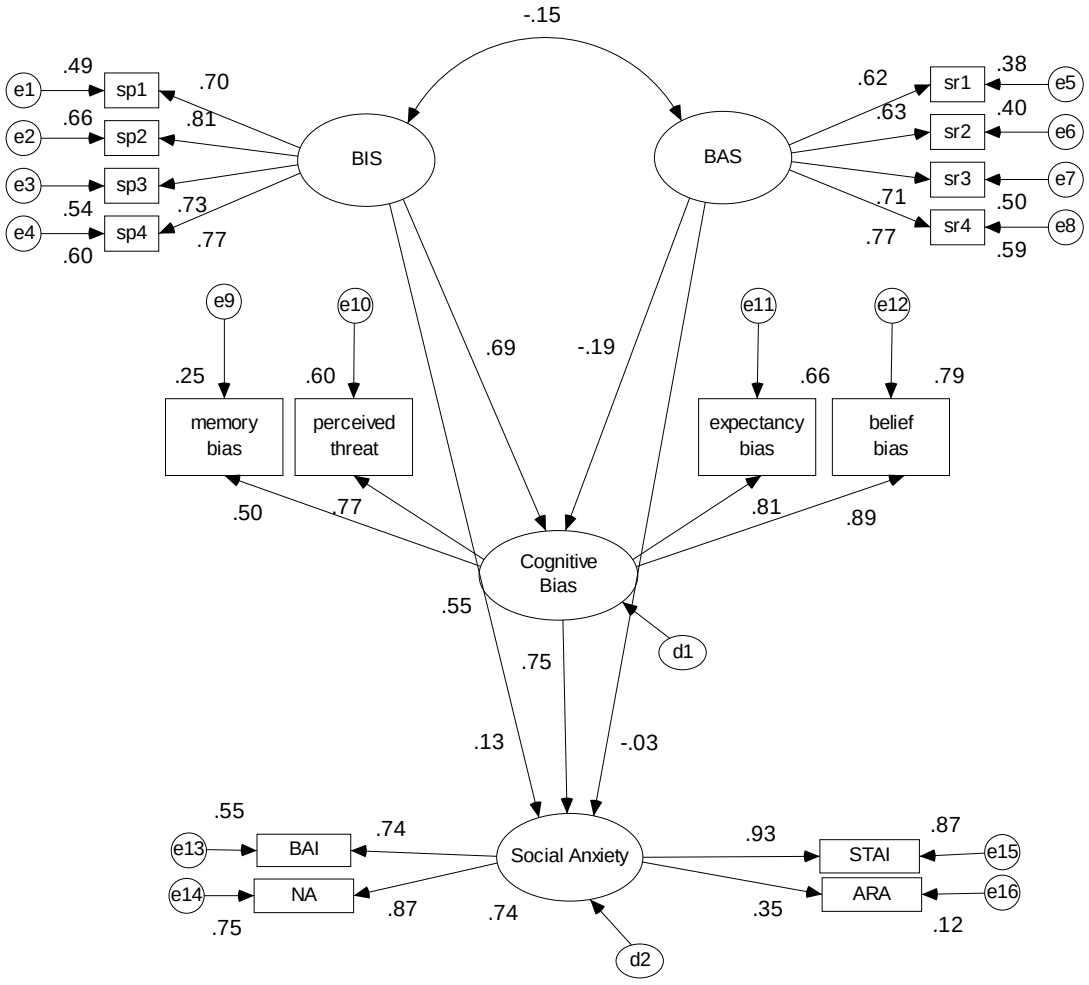
Independent Main Effects Model



Note: sp1 – sp4 = Sensitivity to Punishment parcels 1 – 4; sr1 – sr4 = Sensitivity to Reward parcels 1 – 4; BAI = Beck Anxiety Inventory; STAI = State-Trait Anxiety Inventory, State Version; NA = Negative Affect; ARA = Audience Rated Anxiety; e1 – 17 = error terms; d2 = disturbance term for social anxiety.

Figure 12

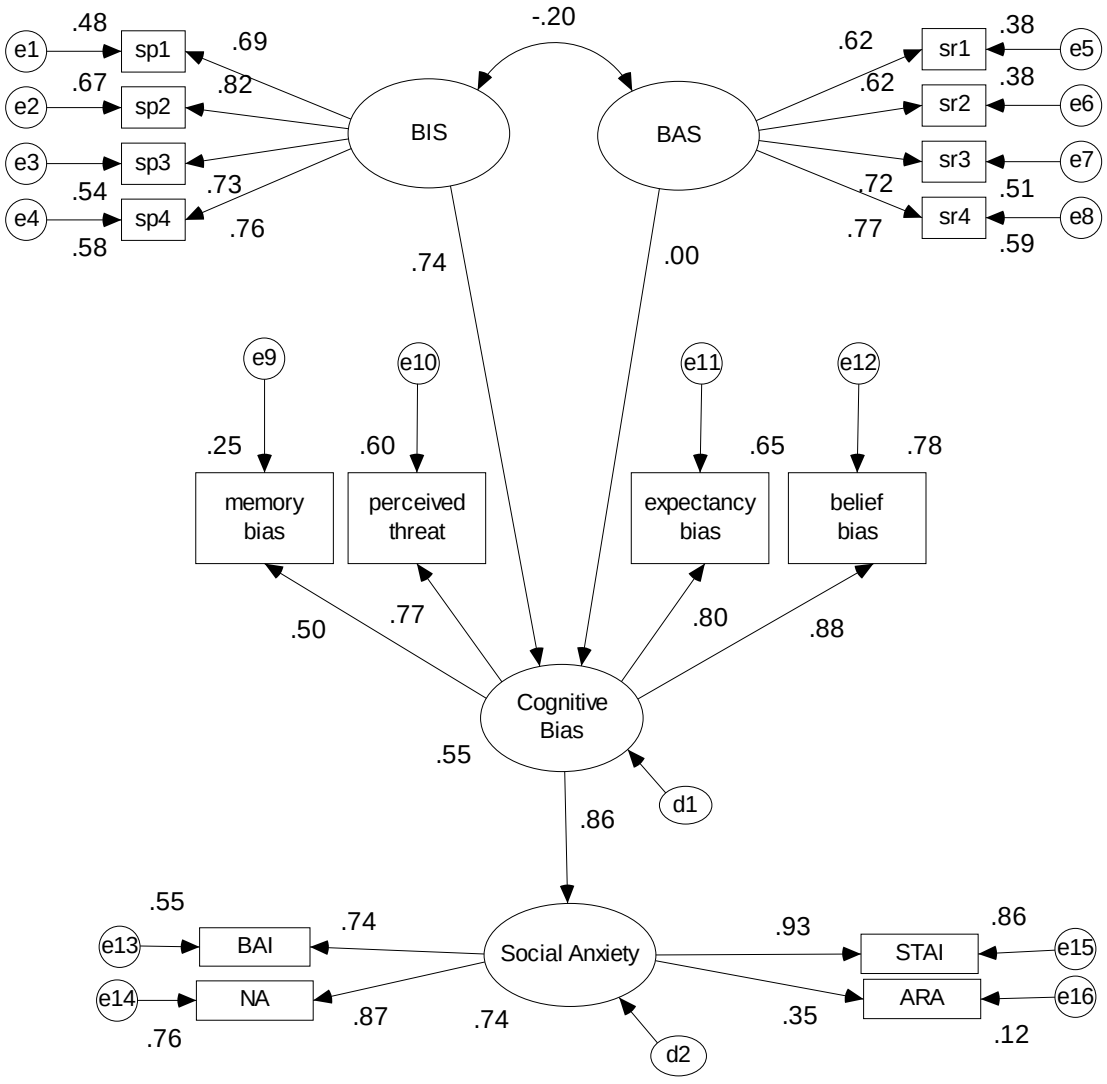
Partial Mediation Model



Note: sp1 – sp4 = Sensitivity to Punishment parcels 1 – 4; sr1 – sr4 = Sensitivity to Reward parcels 1 – 4; BAI = Beck Anxiety Inventory; STAI = State-Trait Anxiety Inventory, State Version; NA = Negative Affect; ARA = Audience Rated Anxiety; e1 – 17 = error terms; d2 = disturbance term for social anxiety.

Figure 13

BAS Constrained Model



Note: sp1 – sp4 = Sensitivity to Punishment parcels 1 – 4; sr1 – sr4 = Sensitivity to Reward parcels 1 – 4; BAI = Beck Anxiety Inventory; STAI = State-Trait Anxiety Inventory, State Version; NA = Negative Affect; ARA = Audience Rated Anxiety; e1 – 17 = error terms; d2 = disturbance term for social anxiety.