ABSTRACT

Title of Dissertation	THE EFFECT OF INTOLERANCE OF UNCERTAINTY ON ATTENTION BIASES AS INDICATED BY PERFORMANCE ON THE EMOTIONAL STROOP AND DOT-PROBE TASK
	Earta Norwood, Doctor of Philosophy, 2014
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Anxiety disorders affect about 28.8% of the United States population at some time in their lifetime. Current theoretical models of anxiety disorders include cognitive constructs that are believed to play a crucial role in the etiology and maintenance of these disorders. Intolerance of uncertainty is one such cognitive construct, and it has been defined as a negative emotional, cognitive, or behavioral response to uncertain situations and events. Intolerance of uncertainty results in selective encoding and interpretation of information, such that people with high intolerance of uncertainty pay more attention to uncertain stimuli, go through greater elaborative encoding of uncertain information, have enhanced recollection of uncertain stimuli, and have a greater tendency to interpret such stimuli as threatening. Studies investigating processing biases in intolerance of uncertainty have used verbal-linguistic stimuli and have assessed biases during the interpretive and elaborative phase of information processing. The current study investigates intolerance of uncertainty as a moderator in the relationship between anxiety

and information processing biases. Attention biases were assessed with the emotional Stroop task (using neutral words, threatening words, and words denoting uncertainty), and the dot-probe task (using photographs displaying faces with neutral or fearful expression). Contrary to our hypothesis, IU was not a moderator in the relationship between anxiety and automatic information processing biases. Additionally, we found no evidence of a relationship between IU and reaction times in the emotional Stroop and dot-probe task. Unexpectedly, the current study did not demonstrate a relationship between anxiety and automatic information processing biases.

THE EFFECT OF INTOLERANCE OF UNCERTAINTY ON ATTENTION BIASES
AS INDICATED BY PERFORMANCE ON THE EMOTIONAL STROOP AND DOT-
PROBE TASK

By

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Dedication

To Jacob Norwood for his patience and support. To Flutura Hoxha, without whom this long road would have taken even longer. To Illyria and Arlind Norwood for the fulfilling and worthwhile delays in getting my degree. To the rest of my family for cheering me on. To those dear to my heart who have passed on and who very much shaped me as a person and a scholar.

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Chapter 1: Introduction

Anxiety disorders affect about 28.8% of the United States population at some time in their lifetime (Kessler, Berglund, Demler, Jin, Merikangas, & Walters, 2005). People diagnosed with anxiety disorders often report experiencing unrelenting feelings of worry, apprehension, nervousness, and fear (Antony, Orsillo, & Roemer, 2001). These feelings are typically accompanied by a future-focused sense of uncontrollability and unpredictability (Suárez, Bennett, Goldstein, & Barlow, 2009), which is best captured in the construct of intolerance of uncertainty (IU; Dugas, Buhr, & Ladouceur, 2004). Research indicates that anxious people tend to process information in a way that reconfirms their view of the world as an uncontrollable, unpredictable, and ultimately dangerous place (Ouimet, Gawrinski, & Dozois, 2009). Several theoretical models of anxiety disorders have proposed that IU plays a crucial role in the etiology and maintenance of anxiety disorders and in how individuals with anxiety process information (Dugas, Freeston, & Ladouceur, 1997; McEvoy & Mahoney, 2012). A better understanding of the role of IU would lead to better theoretical models of anxiety and would inform treatment of anxiety disorders. The focus of the current study is to elucidate the relationship between IU, anxiety, and information processing biases commonly observed in anxious people (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). In particular, the current study investigated whether IU is a moderator of the relationship between anxiety and biases in the automatic stages of processing ambiguous and threatening information.

Anxiety and Information Processing Biases

Biased information processing is at the center of a number of current theoretical models of emotional disorders (Rapee, 2001; Mogg, & Bradley, 1998; Mathews, & Mackintosh, 1998; Eysenck, 1992; Beck, & Clark, 1997; Clark, & Wells, 1995; Woody, & Rachman, 1994; Ohman, 1993; Williams, Watts, MacLeod, & Mathews, 1988; Foa & Kozak, 1986). Mathews and MacLeod (2005) note that biased information processing in people with emotional disorders is not narrow, deficient, incorrect, or distorted. It rather involves selective information processing that is biased towards mood congruent material, resulting in higher-than-normal vigilance for the mood congruent stimuli (McNally & Reese, 2009). Research indicates that information processing biases in people with anxiety disorders tend to reconfirm the anxious person's view of the world as a dangerous place (Ouimet, Gawronski, & Dozois, 2009).

Early cognitive theories of the etiology of anxiety proposed that anxiety is the result of enhanced automatic encoding of threatening stimuli, retrieval of the same, and proliferation of anxiety schemata (Beck, 1976). Other theories propose that anxiety results from interpretation of uncertain stimuli as threatening and that cognitive resources are disproportionately allocated towards threatening stimuli during later, elaborative, and interpretative processes (Bower, 1983; Foa & Kozak, 1986; Mogg, Bradley, de Bono, & Painter, 1997; Mathews, & Mackintosh, 1998;). Although these theories propose different timelines and mechanisms of the automatic cognitive processes that enhance and maintain anxiety, both views predict facilitated processing of threatening stimuli. Later theories combine the two ideas and propose that the attention of anxious individuals is immediately captured by threatening stimuli, and attentional resources are

disproportionately allocated to processing these stimuli during the initial, automatic stages of processing (Amir, Coles, & Foa, 2002; Beck & Clark, 1997; Eysenck, 1992; Mogg et al, 1997; Williams, Watts, MacLeod, & Mathews, 1988; Williams et al., 1997). The preferential automatic processing is followed by sustained selective semantic elaboration of threatening stimuli (Beck & Clark, 1997), threatening interpretation of uncertain stimuli (Eysenck, 1992), or avoidance resulting in failure to assess threat accurately and failure to habituate to threatening stimuli (Amir, Foa, & Coles, 1998; Mogg et al, 1997; Williams et al., 1997).

The early automatic stages of information processing include attention and encoding processes. Anxious individuals are particularly sensitive to threat and automatically direct their attention to threatening stimuli and prioritize such stimuli for encoding before others. They have difficulty habituating to seemingly threatening stimuli that do not pose danger or have difficulty disengaging attention from the threatening features of a stimulus to attend to features indicating safety. Additionally, Mathews (1990) suggested that anxious individuals engage in constant automatic evaluation of their surroundings for possible threatening stimuli, resulting in symptoms of hypervigilance and heightened startle responses (Mobini & Grant, 2007).

The existing evidence for threat-related cognitive biases in anxiety disorders is the result of numerous experimental studies using various cognitive tests, many of which target attentional processes. In addition to the mere presence of attentional biases, these studies have explored other factors that affect the magnitude of information processing biases. These moderating factors include, among others, level of anxiety, specific anxiety disorders, comorbidity, stimulus awareness, specific type of cognitive task (Bar-Haim,

Lamy, Pergamin, Bakermans-Krannnenburg, & van Ijzendoorn, 2007). Bar-Haim et al. (2007) conducted a meta-analysis investigating the magnitude and moderators of information processing biases in anxiety. They found a threat-related bias that was similar across diverse anxiety disorders and concluded that this bias, rather than being disorder specific, may be related to a possible mechanism that underlies both anxiety and anxiety disorders.

Many experimental paradigms have been developed in order to investigate processing biases in attention, memory, interpretation, judgment, and reasoning. The most notable examples of these experimental paradigms include the emotional Stroop, dot-probe, emotional spatial cuing, and visual search paradigms (Bar-Heim et al, 2007). The emotional Stroop and dot-probe tasks have been crucial in investigating biases in attention and specific aspects of attention such as attention allocation, automaticity, or timeline of attention allocation and withdrawal (Shalev & Algom, 2000; Ouimet, Gawronski, & Dozois, 2009).

Intolerance of Uncertainty and Anxiety

The construct of IU first emerged in generalized anxiety disorder literature in 1994 (Freeston, Rhéaume, Letarte, Dugas, & Ladouceur, 1994). In the 20 years since then, the efforts to conceptualize IU have yielded interpretations as a dispositional characteristic, a personality trait, a cognitive process, and as a cognitive filter (Dugas and Robichaud, 2007; Dugas, Hedayati, Karavidas, Buhr, Francis, & Philips, 2005; Fisher & Wells, 2009). The resulting definitions have described IU as biased perception, interpretation, or as negative emotional/cognitive/behavioral response to uncertain situations and events (Buhr & Dugas, 2006; Dugas et al., 2005; Dugas, Buhr, &

Ladouceur, 2004; Freeston et al., 1994). Researchers have identified several behavioral operationalizations of intolerance of uncertainty which include avoidance, inability to act, attempts to control the future, all-or-nothing responses in cases of uncertainty (Yook, Kim, Suh, & Lee, 2010), heightened startle response (Nelson & Shankman, 2011), heightened information-seeking (Starcevic & Berle, 2006), and difficulties with decision-making (Krain, Hefton, Pine, Ernst, Castellanos, Klein, & Milham, 2006). The current study adopts an understanding of IU as a cognitive process, defined as biased perception and interpretation of stimuli denoting uncertainty and threat, and operationalized as heightened information-seeking and difficulties with decision-making.

People with high IU perceive uncertain and novel events as stressful and upsetting (Carleton, 2012). They further interpret such events as negative, threatening, and unfair. They are unable to tolerate the possibility of a negative outcome, even if the probability of such outcome is very small (Mathews, & Funke, 2006; Dugas et al., 2005).

It has been suggested that heightened IU results in selective encoding and interpretation of information, greater elaborative encoding of uncertain statements, enhanced recollection of uncertain material, and greater tendency to interpret such stimuli as threatening (Dugas et al., 2005). Preferential encoding of threatening information, threatening interpretation of uncertain stimuli, and preferential retrieval of threatening information results in extreme concern and worry when any physical or psychological peril is present (Koerner, 2008).

Research aiming to investigate the relationship between anxiety, worry, IU, and information processing shows there are significant relationships between and among each of these constructs (Gentes & Ruscio, 2011). Koerner and Dugas (2008) conducted a

study investigating the relationship between IU, anxiety, and information processing and concluded that IU is a unique contributor that defines the experience of anxiety beyond anxiety symptoms. Further research is needed to explore how IU and worry impact the well-established relationship between anxiety and information processing biases (Bar-Haim, Lamy, Pergamin, Bakermans-Krannnenburg, & van Ijzendoorn, 2007).

The Role of Intolerance of Uncertainty in Anxiety Disorders

IU was initially conceptualized as a construct strongly related with worry and generalized anxiety disorder (GAD; Dugas & Ladouceur, 2000). Recent research indicates that IU is a construct that defines the experience of anxiety and is not necessarily restricted to a specific diagnosis of GAD (McEvoy & Mahoney, 2011). For example, recent studies have identified a relationship between IU and obsessive-compulsive disorder (Lind & Boschen, 2009), social anxiety (Carleton, Collimore, & Asmundson, 2010), panic disorder with agoraphobia (Buhr & Dugas, 2009), and even depression (de Jong-Meyer, Beck, & Riede, 2009).

IU is correlated with other anxiety constructs that play an important role in the etiology and maintenance of different anxiety disorders, such as worry (de Jong-Meyer et al., 2009), anxiety sensitivity (Carleton, Sharpe, Asmundson, 2007), and fear of anxiety. Recent studies indicate that enhancing negative interpretive biases increases vulnerability to stress (White, Suway, Pine, Bar-Haim, & Fox, 2011; Eldar, Ricon, & Bar-Haim, 2008; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). Chen and Hong (2010) investigated the role of IU in heightening anxiety levels in the presence of daily hassles. The researchers found that IU moderated the role of daily stress on the experience of anxiety. They suggested that the heightened levels of anxiety were the result of increased

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perceived threat as individuals with increased levels of anxiety perceived uncertain

elements of the situations as threatening.

Distinction between Intolerance of Uncertainty and Worry

While the focus of the proposed study is on IU, it is important to note a second,

related construct, that of worry. Worry was first defined as an uncontrollable chain of

thoughts charged with negative affect (Borkovec, Robinson, Pruzinsky, & DePree, 1983),

aiming to solve problems with uncertain outcomes, especially when some of these

outcomes may be negative. Worry has also been conceptualized as an anticipatory

cognitive process that is characterized by the tendency to interpret ambiguous stimuli as

threatening, the tendency to predict negative outcomes for uncertain events, and the

tendency to overestimate risk (Ladouseur, Gosselin, & Dugas, 2000). It has been

characterized as fear-producing thoughts and images related to everyday-life experiences

that have the potential to result in adverse consequences (Mathews, & Funke, 2006;

Taylor, Thordarson, Sochting, 2002). These thoughts and images are thought to be

uncontrollable, excessive, repetitive, and to remain unresolved in the absence of

intervention (Mathews, & Funke, 2006).

According to cognitive theories of anxiety, worry is related to threat schemata in

an individual's long-term memory (Mathews, & Funke, 2006). When these threat

schemata are activated, they may increase vigilance for internal or external threats (e.g.

negative evaluation or harm, respectively). The preferential processing of threatening

stimuli, also known as biased information processing, can have causal effects on the

etiology and maintenance of anxiety and worry (Koster, Fox, & MacLeod, 2009). The

variables that have been proposed as predictors of excessive worry are: IU, beliefs that

worry has a protective function, negative orientation towards problem situations, and cognitive avoidance (Dugas, Gagnon, Ladouceur, & Freeston, 1998). The relationship between IU and worry remains strong even after taking into account anxiety and depression (Buhr, & Dugas, 2006; Buhr & Dugas, 2009; Boelen, Vrinssen, & van Tulder, 2010; de Bruin, Rassin, & Muris, 2007; de Bruin, Rassin, & Muris, 2006; Dugas, Gosselin, Ladouceur, 2001). When faced with an uncertain future, individuals with anxiety engage in repetitive cognitions, also known as worry, focused on solving and preparing for the unknown problem waiting for them in the unknown future (Boswell, Thompson-Hollands, Farchione, & Barlow, 2013).

Intolerance of Uncertainty and Depression

Numerous studies have investigated underlying mechanisms, cognitive processes, and dimensional traits shared by anxiety and depression in the attempt to explain the comorbidity between the two and develop better treatments (Querstret & Cropley, 2013; Bauer, Wilansky-Traynor, & Rector, 2012; Kaufman & Charney, 2000). Yook et al. (2010) theorized that individuals with high IU may experience negative affect and low self-esteem due to their bleak outlook for the future and worry that they do not possess sufficient problem solving skills to manage this uncertain future. Anticipation of negative events is a feature associated with IU, anxiety, and depression. This high comorbidity indicates that depression is a correlate that may influence information processing biases. A more detailed review of the relationship between depression, anxiety, and IU can be found in Appendix 1.

Measuring Intolerance of Uncertainty

Many studies investigating processing biases in worry and IU have used verbal-linguistic stimuli and have assessed biases during the interpretative and elaborative phase of information processing (Dugas et al., 2005; Rassin & Muris, 2005; Koerner & Dugas, 2008). Dugas et al. (2005) reasoned that words are the ideal medium for investigating biases in information processing in worriers and people with high intolerance of uncertainty, because verbal-linguistic processes predominate in worry.

Freeston et al. (1994) constructed the first measure to assess IU, the Intolerance of Uncertainty Scale (IUS), a 27 item, 5-point Likert scale that has shown high internal consistency and 5-week test-retest reliability (Norton, 2005; Buhr & Dugas, 2002). The IUS was designed to assess the belief that uncertainty is stressful, upsetting, unfair, negative, to be avoided, and leaves one unable to act. Several factor analyses have attempted to identify the factor structure of IU and have yielded inconsistent conclusions with regards to the number of factors and the dimensions or latent constructs reflected in the factors (Freeston et al, 1994; Buhr & Dugas, 2006; Norton, 2005; Carleton et al, 2007; Berenbaum et al, 2008; Sexton & Dugas, 2009). Factors that have been identified within these studies include: the belief that uncertainty has negative repercussions, the feeling that uncertainty is damaging and unfair (Sexton & Dugas, 2009; Buhr & Dugas, 2002); the need for predictability, inaction in the face of uncertainty, experiencing uncertainty as distressing, and inflexible beliefs about uncertainty (Berenbaum et al, 2008; Buhr & Dugas, 2002); anxiety, and avoidance (Carleton et al, 2007). McEvoy and Mahoney (2011) suggested that these inconsistencies may be due to diversity in the severity of anxiety and IU experienced by participants across studies. Some of these

studies employed participants with non-clinical levels of anxiety and IU which may have led to more homogenous answers, while others employed participants with clinical levels of anxiety which may have led to answers revealing a multidimensional structure of IU.

Intolerance of Uncertainty and Information Processing Biases

Biases in information processing play a meaningful role in the etiology and maintenance of anxiety disorders. Our understanding of the magnitude of the relationship between information processing biases and anxiety disorders comes as the result of a wealth of theoretical discussion and research. Similarly, a better understanding of IU requires an investigation of accompanying information processing biases during all stages of processing. Dugas et al. (2005) were among the first to investigate information processing biases in relation to IU after noting a lack of research on the topic. The goal of their work was to identify how IU influenced information processing and how that, in turn, led to excessive worry and anxiety. The authors focused on biases in recall of material denoting uncertainty, and biases in interpretation of uncertain situations. They found that IU led to better recall of material denoting uncertainty and threatening interpretation of uncertain situations. The materials used in these experiments included a word list and fictitious diary entries (Davey, 1993). These findings were replicated by Koerner-Singh (2008) using both vignettes and pictorial stimuli. Carleton (2012) proposed that IU is associated with automatic information processing biases. Individuals with high IU are faster at identifying uncertain stimuli compared to neutral ones, pointing to facilitated engagement towards uncertain stimuli (Fergus, Bardeen, & Wu, 2013). Current research has employed cognitive tasks that shed light on the relationship between IU and interpretation of ambiguous or threatening stimuli. An understanding of the

relationship between IU and information processing in the automatic stages of information processing requires the use of experimental paradigms that target early stages of processing such as the Stroop and dot-probe tasks.

Emotional Stroop. The classic Stroop task was designed to investigate the interference of the semantic characteristics of the word with the physical characteristics of the print or the interference of names of colors with the color of the ink used to print the words (Stroop, 1935). Phaf and Kan (2007) explained that the delay in naming the ink color of words compared to strings of meaningless symbols is the result of simultaneous automatic processing of the color of print and the semantic meaning of the word, which is absent in the case of meaningless strings of symbols.

In the emotional Stroop task, the participants are asked to name the color of the ink for words that have emotionally neutral or emotionally relevant meaning. Numerous studies have indicated that people with emotional difficulties take longer to name the color of emotional words compared to neutral words, while people in control groups do not show such effect (Williams, Mathews, & MacLeod, 1996). This bias has been explained as the result of attention being automatically directed towards the emotional characteristics of the word processed simultaneously with naming the color of the print (Williams, Watts, MacLeod, & Mathews, 1988). Bar-Haim et al. (2007) reviewed studies investigating threat-related attentional biases using the emotional Stroop task in 1467 individuals. The researchers found a significant threat-related bias in adults and children with high anxiety or anxiety disorders.

Dot Probe. The dot-probe task was designed to investigate attention biases towards threatening material (MacLeod, Mathews, & Tata, 1986). In the dot-probe task

the participants are presented simultaneously with a threatening and a nonthreatening stimulus. After a brief presentation, the stimuli are removed and one of them is replaced with a probe. The participants are asked to respond to the probe as quickly and accurately as possible. It is assumed that the participants will react faster when the probe replaces the stimulus to which they were attending at the onset of the probe. Numerous studies have indicated that people with emotional difficulties are faster at reacting to the probe when it replaces the threatening stimulus rather than when it replaces the neutral stimulus (Cisler, Bacon, & Williams, 2009). The dot-probe task has been used in many studies aiming to investigate selective attention biases in people with anxiety (Frewen, Dozois, Joanisse, & Neufeld, 2008). Bar-Haim et al. (2007) reviewed 35 studies, including 659 individuals that used the dot-probe paradigm. The researchers found that the dot probe paradigm was effective in detecting the differences between anxious and non-anxious individuals. McKay, Thoma, and Pilecki (2009) explained that the observed bias in the dot-probe task is the result of enhanced attention towards threatening stimuli or lower threshold for detecting threat. Similarly to the emotional Stroop task, attention biases towards anxiety-provoking material in the dot-probe task have been associated with key cognitive constructs such as worry (McKay, 2005) and anxiety sensitivity (Hunt, Keogh, & French, 2006).

Bar-Heim et al (2007) found that the emotional Stroop task and the dot-probe task yielded effect sizes that were statistically similar across anxiety disorders. The correlation between results obtained with the emotional Stroop and dot-probe paradigms in both subliminal and supraliminal versions indicate that these tasks target similar constructs (Egloff & Hock, 2003). These studies have observed bias for both general threat

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information and for information that is consistent with the specific concerns of the diagnosed anxiety disorder, indicating an underlying non-specific anxiety component common for all anxiety disorders (McKay, Thoma, & Pilecki, 2009).

Current Study

The purpose of the current study is to investigate the influence of IU on the relationship between anxiety and attentional processing biases. IU has been identified as a cognitive construct that contributes uniquely to the experience of anxiety beyond anxiety symptoms (Koerner and Dugas, 2008). Numerous studies have investigated the relationship between intolerance of uncertainty and interpretive biases (Dugas et al 2005; Kirsch & Windmann, 2009; Koerner-Singh, 2008; Koerner & Dugas, 2008; Robichaud, Dugas, & Conway, 2003); however, most of them have employed experimental paradigms that rely on explicit, top-down, evaluative processes. This association has been investigated by employing tasks that require high levels of semantic analysis and synthesis (Clark & Beck, 2011). Thus, current research indicates that there is an association between intolerance of uncertainty and strategic, intentional, and conscious processes, yet there is very little research exploring the association between intolerance of uncertainty and automatic information processing. The aim of this study is to investigate the association between intolerance of uncertainty and involuntary, unintentional, automatic processes by employing tasks that require a comparatively low level of cognitive processing and minimal semantic analysis and synthesis (Clark & Beck, 2011), i.e. the emotional Stroop task and the dot-probe task.

Another purpose of this study is to investigate IU as a moderator in the relationship between anxiety and information processing biases. The relationship between

anxiety and information processing biases is well documented, and more recent studies have focused on identifying mediators and moderators influencing this relationship (Eysenck, 1992; Mitte, 2008). IU has been identified as a construct moderating the relationship between anxiety and memory of threatening information, which suggests that IU could be a construct moderating the relationship between anxiety and automatic information processing of threatening stimuli. This study aims to investigate the role of IU as a moderator in the relationship between anxiety and information processing as indicated in the performance in the emotional Stroop and the dot-probe tasks.

Primary Aims and Hypotheses

Aim 1. The primary aim of the current study is to investigate the relationship between severity of intolerance of uncertainty and magnitude of attentional information processing biases.

Hypothesis 1. It is hypothesized that severity of intolerance of uncertainty will be positively correlated to reaction time in the trials involving words denoting uncertainty and threat in the emotional Stroop task.

Hypothesis 2. It is hypothesized that severity of intolerance of uncertainty will be negatively correlated to reaction time in the trials involving fearful faces in the dot-probe task.

Aim 2. The secondary aim of this study is to explore the role of intolerance of uncertainty in the relationship between anxiety and information processing biases.

Hypothesis 3. It is hypothesized that intolerance of uncertainty will be a moderator in the relationship between anxiety and information processing biases, such

that higher intolerance of uncertainty will strengthen the relationship between anxiety and reaction time in the trials involving fearful faces in the dot-probe task.

Hypothesis 4. It is hypothesized that intolerance of uncertainty will be a moderator in the relationship between anxiety and information processing biases, such that higher intolerance of uncertainty will strengthen the relationship between anxiety and reaction time in the trials involving words denoting uncertainty and threat in the emotional Stroop task.

Exploratory Aim and Hypothesis

Aim 3. An exploratory aim of this study was to investigate the unique contributions of trait anxiety, worry, and intolerance of uncertainty to information processing biases as evidenced by longer latencies in reaction time in the emotional Stroop and shorter latencies in reaction time in the dot-probe task.

Chapter 2: Method

Sample characteristics

Participants for this study were 110 college students at the University of Maryland, College Park. Participants were 65.8% female, and ranged in age from 18 to 24, with a mean age of 19.43 ($SD = 1.77$). The students were all undergraduates (51.4% freshmen, 24.3% sophomores, 14.4% juniors, 9% seniors). The study sample was diverse with regard to race and ethnicity: 8.1% of the participants identified as African-American, 14.4% identified as Asian-American, 62.2% identified as Caucasian, 8.1% identified as Hispanic American, 6.3% identified as other and did not specify their race or ethnicity, and .9% did not complete that part of the Demographics Questionnaire.

Procedures

Recruitment

The participants in this study were students registered to take undergraduate psychology courses that encouraged research participation and were awarded class credit. The students were directed to the Sona system (http://psychology.umd.edu/research/sona.html), where they were able to sign up for the study. The students were informed that the study examined the effects of individual characteristics in information processing of emotional information. The inclusion criteria for the study were that each participant be at least 18 years of age and a student at the University of Maryland, College Park. The exclusion criterion was a diagnosis of any psychotic disorder at any point during the participant's lifetime, which was assessed with the Structured Clinical Interview for DSM Disorders (SCID). No participants met the exclusion criteria.

Pre-session

Prior to the laboratory procedures, the students were randomly assigned to one of the *Order of Procedures* groups, which determined whether the participants would first complete the emotional Stroop or dot-probe task first. The participants were then randomly assigned to one of the *Order of Stimulus Emotion* groups, which determined the order of emotion in the emotional Stroop task (neutral, fearful, denoting uncertainty).

Laboratory Session

The participants were informed that the laboratory procedure for this study could last up to 142 minutes. The length of the procedure was strongly dependent on the time it took to administer the SCID. Previous studies with the same student population indicated that the time necessary to complete the SCID ranges from 30 – 90 minutes (Spitzer, Williams, Gibbon, & First, 1996; First & Gibbon, 2004). In the current study, the time to complete the SCID ranged from 25 – 40 minutes. An overview of the procedures is presented in Table 1.

Table 2 Laboratory Protocol

Time	Procedure 1	Time	Procedure 2
T – 10	Informed Consent	T – 10	Informed Consent
T – 5	Emotional Stroop Task instructions	T – 5	Dot-probe instructions
T 0	Emotional Stroop Task	T 0	Dot-probe Task
T + 10	Dot-probe task info	T + 10	Emotional Stroop instructions
T + 15	Dot-probe Task	T + 15	Emotional Stroop Task
T + 25	Demographic Questionnaire	T + 25	Demographic Questionnaire
T + 27	IUS	T + 27	IUS
T + 31	PSWQ	T + 31	PSWQ
T + 35	BAI	T + 35	BAI
T + 40	BDI-II	T + 40	BDI-II
T + 45	SCID-IV	T + 45	SCID-IV
T + 135	Debriefing and Conclusion	T + 135	Debriefing and Conclusion

Note: IUS = Intolerance of Uncertainty Scale; PSWQ = Penn State Worry Questionnaire; BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory; SCID-IV = Structured Clinical Interview for DSM-IV.

Informed Consent. The participants were provided with a written description of the study procedures and asked to complete a written consent form. The participants were also informed verbally about the procedures involved in the study, the potential risks of this study, issues pertaining to confidentiality, and their rights as participants (e.g., that they have the right to withdrawal from the study at any point in time).

Cognitive Tasks. The participants completed the emotional Stroop task or the dot-probe task. Each task took no longer than 10 minutes to complete.

Assessment Procedures. The participants were asked to complete the demographics questionnaire, IUS, PSWQ, BAI, and BDI-II. After completing the self-report questionnaires, the participants were asked to complete the SCID.

Debriefing and Conclusion. Upon the completion of all tasks and assessment measures the participants were given more detailed information about the purpose of the study: investigating information processing biases in relationship with intolerance of uncertainty, theoretical models of information processing biases, and how the tasks completed by the participants relate to the purpose of the study. All participants were provided with referrals to mental health professionals, obtained from an established referral list already in use at the University of Maryland Psychology Clinic, in case any of them were left with questions they wanted to discuss with a mental health professional as a result of the assessment procedures.

<u>Measures</u>

Demographic Variables

The demographic questionnaire was administered to obtain data on the participants' age, gender, ethnicity, and education. (Appendix C), for the purpose of

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including these variables into the model if they showed significant associations with reaction time, in order to control for their effect.

Key Measures

Reaction time. Reaction time (RT) was the dependent variable in both the dot-probe and the emotional Stroop task. In the dot-probe task RT was the time it took for the participants to indicate the orientation of the arrow following one of the photographs presented on the computer screen. In the emotional Stroop task RT was the time that it took for the participant to indicate the color of the print, by pressing buttons on a keyboard.

Emotional Stroop Task. The emotional Stroop task included a training phase and one test phase. The test phase included 8 trials and the test phase included 120 trials. Each trial began with a fixation mark presented in the center of the laptop screen for 500 milliseconds. The fixation mark was followed by a word typed in one of four colors (red, green, yellow, and blue) for 500 milliseconds. The word was replaced by a blank screen in which the participants were allowed up to 1400 milliseconds to indicate the color of the word before the next trial began. Participants were asked to press one of four response buttons as quickly and accurately as possible. The trial ended when a participant pressed a button or at the end of the response window. The color and certainty valence of the words were balanced throughout the trials.

Word List. The word stimuli consisted of 15 words (5 neutral, 5 threatening, and 5 denoting uncertainty). The word list was created by Dugas et al. (2005) and the words were matched on basis of length, written frequency, familiarity, concreteness, imaginability, and syntactic function.

Dot Probe Task. The dot-probe task included a training phase and one test phase. The test phase included 8 trials and the test phase included 100 trials. Each trial will begin with a fixation mark presented in the center of the laptop screen for 500 milliseconds. The fixation mark was followed by a face display for 500 milliseconds. The face display was replaced by an arrow, oriented up or down, which appeared in the location of the previously viewed fearful face (threat congruent trial) or happy face (threat incongruent trial) for 200 milliseconds. The arrow was replaced by a blank screen in which the participants were allowed up to 1400 milliseconds to indicate the arrow orientation before the next trial begins. Participants were asked to press the right or left arrow on a keyboard as quickly and accurately as possible. The trial ended when a participant pressed a button or at the end of the response window. The location of the fearful face, the location of the probe, and the orientation of the probe were balanced across trials.

Pictures of Faces. The picture stimuli consisted of photographs of faces, each shown both with a happy and fearful expression. The photographs are part of the NimStim databases of photographs of faces displaying a variety of emotions, with fear and happiness as two of the possible emotions (Tottenham, Tanaka, Leon, McCarry, Nurse, Hare, Marcus, Westerlund, Casey, Nelson, in press; Gur, Sara, Hagendoorn, Marom, Hughett, Macy, Turner, Bajcsy, Posner, Gur, 2002).

IUS. IUS is a self-report assessment instrument intended to measure the emotional and behavioral consequences of feelings of uncertainty, how feelings of uncertainty reflect on one's character, the expectation of a predictable future, frustration with unpredictability, efforts to control the future, and inflexible answers in response to

uncertainty (Freeston, Rheaume, Letarte, Dugas, & Ladouceur, 1994). Reliability studies have demonstrated that IUS has excellent internal consistency with α = .95, and good 5-week test-retest reliability with r = .74 (Buhr & Dugas, 2000). The IUS has shown good validity when used alongside measures of worry, *r*'s = .53 and .63, and trait anxiety, *r* = .57 (Freeston et al., 1994; Buhr & Dugas, 2000). In addition to the high correlation between measures of intolerance of uncertainty and anxiety or worry, intolerance of uncertainty has shown to be a unique contributor to the experience of anxiety beyond anxiety symptoms (Koerner & Dugas, 2008).

PSWQ. PSWQ is a self-report questionnaire intended to measure the intensity of a tendency to excessive pathological worry, without reference to the content of worries (Robichaud et al, 2003; Roemer, 2001). The PSWQ has demonstrated good 2 to 10-week test-retest reliability in college samples with r's ranging from .74 to .93, and very good internal consistency with α ranging from .86 to .93. The PSWQ has shown good validity when used alongside measures of worry, *r*'s = .59 and .67, and anxiety, *r*'s = .40 to .74 (Davey, 1993; Meyer, Miller, Metzger, & Borkovec, 1990).

BAI. The BAI is a 21-item self-report questionnaire intended to measure typical features of anxiety (Beck, Epstein, Brown, & Steer, 1988). The BAI has demonstrated good 1 to 5-week test-retest reliability with *r*'s ranging from .75 to .83 (Beck & Steer, 1993) and very good internal consistency with α ranging from .85 to .93 (de Beurs, Wilson, Chambless, Goldstein, & Feske, 1997). The BAI has shown good validity when used alongside measures of anxiety, *r*'s = .51 and .69 (Osman, Kopper, Barrios, Osman, & Wade, 1997).

Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental

Disorders Axis I Disorders (SCID). The SCID is a semi-structured interview based on the

DSM-IV diagnostic criteria and is the most widely used assessment instrument in the

United States (First & Gibbon, 2004). The SCID is organized in modules that cover

psychological disorders in accordance with DSM-IV diagnostic criteria. This instrument

was chosen because it is a widely used diagnostic instrument with good psychometric

properties and it has been suggested as a good candidate for assigning diagnostic status in

research studies (Antony, & Rowa, 2005). The SCID was used to test the primary

hypothesis of this study, which states that participants with an anxiety disorder will show

impairment in implicit memory. The reliability of the SCID has been investigated using

joint or videotaped interviews and has produced kappas ranging from 0.70 to 1.00

(Spitzer, Williams, Gibbon, & First, 1996). The validity of the SCID has been more

challenging to measure; however, studies to date comparing it to standard clinical

interviews reveal good validity, with kappa coefficients ranging from .57 to .76.

BDI-II. The BDI-II is a 21-item self-report questionnaire intended to measure

typical symptoms of depression (Beck, Steer, & Brown, 1996). The BDI-II has

demonstrated good few hours to several months test-retest reliability with r 's ranging

from .48 to 0.86 with higher reliability in shorter test-retest periods (average $r = .72$;

Beck, Steer, Carbin, 1988). The BDI-II has excellent internal consistency with α ranging

from 0.89 to 0.94 (Dozois & Covin, 2004). The BDI-II has shown excellent validity when

used alongside other measures of depression, r's = 0.68 to 0.93 ((Dozois & Covin, 2004;

Storch, Roberti, & Roth, 2004).

Chapter 3: Data Analysis

Descriptive Analyses

One-hundred and ten students presented to the laboratory and provided their informed consent for participation and completed the demographic questionnaires. Of these, 104 or 95% of the participants completed the self-report questionnaires. Due to a combination of non-completion of questionnaires and technical difficulties, data for 100 or 90% of the participants could be used for the primary analysis with the emotional Stroop task and data for 103 or 92.7% of the participants could be used for the primary analysis with the dot-probe task. A set of preliminary analyses were conducted in order to examine the means, standard deviations, and skew of the data from the self-report questionnaires and the cognitive tasks.

The threat bias scores for the emotional Stroop task were calculated by subtracting mean RTs of threatening stimuli from mean RTs of neutral stimuli. This procedure results in high positive scores indicating attention bias away from threat and negative scores indicating attention bias toward threat. All trials with reaction times above or below 2 standard deviations from the individual mean were excluded from further analyses. Similarly, trials with incorrect responses were also excluded; accuracy rates ranged from 82% - 96%. The data from the emotional Stroop task displayed problematic skewness and were consequently log transformed to produce skewness values within the normal range.

The bias scores for the dot-probe task were calculated by subtracting mean RTs of threat congruent trials from mean RTs of threat incongruent trials. This procedure results in high positive scores indicating attention bias toward threat and negative scores

indicating attention bias away from threat. All trials with reaction times above or below 2 standard deviations from the individual mean were excluded from further analyses. Similarly, trials with incorrect responses were also excluded; accuracy rates ranged from 86% - 100%. The data from the dot-probe task were normally distributed.

Primary Analyses: Moderation

Baron and Kenny (1986) defined moderators as variables that influence the direction or strength of the relationship between a predictor and a criterion variable. Hayes (2013) describes moderation as a regression-based procedure that includes a predictor, a moderator, and their interaction term. The moderation model was estimated using PROCESS, which is a macro for SPSS that evaluates the statistical significance of the model and yielded the proportion of the variance in the reaction time differences attributable to the moderation of the effect of anxiety by IU. Mean centering is the process by which the sample mean of each variable is subtracted from each data point, resulting in a zero-centered distribution. Centering has been recommended as a necessary step in testing moderation due to the often high correlation between predictors and moderators resulting in multicollinearity and reduced power of the moderation test (Aiken & West, 1991). Hayes (2013) has criticized this approach stating that analysis of both centered and uncentered data results in the same regression coefficients. However, Hayes (2013) also points out that data centering facilitates data interpretation, which is why we decided to center the data for the anxiety measure, the IU measure, and the reaction time differences for both the Stroop and dot-probe tasks.

Power analysis for the primary aim was conducted in order to determine the sample size that would ensure adequate power to detect a medium effect size. A moderation model is a regression model that includes predictor variables and their interaction term. Field (2013) lists several "rules of thumb" recommending between 10 and 15 cases of data per predictor, which for the current study would translate into a sample size of 30. Green (1991) recommends a minimum acceptable sample size for testing a regression model of $50 + 8k$, where k is the number of predictors, which for the current study would require 66 participants. Using G*Power (Faul, Erdfelder, Buchner, & Lang, 2009) and selecting linear multiple regression test with two predictors, an effect size $f^2 = 0.15$, and power $(1 - \beta) = 0.9$, the minimum required sample size was 59. Our smallest sample size of 86 participants is sufficient to detect a medium effect size.

Chapter 4: Results

Preliminary Analyses

  Preliminary analyses were conducted in order to examine the means, standard deviations, and skew of the data from the self-report questionnaires and the cognitive tasks. The full sample counted 110 participants. Failure to complete questionnaires or the cognitive tasks resulted in largely overlapping samples, with 100 participants and 1 participant unique to the sample used for the emotional Stroop task analyses, and 103 participants and 5 of them unique to the sample used for the dot-probe task analyses. BAI, IUS, and BDI II displayed significant skewness and were consequently log transformed to produce skewness values within the normal range.

Table 2. Means, Standard Deviations, Skew, and Kurtosis of Continuous Variables

Variable	Mean	St. Dev	Skewness	Kurtosis
BAI[*]	8.98	8.59	1.489	1.714
IUS[*]	63.16	17.45	.629	-.228
PSWQ[*]	41.93	8.12	.179	-.216
BDI-II[*]	10.26	7.72	1.011	1.66
Emotional Stroop Threatening Stimuli[†]	-6.702	71.814	-.034	.854
Emotional Stroop Uncertain Stimuli[†]	-22.719	81.384	.290	1.024
Dot-Probe[‡]	-1.588	27.838	.273	.929

[*]N = 110; [†]N = 100; [‡]N = 103

  A set of preliminary analyses were conducted in order to determine if the reaction times in each cognitive task in the sample for this study differed significantly on a variety of demographic characteristics and stimulus characteristics. A series of one way ANOVA's indicated that there were no significant differences on the performance on the emotional Stroop and the dot-probe tasks based on gender, age, ethnicity, and education (Table 3).

Table 3. Reaction Times by Demographic Characteristics

Demographic Variables	Emotional Stroop Threatening Stimuli	Emotional Stroop Uncertainty Stimuli	Dot Probe
Gender	$F_{1, 102} = 0.35$, p =.55	$F_{1, 102} = 0.18$, p =.67	$F_{1, 104} = 0.30$, p =.58
Males	M = -.60, SD = 64.51	M = -27.36, SD = 74.22	M = -3.69, SD = 25.48
Females	M = -9.41, SD = 74.87	M = -20.33, SD = 85.29	M = -0.54, SD = 29.04
Age	$F_{2, 101} = 1.02$, p =.426	$F_{8, 95} = 1.02$, p =.42	$F_{8, 97} = 0.55$, p =.82
18	M = -6.67, SD = 77.26	M = -23.35, SD = 81.48	M = -0.22, SD = 28.84
19	M = -27.40, SD = 63.96	M = -37.4, SD = 67.51	M = .70, SD = 31.46
$\geq$20	M = 12.74, SD = 69.66	M = -8.26, SD = 92.32	M = -4.97, SD = 23.46
Ethnicity	$F_{1, 102} = 0.18$, p =.95	$F_{4, 99} = 0.21$, p =.93	$F_{4, 101} = 0.63$, p =.55
Caucasian	M = -9.03, SD = 75.22	M = -25.51, SD = 73.33	M = -1.94, SD = 27.63
Other	M = -2.74, SD = 66.43	M = -17.96, SD = 94.42	M = -2.16, SD = 27.56
Education	$F_{3, 100} = 0.31$, p =.82	$F_{3, 100} = 1.79$, p =.15	$F_{3, 102} = 1.94$, p =.13
Freshman	M = -8.03, SD = 73.58	M = -30.12, SD = 74.65	M = 3.68, SD = 30.76
Sophomore	M = -10.27, SD = 85.27	M = 2.31, SD = 90.81	M = -4.47, SD = 24.40
Junior	M = 1.86, SD = 55.23	M = -51.30, SD = 75.94	M = -13.45, SD = 16.68
Senior	M = -0.72, SD = 42.51	M = -0.50, SD = 95.05	M = -8.66, SD = 26.53

A series of univariate ANOVAs was conducted in order to investigate differences in the scores on BAI, IUS, PSWQ, and BDI-II across demographic characteristics. These analyses indicated significant differences in the scores of BAI based on gender, such that females [M(SD) = 10.33 (9.56)] scored significantly higher than males [M(SD) = 6.25 (5.28)]. All other comparisons were not significant (Table 4).

Table 4. BAI, IUS, PSQW, and BDI-II Scores by Demographic Characteristics

Demographic Variables	BAI	IUS	PSWQ	BDI-II
Gender	$F_{1, 99}$ = 4.18, p =.04*	$F_{1, 105}$ = .03, p =.87	$F_{1, 108}$ = 3.88, p =.05	$F_{1, 106}$ = 2.31, p = .13
Males	M = 6.38, SD = 5.35	M = 62.79, SD = 15.22	M = 40.05, SD = 8.17	M = 8.79, SD = 5.26
Females	M = 10, SD = 9.46	M = 62.57, SD = 18.16	M = 42.75, SD = 7.84	M = 10.03, SD = 8.71
Age	$F_{8, 92}$ = 1.51, p =.16	$F_{8, 98}$ = .58, p =.79	$F_{8, 101}$ = .79, p =.55	$F_{8, 99}$ = .85, p =.56
18	M = 8.20, SD = 8.38	M = 65.17, SD = 19.45	M = 41.23, SD = 8.57	M = 10.67, SD = 6.85
19	M = 8.15, SD = 7.72	M = 62.03, SD = 14.47	M = 41.06, SD = 7.32	M = 9.15, SD = 6.61
$\geq$20	M = 9.91, SD = 9.26	M = 62.34, SD = 18.86	M = 42.47, SD = 7.69	M = 9.13, SD = 7.26
Ethnicity	$F_{4, 96}$ = .27, p =.89	$F_{4, 102}$ = .44, p =.78	$F_{4, 105}$ = .28, p =.89	$F_{4, 103}$ = .47, p =.76
Caucasian	M = 8, SD = 7.93	M = 62.06, SD = 16.51	M = 42.38, SD = 7.30	M = 10.01, SD = 8.19
Other	M = 10.08, SD = 9.22	M = 63.64, SD = 18.35	M = 40.91, SD = 9.14	M = 11.19, SD = 7
Education	$F_{3, 97}$ = .86 p =.46	$F_{3, 103}$ = .27, p =.85	$F_{3, 106}$ = .61, p =.61	$F_{3, 104}$ = .44, p =.72
Freshman	M = 9.01, SD = 9.36	M =63.6 , SD = 17.64	M = 41.9, SD = 8.55	M = 10.48, SD = 7.81
Sophomore	M = 7.58, SD = 6.68	M = 59.37, SD = 14.38	M = 40.33, SD = 7.34	M = 10.52, SD = 7.07
Junior	M = 9.3, SD = 7.89	M = 64.46, SD = 20.88	M = 43.38 , SD = 8.97	M = 10.3, SD = 8.47
Senior	M = 9.75, SD = 8.54	M = 63, SD = 16.62	M = 43.37, SD = 3.81	M = 10.25, SD = 7.06

Correlation analyses were conducted to examine the relationship between measures of anxiety, IU, worry, and depression. As expected, all constructs were significantly correlated to each other (Table 6). The results indicate strong and positive relationships between each of the following: anxiety, IU, worry, and depression.

Table 6. Pearson Bivariate Correlations Among Self-report Measures

	BAI	IUS	PSWQ	BDI-II
BAI	1			
IUS	.673*	1		
PSWQ	.497*	.496*	1	
BDI-II	.605*	.492*	.621*	1

*Statistically significant correlation (p < .01)

Primary Analyses: Moderation Model

A primary objective of this study was to evaluate the relationship between IU and information processing biases as indicates by reaction time differences in the emotional Stroop and dot-probe task. Regression analyses were conducted in order to investigate the effect of IUS, BAI, PSWQ, and BDI-II on reaction times in the two cognitive tasks, as

measured by the differences between performance in trials with neutral stimuli and performance in trials with stimuli conveying threat or uncertainty. The results did not yield any significant effects of IUS on reaction times in the cognitive tasks (Table 5). They also indicated that changes in levels of anxiety were not significantly associated with changes in reaction times in the two tasks with all three types of stimuli. Similarly, there was no significant association between changes in the levels of PSWQ and changes in reaction times in performance in the cognitive tasks. Scores on the BDI-II were not significantly associated with performance on the emotional Stroop and the dot-probe, as measured by reaction time differences.

Table 5. Regression Analyses Testing the Effect of BAI, IUS, PSWQ, and BDI-II on Reaction Times

Predictor	Dependent Variable	β	SE	r	p
BAI	Emotional Stroop Threatening Stimuli	-2.138	8.369	.026	.799
	Emotional Stroop Uncertain Stimuli	-8.923	9.224	.101	.336
	Dot Probe	-2.824	3.16	.091	.374
IUS	Emotional Stroop Threatening Stimuli	-44.156	26.695	.164	.101
	Emotional Stroop Uncertain Stimuli	-21.215	30.333	.070	.486
	Dot Probe	-13.129	10.076	.128	.195
PSWQ	Emotional Stroop Threatening Stimuli	-.838	.874	.094	.340
	Emotional Stroop Uncertain Stimuli	-.172	.984	.017	.862
	Dot Probe	.016	.332	.005	.961
BDI-II	Emotional Stroop Threatening Stimuli	-0.170	.888	.019	.842
	Emotional Stroop Uncertain Stimuli	-1.088	1.024	.105	.290
	Dot Probe	-.277	.363	.075	.447

One of the primary objectives of this study was to evaluate the hypothesized role of IU as a moderator in the relationship between anxiety and attentional information processing biases as indicated in reaction time differences between neutral and emotional stimuli in three cognitive tasks: the emotional Stroop with threatening stimuli, the

emotional Stroop with uncertain stimuli, and the dot-probe with fearful stimuli. The analysis is based on the statistical interaction between the predictor and the moderator and their influence on the dependent variable. The SPSS PROCESS macro utilizes a regression model in which the effect of anxiety on attentional information processing biases is allowed to vary linearly with IU, by including the product of anxiety and IU as a predictor of processing biases along with anxiety and IU (Hayes, 2013). PROCESS also uses bootstrapping, which is a method that re-samples observations with replacement and tests the hypothesized model thousands of times by treating the sample as a representation of the targeted population. Following Hayes' (2009) suggestion bootstrapping was set at 5000 resamples. Three sets of moderation analyses were conducted, using as the dependent variable (1) the reaction time outcome measure for the emotional Stroop using words denoting threat, (2) the emotional Stroop using words denoting uncertainty, and (3) the dot-probe task.

Figure 1 represents the proposed moderation model with anxiety as the predictor, reaction time as the dependent variable, and IU as the moderator.
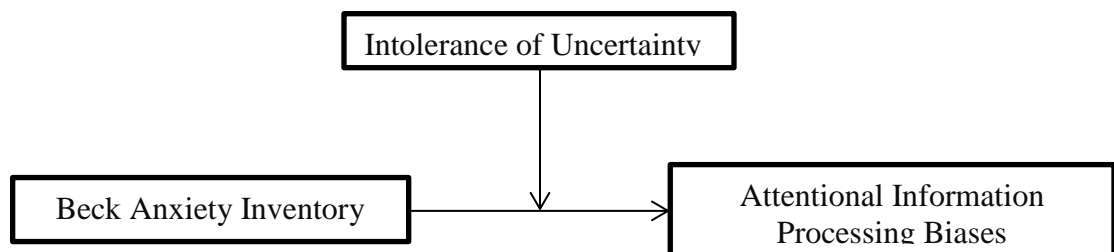

Figure 1. Hypothesized moderation model

The main hypotheses were not supported given that the moderation models were not significant with each of the dependent variables: i.e. reaction time difference means for the emotional Stroop using words denoting threat, the emotional Stroop using words denoting uncertainty, and the dot-probe task. Specifically, the result of the moderation

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test indicated that IU did not moderate the relationship between anxiety and reaction times in emotional Stroop using words denoting threat ($R = .241$, $R^{2} = .058$, $F_{3, 96} = 1.97$, $p = .122$),. Similarly, IU did not moderate the relationship between anxiety and reaction times in the emotional Stroop using words denoting uncertainty ($R = .158$, $R^{2} = .025$, $F_{3, 96} = .822$, $p = .484$). Also IU did not moderate the relationship between anxiety and reaction times in the dot-probe task ($R = .198$, $R^{2} = .039$, $F_{3, 99} = 1.356$, $p = .260$). Results from the PROCESS (Hayes, 2013) moderation analysis are presented in Table 7.

Table 7. Contributions of IUS and BAI in Predicting Reaction Times

Task	Predictors	β	SE	t	p
Emotional	IUS	-1.079	.491	-2.197	.030
Stroop Threat	BAI	.511	.975	.524	.600
Stimuli	IUS x BAI	.062	.039	.1.586	.116
Emotional	IUS	.013	.566	.023	.981
Stroop Uncertain	BAI	-.979	1.124	-.870	.386
Stimuli	IUS x BAI	-.039	.0450	-.865	.389
	IUS	-.300	.189	-1.130	.116
Dot-probe	BAI	.031	.378	.084	.933
	IUS x BAI	.023	.015	1.559	.122

Despite non-significant models and interactions, PROCESS was used to generate the estimates of the dependent variables for various combinations anxiety and IU values. The predicting values for BAI and IUS included the mean, mean + S.D., and mean – S.D. The visual representations of the models are presented in Figure 2, 3, and 4.

Exploratory Analyses

Based on the results of the preliminary and primary analyses, information processing biases as evidenced reaction times in the emotional Stroop and dot-probe tasks were unrelated to anxiety, intolerance of uncertainty, and worry, as measured by BAI, IUS, and PSWQ. As such, it was not possible to investigate information processing biases

as evidenced by longer latencies in reaction time in the emotional Stroop and shorter

latencies in reaction time in the dot-probe task.

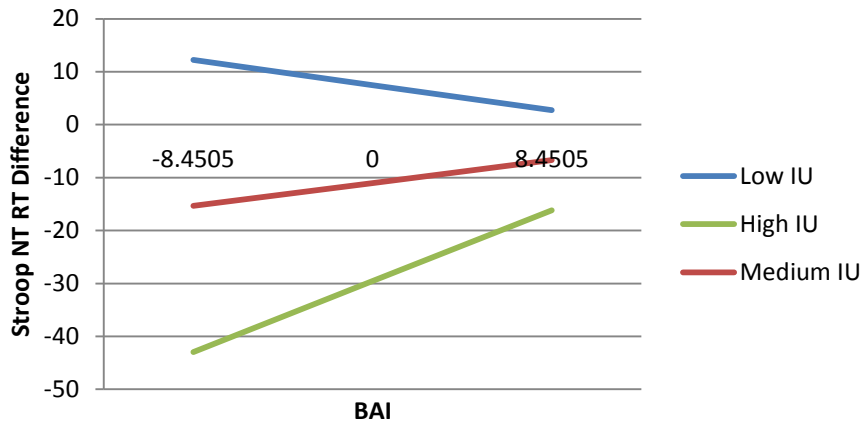**Figure 2. IUS Moderating BAI on Emotional Stroop Threatening Stimuli**

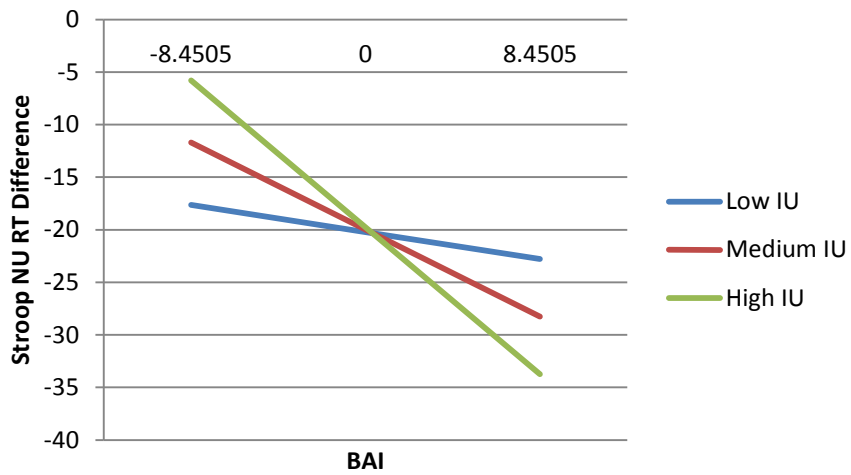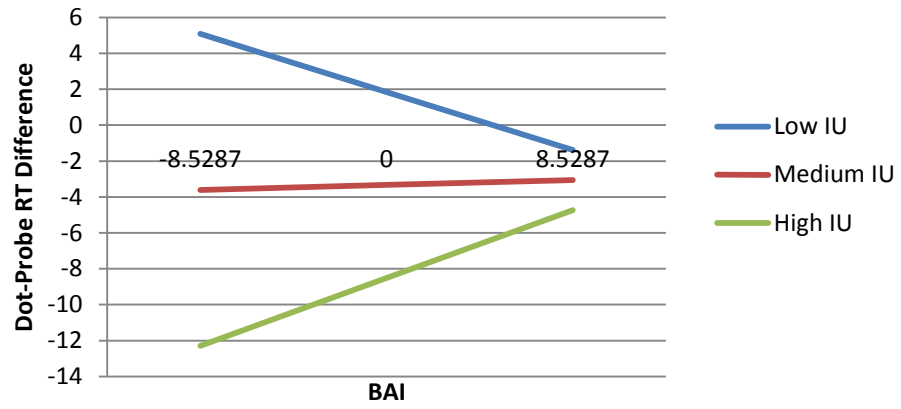**Figure 3. IUS Moderating BAI on Emotional Stroop NU**

Figure 4. IUS Moderating BAI on Dot-Probe

Chapter 5: Discussion

Summary of Findings

This study was designed to investigate the role of IU as a moderator in the relationship between anxiety and automatic information processing biases. Contrary to expectations, IU was not a moderator in the relationship between anxiety and automatic information processing biases. Additionally, we found no evidence of a relationship between IU and reaction times in the emotional Stroop and dot-probe task. Unexpectedly, the current study did not demonstrate a relationship between anxiety and automatic information processing biases.

IU, Anxiety, and Automatic Information Processing Biases

The current study did not provide support for IU as a moderator in the relationship between anxiety and information processing biases. We had expected that heightened IU would strengthen the relationship between anxiety and information processing biases. This expectation was founded on extant research on the relationship between IU, anxiety globally, and specific features of anxiety. Specifically, IU was found to moderate the relationship between pathological worry and heart rate variability, indicating that IU affects physiological responses that are characteristic of anxiety and anxiety disorders (Ottaviani, Borlimi, Brighetti, et al, 2014). IU was also found to moderate the relationship between daily stress and worry, which is a central feature and symptom of anxiety (Zlomke & Jetter, 2014). Some studies found that IU mediates the relationship between negative affectivity and worry, as well as physical symptoms of anxiety (McEvoy & Mahoney, 2012). Thus, research to date has provided considerable support for the association of IU with worry and other factors that are crucial in the etiology and

maintenance of anxiety (Buhr & Dugas, 2006; Koerner & Dugas, 2008). Clearly, IU needs to be recognized as a central actor in the development and maintenance of anxiety (Laugesen, Dugas, & Bukowski, 2003). In light of past research, our findings are puzzling and highlight the need for a careful evaluation of the study design and potential limitations.

Stemming from current theories of anxiety, we expected to see a strong significant relationship between anxiety and IU. Similarly, we expected IU to be correlated with worry and depression. We found significant strong correlations between each of the constructs. The strong correlation between IU and both anxiety and depression conforms with the view of IU as a transdiagnostic factor of internalizing disorders (McEvoy & Mahoney, 2012). It remains unclear if the correlation between IU and depression is due to the frequent co-occurrence between anxiety and depression or if IU is a mechanism underlying both disorders. Dugas, Schwartz, and Francis (2004) hypothesized that IU is a construct uniquely related to anxiety disorders more so than to depression, but the difference between those correlations was not statistically significant. In light of current findings and past research, it seems that IU has a significant strong relationship with both depression and anxiety, however the specific of these relationships need further exploration.

The significant relationship between IU and anxiety has been shown to extend to other features of anxiety, such as worry, anxiety sensitivity, and elaborative cognitive processing (Gentes & Ruscio, 2011). Thus, we expected that the significant relationship between IU and anxiety would extend to automatic information processing biases. Attentional processing biases refer to cognitive functions that are instrumental in

establishing the order in which stimuli will be processed and the extent to which a stimulus will be processed. Thus, biased information processing is evident when an individual prioritizes for processing a certain category of stimuli over others, when he/she spends more time processing specific stimuli compared to other stimuli, and sometimes when he/she fails to eventually habituate to certain stimuli (Shechner, Britton, Perez-Edgar, Bar-Haim, Ernst, Fox, Leibenluft, & Pine, 2012). There is evidence of a relationship between IU and better recall of material denoting uncertainty and threatening interpretation of uncertain situations (Davey et al., 1992; Koerner-Singh, 2008), which indicates biased information processing during the elaborative and interpretative stage. This study utilized cognitive tasks that target direction of attention to threatening characteristics of stimuli and attention disengagement during early automatic stages of information processing. We were unable to establish a relationship between IU and automatic information processing biases. This could mean that the association between IU and information processing biases is limited to the elaborative and interpretative processes and does not influence initial processing, to include attention orientation to and attention disengagement from stimuli denoting threat.

In the current study, there was also a nonsignificant relationship between anxiety and automatic attentional processing biases. The failure to find a significant relationship between anxiety and information processing biases is particularly surprising, as this relationship has been confirmed in multiple studies and meta-analyses (Bar-Haim et al., 2007). A relationship between anxiety and attentional processing biases, in the lack of such relationship between IU and attentional processing biases would indicate that IU is not one of the mechanisms by which attention is oriented towards and maintained on

threatening stimuli. The failure to observe a significant association between information processing and both anxiety and IU makes it difficult to draw any conclusions specific to IU. It is possible that the lack of a relationship between IU and reaction times in cognitive tasks mirrors the lack of the relationship between anxiety and performance in the emotional Stroop and the dot-probe.

The relationship between anxiety and attentional information processing biases is well-established (Bar-Haim et al., 2007). A more contentious issue is the presence of threat-related bias in low-anxiety or non-anxious individuals. Several studies have demonstrated the presence of threat-related biases in non-anxious individuals, while some have failed to do so. Thus it has been suggested that the relationship between anxiety and information processing biases is affected by either the range of anxiety in the participants or by the severity of threat conveyed by the stimuli. The participants in the current study displayed low scores of anxiety on the BAI averaging 8.98, which fall in the window of 0-9 points and are characteristic of non-anxious samples (Antony & Orsillo, 2001; McDowell, 2006). The general low levels of anxiety and IU in our sample may explain the lack of an observable relationship between these scores and reaction times in the emotional Stroop and dot-probe tasks. At this point, it is important to note that other studies with similar samples, i.e. undergraduate students, and similar levels of anxiety, i.e. within the window of scores indicating healthy adults, have produced significant associations between anxiety and information processing biases as indicated by performance on the Stroop task (Egloff & Hock, 2003). It is possible that low anxiety scores led to small effect sizes, for which this study was underpowered to detect.

A similar picture emerges in the IU literature, where comparable levels of IU in a similar population were significantly associated with cognitive processes such as decision making (Luhman, Ishida, & Hajcak, 2011). The IUS scores in our sample were slightly higher than those previously found in non-anxious populations; unlike previous samples we noted a higher variability of scores. Hence, there is the possibility that a changing relationship between IU and reaction times at different points in the continuum of IU scores contributed to our inability to observe a statistically significant relationship between IU and processing biases. Ultimately, it may be that overall levels of IU are a poor predictor of automatic processing biases.

The debate on the factor structure of IUS and other scales derived from IUS may provide further insight into our findings. Sexton and Dugas (2009) proposed two factors, namely *Uncertainty Has Negative Behavioral and Self-Referent Implications* and *Uncertainty is Unfair and Spoils Everything*, while Fergus (2013) divided the items into a *behavioral* and *cognitive* factor. Carleton et al. (2012) on the other hand examined the latent structure of IU and provided support for a continuous latent structure along a low-high axis; they recommended that researchers strive for "comprehensive ranges of IU" in their samples.

Some researchers have suggested that non-anxious individuals may show biases in information processing only when encountering highly threatening stimuli or prolonged exposure to threatening stimuli. Unfortunately, the current study used standard versions of the emotional Stroop and dot-probe tasks and did not utilize highly threatening stimuli nor prolonged exposure to such stimuli. In addition to the standard stimuli, we used stimuli denoting uncertainty. Consistent with this suggestion, stimuli

denoting uncertainty may be even less threatening and thus fail to elicit attentional biases in non-anxious individuals. Studies with non-clinical populations show small effect sizes and the findings are not consistent across studies. Ultimately, threat-related bias is strongest in clinically anxious samples, smaller in non-clinical but highly anxious samples, and very small in non-anxious samples. Consistent with these suggestions, either because of low anxiety in our sample or because of standard level of threat and duration of threat of the stimuli, we found no significant relationships between scores in anxiety, IU, and worry measures and reaction times to both stimuli denoting threat and uncertainty.

We considered IU as a cognitive process aimed at processing stimuli denoting uncertainty and characterized by processing biases that become increasingly consuming for individuals with heightened IU. We hypothesized that IU would influence not only interpretation of threatening material as more threatening than non-anxious people, but that uncertain material would connote danger and they would react to that material as if it were dangerous. This is in difference to the definition of IU that focuses on fear of possible danger (Mathews, & Funke, 2006; Dugas et al., 2005). The stimuli connoting uncertainty in the emotional Stroop included words associated with ambiguous outcomes. The stimuli connoting uncertainty in the dot-probe task included faces of a fearful expression, since it has been hypothesized that fear signifies a threat of uncertain source (Tottenham, Tanaka, Leon, McCarry, Nurse, Hare, Marcus, Westerlund, Casey, Nelson, 2010). Based on the findings from this study, we are unable to clarify whether a basic characteristic of IU is preoccupation with danger that may follow the uncertain or

whether uncertainty itself is associated with negative affectivity and arousal characteristic of anxiety.

Limitations

The present findings should be interpreted in the context of several limitations.

First, the participants in the current study showed low levels of anxiety, worry, and IU. Participants in a previous study conducted with a similar population resulted in levels of anxiety, worry, and IU comparable to non-clinical samples. The low levels of anxiety may have contributed to a small effect size in the relationship between the predictors and dependent variables and this study was underpowered to detest an effect size of that magnitude. Alternatively, the time frame in which the data was collected may be an unexpected influential factor. The data for this study were collected during the first half of an academic semester, and there may be a time of semester by anxiety level correlation that we are unable to test or account for. Low anxiety scores are important as IU may relate differently to anxiety symptoms depending on the severity level of anxiety.

Following procedures established in previous studies using the Stroop and dot-probe tasks, the information processing bias scores were calculated by subtracting the reaction time for neutral stimuli from the mean reaction time for stimuli denoting threat or uncertainty. This method has been used widely in studies with cognitive, physiological, and neuropsychological assessments, despite suggested low reliability and problematic relation of the difference score to the baseline score (Salthouse & Hedden, 2002). Unfortunately, there are no clearly better alternatives. Related to the use of differences between mean reaction times is the loss of information of individual means and standard deviations in each condition.

Finally, the focal and moderating predictors were strongly and positively correlated. Such strong correlations are associated with inflation of variance in the dependent variable, which may have contributed to the current findings.

Future Directions

The present study is the first to investigate the role of IU as a moderator in the relationship between anxiety and automatic information processing biases and the relationship between IU and automatic information processing biases. Considering the limitations of this study, it is important to continue exploring these relationships in samples with a greater range of IU and anxiety scores. Another potential implication of the present study for research in the area of IU utilizing the emotional Stroop task is to select stimuli denoting general threat in addition to stimuli denoting uncertainty. Using a range of stimuli would serve to enhance our understanding of IU.

In future research, it would be useful to revisit and further explore the conceptualization of IU. Current interpretations include a wide range of characterizations, yet we lack a defined theoretical structure of IU and its relationship with related phenomena. Definitions of IU as a dispositional characteristic, a personality trait, a cognitive process, and as a cognitive filter (Dugas and Robichaud, 2007; Dugas et al., 2005; Fisher & Wells, 2009) have yet to specify if IU is a constituent of anxiety or an associated construct. Gentes and Ruscio (2011) theorized that IU is a feature shared by anxiety and mood disorders as evidenced by significant relationships between IU and GAD, OCD, and MDD. IU as a shared feature may explain the high comorbidity and common characteristics between anxiety and depression. Several studies have explored the relationship between IU and worry and have pointed to a strong correlation between

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the two (Dugas et al, 2004). Fewer studies have included both worry and rumination in their investigation (de Jong-Meyer, Beck, & Riede, 2009; Liao & Wei, 2011). Worry and rumination are similarly characterized by repetitive thinking and negative affect. De Jong-Meyer et al (2009) suggested that it is the cognition and emotion based processes rather than the physical arousal symptoms that are more closely related to IU. Ultimately, a clear understanding of the construct of IU may provide a window to a better understanding of anxiety, anxiety symptoms, and other affective disorders.

Future studies should test the possibility that IU is part of a more complex model and mediates or moderates the relationship between overall anxiety and different domains of symptoms of anxiety. The findings of this current study need to be considered with caution, given its limitations. Previous studies have investigated several models where IU is a mediator or a moderator of anxiety symptoms or where symptoms of anxiety moderate IU. A wealth of studies has found associations between IU and affective symptoms of anxiety, such as fear, negative affectivity, and low self-esteem (Carleton, Collimore, & Asmundson, 2010). Similarly, there is support for an association between IU and behavioral symptoms of anxiety, such as checking and repeating in obsessive-compulsive disorders (Tolin, Abramowitz, Brigidi, & Foa, 2003). The same goes for cognitive symptoms of anxiety, such as threatening interpretation of ambiguous stimuli, worry, and cognitive avoidance. Attentional processing biases are part of the cognitive system (Shechner et al., 2012). The possibility that IU is a moderator or a mediator in the relationship between anxiety and attentional information processing biases needs to be explored further.

Research on the factor structure of IU as measured by the IUS (Freeston et al, 2004; Buhr & Dugas, 2002; Norton, 2005; Carleton et al, 2007; Berenbaum et al, 2008; Sexton & Dugas, 2009) and on the relationship between IU, worry, and physiological activity (Ottaviani et al., 2014) seems to indicate that IU may be a qualitatively different construct in individuals with low versus high anxiety. Research on this topic is still far from conclusive, and little is known about the possible multidimensional structure of IU in highly anxious people and the cutoff levels of anxiety and IU in which this multidimensionality becomes apparent. In light of this possibility, future studies may need to take into account that IU may behave differently in its relationship with anxiety and anxiety symptoms, depending on the severity of anxiety. Additionally, the models of mediation and moderation may be different, depending on severity of anxiety. Specifically, IU may moderate the relationship between anxiety and attentional processing biases only in highly or clinically anxious people. If future research provides support for this hypothesis, further study is needed to establish the cutoff levels of anxiety, that are associated with possible changes in the factor structure and models of IU.

A better understanding of IU and its relationship with anxiety and symptoms of anxiety would ultimately inform treatments targeting anxiety. Despite numerous treatments designed for individuals suffering from anxiety, worry, and IU, treatment efficacy for these cases still leaves room for improvement (Robichaud, 2013). Is there clinical utility in developing treatments that target IU specifically? Several studies suggest that IU may be a mediator and moderator of anxiety symptoms. If IU is the underlying driving mechanism of worry and anxiety, further research is needed to explore

its unique contribution to anxiety symptoms. In the end, clinical trials of treatments targeting IU can shed light on the value of such interventions, above and beyond existing treatments for anxiety and worry.

Ultimately, continued investigation of IU can serve to elucidate the role it plays in the etiology and maintenance of anxiety. A better understanding of IU and anxiety can have important implications for tailoring interventions for those individuals experiencing heightened anxiety and IU.

Appendix A: Literature Review

Anxiety is the predominant symptom in anxiety disorders, as classified and described in the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 2000). These disorders affect about 19 million adults in the United States every year (Grisel, Rasmussen, & Sperry, 2006). Feelings of anxiety may often be accompanied by unrelenting feelings of worry, apprehension, nervousness, fear, panic, obsessive thoughts, unwanted intrusive memories, nightmares, or repetitive ritualized behaviors. These feelings, thoughts, and behaviors are often characterized by dysregulation in muscle-tension or in sleep, respiratory, cardiovascular, or gastrointestinal systems. The list of anxiety disorders includes Panic Disorder and Agoraphobia, Social Anxiety Disorder, Specific Phobia, Generalized Anxiety Disorder, Obsessive-Compulsive Disorder, and Posttraumatic Stress Disorder.

Anxiety and fear are both important, common elements found in all anxiety disorders. Anxiety has been described as an emotional state that is future-oriented, while fear has been described as an alarm reaction that is focused and inflexible (Antony, Orsillo, & Roemer, 2001). Intense anxiety and fear are often accompanied by more generally negative affect, a sense of unpredictability and uncontrollability, avoidance of feared situations/experiences, reliance on safety behaviors in order to reduce perceived threat, difficulty concentrating, and worry (Antony, Federici, & Stein, 2009; Antony, et al., 2001).

Anxiety and Information Processing Biases

Information processing bias is one of the factors that some theorists deem critical in the development and maintenance of anxiety disorders (Koster, Fox, & MacLeod,

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2009). In fact, biased information processing is at the center of a number of current theoretical models of anxiety and anxiety disorders (Rapee, 2001; Mogg, & Bradley, 1998; Mathews, & Mackintosh, 1998; Eysenck, 1992; Beck, & Clark, 1997; Clark, & Wells, 1995; Woody, & Rachman, 1994; Ohman, 1993; Williams, Watts, MacLeod, & Mathews, 1988; Foa & Kozak, 1986). Mathews & MacLeod (2005) note that biased information processing in people with anxiety is not narrow, deficient, incorrect, or distorted. It rather involves selective information processing that is negatively biased, resulting in higher-than-normal vigilance for threatening and other adverse stimuli (McNally & Reese, 2009). In this view, information processing biases occur in all people, and these biases are driven by a person's experiences and cognitions regarding the world and the self. In addition to the influence of normative human experiences on information processing, a great deal of attention has been focused on the influence of emotional and cognitive difficulties on this process. Research indicates that in anxious people information processing biases tends to reconfirm their view of the world as a dangerous place (Ouimet, Gawrinski, & Dozois, 2009). Information processing bias has been investigated during different stages of information processing—specifically during transformation of stimuli into subjective cognitive representations of these stimuli (encoding) (Amir, Coles, & Foa, 2002; MacLeod, 1991), during the process of assigning meaning and placing stimuli in a constellation of similar and related cognitive structures (interpretation) (Wilson, MacLeod, & Campbell, 2007; Amir, Coles, & Foa, 2002), and during the process by which subjective representations of stimuli that had been stored in memory are recalled or recognized (retrieval) (Mitte, 2008; Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, van Ijzendoorn, 2007). While most researchers agree, in part,

that anxiety is characterized by information processing biases (McNally & Reese, 2009); they disagree on the pattern and timeline in which such biases occur.

Early cognitive theories of the etiology of anxiety proposed that anxiety is the result of enhanced automatic encoding of threatening stimuli, enhanced automatic retrieval of the same, enhanced automatic proliferation of anxiety schemata (Beck, 1976), and interpretation of uncertain stimuli as threatening (Bower, 1983). Although these theories propose different timelines and mechanisms of the automatic cognitive processes that enhance and maintain anxiety, they both predict facilitated processing of threatening stimuli. Some later theories proposed that the attention of anxious individuals is immediately captured by threatening stimuli and attentional resources are disproportionately allocated to processing these stimuli during the initial, automatic stages of processing (Williams, Watts, MacLeod, & Mathews, 1988; Ohman, 1999). Other theories proposed that cognitive resources are disproportionately allocated towards threatening stimuli during later, elaborative, and interpretative processes (Mathews, & Mackintosh, 1998; Foa & Kozak, 1986; Mogg, Bradley, De Bono, & Painter, 1997). Yet other theoretical models propose biased or selective processing in both initial automatic and later conscious stages of information processing. These models include preferential processing of threatening stimuli during initial, automatic stages of information processing (Amir, Foa, & Coles, 1998; Beck & Clark, 1997; Eysenck, 1992; Mogg et al, 1997; Williams, Watts, MacLeod, & Mathews, 1997). The preferential automatic processing is followed by sustained selective semantic elaboration of threatening stimuli (Beck & Clark, 1997), threatening interpretation of uncertain stimuli (Eysenck, 1992), or avoidance resulting in failure to assess threat accurately and failure to habituate to

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threatening stimuli (Williams, Watts, MacLeod, & Mathews, 1997; Amir, Foa, & Coles, 1998; Mogg et al, 1997).

The existing evidence for threat-related cognitive biases in anxiety disorders is the result of numerous experimental studies using various cognitive tests, many of which target attentional processes. In addition to the mere presence of attentional biases, these studies have explored other factors that affect the magnitude of information processing biases. These moderating factors include level of anxiety, specific anxiety disorders, comorbidity, stimulus awareness, specific cognitive task, and others (Bar-Haim, Lamy, Pergamin, Bakermans-Krannnenburg, & van Ijzendoorn, 2007). Bar-Haim et al. (2007) conducted a meta-analysis investigating the magnitude, boundary conditions, and moderators of information processing biases in anxiety. They found a threat-related bias similar across diverse anxiety disorders and concluded that this bias, rather than being disorder specific, may be related to a possible mechanism that underlies both anxiety and anxiety disorders.

Experimental Studies of Information Processing Biases

Development and maintenance of anxiety disorders is the result of the strategies individuals apply in order to eliminate threatening stimuli and the strength if these stimuli (Ouimet, Gawronski, & Dozois, 2009). Many experimental paradigms have been developed in order to investigate processing biases in attention, memory, interpretation, judgment, and reasoning. Research on information processing biases has provided support for the existence of such biases in people with specific anxiety disorders (Mogg & Bradley, 2005; Clark & McManus, 2002; Heinrichs & Hofman, 2001; Buckley, Blanchard, & Neill, 2000; Musa & Lepine, 2000; McNally, 1999; Summerfeldt & Endler,

1998). A systematic quantitative review of this research provided evidence that threat-related bias is a robust phenomenon, which differentiates non-anxious individuals from those with different types of anxiety across a variety of experimental conditions (Bar-Haim et al., 2007).

Experimental paradigms used to investigate information processing differ in how presence of anxiety affects task completion and in how information processing biases are operationalized. The presence of anxiety can either facilitate or disrupt performance on a task. Most paradigms entail tasks performed in the presence and/or absence of threatening stimuli. In some paradigms the presence of threatening stimuli disrupts or interferes with task completion. In other paradigms the presence of threatening stimuli increases ease of completing the task in the presence of anxiety. The combined results of these types of experiments provide strong support for the presence of information processing biases in anxiety disorders.

The most notable examples of these experimental paradigms include the emotional Stroop, dot-probe, emotional spatial cuing, and visual search paradigms (Bar-Heim et al, 2007). These paradigms have been crucial in investigating biases in attention and specific aspects of attention such as attention allocation, automaticity, or timeline of attention allocation and withdrawal (Shalev & Algom, 2000). Information processing biases in these paradigms are operationalized as the difference in the time it takes an individual to react to threatening stimuli versus time to react to neutral or positive stimuli. Experiments using these paradigms allow for making conclusions with regards to information processing biases in general, and specifically with regards to disproportionate allocation of cognitive resources in verbal-linguistic processing of

threatening stimuli (emotional Stroop), engaged attention or inability to disengage attention with threatening stimuli (dot-probe task), engaged attention with threatening stimuli (spatial cuing), and enhanced attentional capture of threatening stimuli (emotional visual search). These experiments do not allow for making conclusions with regards to the disproportionate allocation of cognitive resources during the non-verbal processing of threatening stimuli.

The emotional Stroop and dot-probe tasks have often been used to investigate information processing biases during attention orientation and engagement (Ouimet, Gawronski, & Dozois, 2009).

Emotional Stroop. The classic Stroop task was designed to investigate the interference of names of colors with the color of the ink used to print the words or the interference of the semantic characteristics of the word with the physical characteristics of the print (Stroop, 1935). The Stroop paradigm was designed to investigate how preexisting associations inhibit or interfere with processing certain aspects of presented stimuli (Stroop, 1935). Specifically, Stroop (1935) wanted to find "why it takes more time to name colors than to read color names (pp. 645)." The innovation of the paradigm designed by Stroop rested on the fact that the two conflicting or interfering stimuli were different aspects of the same symbol. The symbols were words (i.e. names of colors) or non-words (i.e. series of squares or X-s) printed in different colors. The two interfering stimuli that were inherent aspects of these words were (1) the color of the print and (2) the status as a word or non-word. 100 symbols (words or non-words) were printed on a card and arranged in a square (10 words across and 10 words down). The participants were asked to read or name colors as quickly as possible and correct all errors they may

have made. One of the first studies described by Stroop compared the time that it took for the participants to read names of colors printed in black and names of colors printed in colors different than the one named by the word. Another study compared the time that it took to name the color of the print of groups of solid squares or swastikas (although published three months after the Hitler introduced the new German flag with the swastika, the studies were conducted months prior to that event) to the time it took to name the color of the print when the word spelled the name of a different color. Stroop's studies investigated the association between the word stimuli and the reading response compared to the association between the color stimuli and the naming response. He concluded that the association between the word stimulus and the reading response is stronger and it inhibits or interferes with other weaker associations, i.e. between the color stimuli and naming response. The time difference between naming the color of words and non-words is an indicator of the conflict introduced by the word stimuli.

Stroop's studies established that some cognitive processes are more equal than others; however, identifying the specific characteristics of these processes and their timeline has proven more challenging. Research inspired by Stroop's studies has focused on establishing which cognitive processes take priority and consume more cognitive resources, and how individual or stimulus differences affect these priorities. Since its creation, the Stroop Color-Word Test has inspired many variations from its basic form which was designed to tap "into the primitive operations of cognition (pp. 163)" (MacLeod, 1991). Klein (1964) expanded on Stroop's study by introducing word meaning as another aspect that can interfere with processing and reacting to the color of the print. Klein included names of colors used as color stimuli, names of colors not used

as color stimuli, common words, rare words, and non-words. He found that interference with performance on the Stroop task, increased with the meaningfulness of the word. The meaning of a word can be more accessible because of greater practice with the word or because of greater relevance.

The terms *Modified Stroop* or *Emotional Stroop* refer to a task similar to the original Stroop, where the names of colors have been replaced with words that are hypothesized to have emotional significance for the participants that will complete the task. Following Klein's example, researchers have created multiple versions of the Stroop Test by altering the meaning of the words from names of colors to words with special significance to the population of interest: sad words for participants with depression (Mitterschifthaler, Williams, Walsh, Cleare, Donaldson, Scott, & Fu, 2008; McNeely, Lau, Christensen, & Alain, 2008), anxiety provoking words for participants with phobias (Andersson, Westoo, Johansson, & Carlbring, 2006; Becker, Rinck, Margraf, & Roth, 2001), or trauma related words for participants with PTSD (Bremner, Vermetten, Vythilingam, Afzal, Schmahl, Elzinga, & Charney, 2004; Paunovic, Lundh, & Ost, 2002; McNally, 1998). Numerous studies indicate that participants take longer to name the color ink of words compared to the meaningless string of symbols. Phaf & Kan (2006) explained that the delay in naming the ink color is the result of simultaneous automatic processing of the semantic meaning of the word which is absent in the case of meaningless strings of symbols. Generally, the goal of the task was to determine how a stimulus characteristic affects the processing of another characteristic of the same stimulus. In the emotional Stroop task the participants are asked to name the color of the ink for words that have emotionally neutral or emotionally relevant meaning. Numerous

studies have indicated that people with emotional difficulties take longer to name the color of emotional words compared to neutral words, while people in control groups do not show such effect (Williams, Mathews, & MacLeod, 1996). The hypotheses of these studies state that the disorder-specific content of the words will interfere with the cognitive processes of the participants who suffer from that disorder and they will take longer to name their color compared to naming the color of neutral or irrelevant words. Reviews of such studies reveal that the emotional Stroop interference has been observed in a variety of clinical conditions (Williams, Mathews, & MacLeod, 1996).

The emotional Stroop task has been widely used to investigate information processing biases in relation to anxiety (Bar-Haim et al., 2007). Bar-Haim et al. (2007) conducted a thorough meta-analytic review of studies investigating threat-related attentional biases using the emotional Stroop task in 1467 individuals. The researchers found a significant threat-related bias in adults and children with high anxiety or anxiety disorders. Similar findings have been observed in individuals with specific anxiety disorders like post-traumatic stress disorder (Cisler, Wolitzky-Taylor, Adams, Babson, Badour, & Willems), generalized anxiety disorder (Mogg & Bradley, 2005), specific phobias, social phobia, and obsessive-compulsive disorder (Tobon, Ouimet, & Dozois, 2011). Longer reaction times with anxiety provoking material in the emotional Stroop task have also been associated with key cross-anxiety disorder cognitive constructs such as worry (Oathes, Siegle, Ray, 2011) and anxiety sensitivity (Taake, Jaspers-Fayer, & Liotti, 2009).

This bias has been explained as the result of attention being automatically directed towards the emotional characteristics of the word processed simultaneously with naming the color of the print (Williams, Watts, MacLeod, & Mathews, 1988).

Dot Probe. The dot-probe task was designed to investigate attention biases towards threatening material (MacLeod, Mathews, & Tata, 1986). In the dot-probe task the participants are presented simultaneously with a threatening and a nonthreatening stimulus. After a brief presentation, the stimuli are removed and one of them is replaced with a probe. The participants are asked to respond to the probe as quickly and accurately as possible. It is assumed that the participants will react faster to the probe that replaced the stimulus to which they were attending at the onset of the probe. Numerous studies have indicated that people with emotional difficulties are faster at reacting to the probe when it replaces the threatening stimulus rather than when it replaces the neutral stimulus (Cisler, Bacon, & Williams, 2009). The dot-probe task has been used in many studies aiming to investigate selective attention biases in people with anxiety (Frewen, Dozois, Joanisse, & Neufeld, 2008). Bar-Haim et al. (2007) reviewed 35 studies including 659 individuals that used the dot-probe paradigm. The researchers found that the dot probe paradigm was effective in detecting the differences between anxious and non-anxious individuals. McKay, Thoma, and Pilecki (2009) explained that the observed bias in the dot-probe task is the result of enhanced attention towards threatening stimuli or lower threshold for detecting threat. Shorter reaction times when the probe replaces anxiety provoking or threatening material have been observed in individuals with specific anxiety disorders like post-traumatic stress disorder (Wald, Shechner, Bitton, Holoshitz, Charney, Muller, Fox, Pine, & Bar-Haim, 2011), generalized anxiety disorder (Bradley, Mogg,

White, Groom, & de Bono, 1999), specific phobias (Wenzel & Holt, 1999), social phobia (Stevens, Rist, & Gerlach, 2011), and possibly obsessive-compulsive disorder (Amir, Najmi, & Morrison, 2009). Attention biases towards anxiety-provoking material in the dot-probe task have also been associated with key cross-anxiety disorder cognitive constructs such as worry (McKay, 2005) and anxiety sensitivity (Hunt, Keogh, & French, 2006).

Bar-Heim et al (2007) found that the emotional Stroop task and the dot-probe task yielded effect sizes that were statistically similar across anxiety disorders. Emotional Stroop and dot-probe tasks have been used with general threatening stimuli and threatening stimuli that are specific to certain anxiety disorders (i.e., generalized anxiety disorder, social or specific phobias, panic disorder, obsessive compulsive disorder, and posttraumatic stress disorder). These studies have observed bias for both general threat information and for information that is consistent with the specific concerns and diagnosed anxiety disorder of the participant indicating an underlying non-specific anxiety component common for all anxiety disorders (McKay, Thoma, & Pilecki, 2009). The correlation between results obtained with the emotional Stroop and dot-probe paradigms in both subliminal and supraliminal versions indicate that these tasks target similar constructs (Egloff & Hock, 2003).

The stimuli used in the dot-probe task include both verbal and non-verbal material. Photographs of faces are often used as non-verbal stimuli in the dot-probe task. The presentation of a human face is a powerful stimulus that initiates immediate cognitive processing (Wiese, Schweinberger, & Neuman, 2008). Within fractions of a second we perceive enough information from a presented face so as to make judgments

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on someone's gender, race and age (Bruce, & Young, 1998). One of the vital characteristics of a face is the emotion of the face (Wiese, Schweinberger, Neuman, 2008). Emotionality is a characteristic that often results in a lasting and salient memory of that stimulus (Parrot & Spackman, 2000). Emotional expressions are one of the factors that have been investigated in the framework of repetition priming, in the attempt to better understand the impact of emotions on perception (Burton, Rabin, Wyatt, Frohlich, Vardy, & Dimitri, 2005; Bentley, Vuilleumier, Thiel, Driver, & Dolan, 2003; Campanella, Quinet, Bruyer, Crommelinck, & Guerit, 2002). Research to date indicates that the introduction of an emotional dimension leads to changes in the repetition priming effect; however, the findings are mixed and difficult to integrate (Burton et al., 2005; Bentley et al., 2003). This study will investigate the repetition priming effect for photographs of faces displaying happy or fearful expressions. The advantage of using photographs of emotional faces is that it requires minimal verbal-linguistic processing; hence, it focuses the search for processing biases in the time window following the attention capture and preceding the verbal processing of threatening stimuli or disengagement from stimuli.

Anxiety and Intolerance of Uncertainty

Theoretical models of anxiety disorders include cognitive constructs that are believed to play a crucial role in the etiology and maintenance of these disorders. Some of these cognitive constructs are thought to be specific to certain anxiety disorders, such as fear of negative evaluation being specific to social anxiety disorder (Starcevic & Berle, 2006) or fragmentation of memory being specific to posttraumatic stress disorder (Zoellner & Bittenger, 2004). Other cognitive constructs are thought to be common

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across diagnoses, such as worry being associated with several anxiety disorders and depression (Gordon & Heimberg, 2011).

Worry was first defined as an uncontrollable chain of thoughts charged with negative affect (Borkovec, Robinson, Pruzinsky, & DePree, 1983). This chain of thoughts aims to solve problems with uncertain outcomes, especially when some of these outcomes may be negative. Worry has also been defined as an anticipatory cognitive process that is characterized by the tendency to interpret ambiguous stimuli as threatening, the tendency to predict negative outcomes for uncertain events, and the tendency to overestimate risk (Ladouseur, Gosselin, & Dugas, 2000). Worry has further been defined as fear-producing thoughts and images related to everyday-life experiences that have the potential to result in adverse consequences (Mathews, & Funke, 2006; Taylor, Thordarson, Sochting, 2002). These thoughts and images are thought to be uncontrollable, excessive, repetitive, and to remain unresolved in the absence of intervention (Mathews, & Funke, 2006).

According to cognitive theories of anxiety, worry is related to threat schemata in an individual's long-term memory (Mathews, & Funke, 2006). When these threat schemata are activated, they may increase vigilance for internal or external threats (e.g. negative evaluation or harm, respectively). The preferential processing of threatening stimuli, also known as biased information processing, can have causal effects on the etiology and maintenance of anxiety and worry (Koster, Fox, & MacLeod, 2009). The variables that have been proposed as predictors of excessive worry are: intolerance of uncertainty, beliefs that worry has a protective function, negative orientation towards problem situations, and cognitive avoidance (Dugas, Gagnon, Ladouceur, & Freeston,

1998). The relationship between intolerance of uncertainty and worry remains strong even after taking into account anxiety and depression (Buhr, & Dugas, 2006; Buhr & Dugas, 2009; Boelen, Vrinssen, & van Tulder, 2010; de Bruin, Rassin, & Muris, 2007; de Bruin, Rassin, & Muris, 2006; Dugas, Gosselin, Ladouceur, 2001).

Based on the proposed models of the relationship between intolerance of uncertainty and worry, intolerance of uncertainty can be conceptualized as both a mediator and a moderator in the relationship between worry and anxiety symptoms (Newman & Llera, 2011). In its mediating role, intolerance of uncertainty has been conceptualized as the underlying mechanism or the core schema by which ambiguous and uncertain situations are considered dangerous and result in worry (van der Heiden, Melchoir, Muris, Bouwmeester, Bos, & van der Molen, 2010). In its moderating role, intolerance of uncertainty has been conceptualized as the factor that enhances worry by enhancing the beliefs that worry has a protective function, negative orientation towards problem situations, and cognitive avoidance (Luhmann, Ishida, & Hajcak, 2011).

Theoretical Conceptualizations of Intolerance of Uncertainty

Intolerance of uncertainty has been defined as biased perception, interpretation, or negative emotional/cognitive/behavioral response to uncertain situations and events (Buhr & Dugas, 2006; Dugas, Hedayati, Karavidas, Buhr, Francis, & Philips, 2005; Dugas, Buhr, & Ladouceur, 2004). Intolerance of uncertainty has been conceptualized as a dispositional characteristic, a personality trait, a cognitive process, and a cognitive filter (Dugas and Robichaud, 2007; Dugas et al., 2005; Fisher & Wells, 2009). Behavioral operationalizations of intolerance of uncertainty include attempts to control the future, all-or-nothing responses in cases of uncertainty (Yook, Kim, Suh, & Lee, 2010),

heightened information-seeking (Starcevic & Berle, 2006), and difficulties with decision-making (Krain, Hefton, Pine et al., 2006).

People with high intolerance of uncertainty perceive uncertain events as stressful and upsetting. They further interpret such events as negative, threatening, and unfair, and they avoid or are unable to act in uncertain situations. In addition, they are unable to tolerate the possibility of a negative outcome, even if the probability of such outcome is very small (Mathews, & Funke, 2006; Dugas et al., 2005). It has been suggested that intolerance of uncertainty results in selective encoding and interpretation of information, such that people with high intolerance pay more attention to uncertain stimuli, go through greater elaborative encoding of uncertain information, have enhanced recollection of uncertain stimuli, and have greater tendency to interpret such stimuli as threatening (Dugas et al., 2005). Researchers suggest that preferential encoding of threatening information, threatening interpretation of uncertain stimuli, and preferential retrieval of threatening information results in extreme concern and worry when any physical or psychological peril is present (Koerner, 2008).

Research investigating the influence of anxiety and of intolerance of uncertainty on information processing has indicated that intolerance of uncertainty is a unique contributor that defines the experience of anxiety beyond anxiety symptoms. Intolerance of uncertainty has been conceptualized both as a cognitive vulnerability and as a characteristic of anxiety; it is part of a vicious circle where its presence influences worry which in turn interferes with information processing of uncertain stimuli, which then maintains and enhances anxiety symptoms (Koerner and Dugas, 2008).

Several factor analyses have attempted to identify the factor structure of

intolerance of uncertainty and have yielded inconsistent conclusions with regards to the

number of factors, ranging from 2 to 5, and the ideas reflected in the factors (Freeston et

al, 2004; Buhr & Dugas, 2002; Norton, 2005; Carleton et al, 2007; Berenbaum et al,

2008; Sexton & Dugas, 2009). Factors that have been identified by these studies include:

the belief that uncertainty has negative repercussions, and the belief that uncertainty is

damaging and unfair (Sexton & Dugas, 2009; Buhr & Dugas, 2002); need of

predictability, inaction in the face of uncertainty, experiencing uncertainty as distressing,

and inflexible beliefs about uncertainty (Berenbaum et al, 2008; Buhr & Dugas, 2002);

anxiety, and avoidance (Carleton et al, 2007). McEvoy and Mahoney (2011) suggested

that these inconsistencies may be due to diversity in the severity of anxiety and

intolerance of uncertainty experienced by participants across studies. Some of these

studies employed participants with non-clinical levels of anxiety and intolerance which

may have led to more homogenous answers, while others employed participants with

clinical levels of anxiety which may have led to answers revealing a multidimensional

structure of intolerance of uncertainty.

Intolerance of uncertainty was initially conceptualized as a construct strongly

related with worry and generalized anxiety disorder (Dugas & Ladouceur, 2000). Recent

research indicates that intolerance of uncertainty may be a construct that defines the

experience of anxiety and is not necessarily restricted to a specific generalized anxiety

disorder diagnoses (McEvoy & Mahoney, 2011). For example, recent studies have

identified a relationship between intolerance of uncertainty and obsessive-compulsive

disorder (Lind & Boschen, 2009), social anxiety (Carleton, Collimore, & Asmundson,

2010), panic disorder with agoraphobia (Buhr & Dugas, 2009), and even depression (de Jong-Meyer, Beck, & Riede, 2009). In addition, intolerance of uncertainty is correlated to other anxiety constructs that play an important role in the etiology and maintenance of different anxiety disorders, such as worry (de Jong-Meyer, Beck, & Riede, 2009), anxiety sensitivity (Carleton, Sharpe, Asmundson, 2007), and fear of anxiety. Recent studies indicate that enhancing negative interpretive biases increases vulnerability to stress (White, Suway, Pine, Bar-Haim, & Fox, 2011) in both children (Eldar, Ricon, & Bar-Haim, 2008) and adults (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). Chen and Hong (2010) investigated the role of intolerance of uncertainty in heightening anxiety levels in the presence of situations. The researchers found that intolerance of uncertainty moderated the role of daily stress on the experience of anxiety. They suggested that the heightened levels of anxiety were the result of increased perceived threat as uncertain elements of the situations are perceived as threatening.

Information Processing Biases in Intolerance of Uncertainty

Research on information processing biases and worry or intolerance of uncertainty has provided support for biased recall of stimuli denoting uncertainty (Dugas et al., 2005), threatening interpretation of ambiguous statements (Dugas et al., 2005), indecisiveness and hypersensitivity regarding threat (Rassin & Muris, 2005), and concern and threatening appraisal regarding ambiguous situations (Keorner & Dugas, 2008). Studies investigating processing biases in worry and intolerance of uncertainty have used verbal-linguistic stimuli and have assessed biases during the interpretative and elaborative phase of information processing. Dugas et al. (2005) reasoned that words are the ideal medium for investigating biases in information processing in worriers and

people with high intolerance of uncertainty, because verbal-linguistic processes predominate in worry.

Experimental Studies of Information Processing Biases in Intolerance of Uncertainty

Dugas et al. (2005) were among the first to investigate information processing biases in relation to intolerance of uncertainty after noting a lack of research on the topic. The goal of their work was to identify how intolerance of uncertainty information processing and how that in turn led to excessive worry and anxiety. The authors focused on biases in recall of material denoting uncertainty, and biases in interpretation of uncertain situations; they found that intolerance of uncertainty led to better recall of material denoting uncertainty and threatening interpretation of uncertain situations. The materials used in these experiments included a word list including 30 words (15 of which were ambiguous), and the Ambiguous/Unambiguous Situations Diary (AUSD; Davey et al., 1992) consisting of 28 fictitious diary entries (14 of which were ambiguous). These findings were replicated by Koerner-Singh (2008), who, in addition, investigated the effect of intolerance of uncertainty on using anxious affect in processing uncertain material using both vignettes and pictorial stimuli. The materials used in these experiments included 17 fictitious diary entries from AUSD with an additional 38 original vignettes, the Emotional Reasoning Task (Engelhard et al., 2002) consisting of scenarios capturing a wide variety of threatening situations, and photographs of varied levels of pleasantness. Existing research indicates people high in intolerance of uncertainty make threatening interpretations and negative evaluations of uncertain stimuli.

Grupe & Nitschke (2011) presented their participants with aversive and neutral pictures. Each picture was preceded by a cue indicating varying degrees of certainty that an aversive picture would follow, however the participants were not explicitly informed of the meaning of each cue. Throughout this task, as the participants were presented with each cue they recorded the level of expectancy that the image following that cue would be aversive. The participants also recorded their level of certainty that their judgment about the valence of the following image was correct. The self-report data was also accompanied by measurement of the participants' skin conductance. Through the self monitoring procedures and skin conductance measurements, the participants showed higher than chance expectancy that cues denoting uncertainty were followed by an aversive image. The authors concluded that there is a relationship between uncertainty and threatening interpretation of uncertain cues and situations.

Ritter (2007) aimed to identify a measurable behavioral manifestation of intolerance of uncertainty. The participants completed a task in which they were presented simultaneously with two gambles with differing levels of probability to win. They were asked to choose the gamble that would result in the best chance to win. The participants with higher self-reported levels of worry and intolerance of uncertainty consistently chose the gamble with full probability disclosure that was associated with the lowest level of uncertainty. The author concluded that high levels of intolerance of uncertainty are associated with consistent avoidance of ambiguity, while recognizing that such behavior could also be influenced by worry, state anxiety, and depression.

Intolerance of uncertainty has also been investigated as a crucial cognitive feature of obsessive compulsive disorder (Gangerni, Baldini, Carini, Cieri, Ciocci, Cioce, Ercoli,

Frellicca, Frenza, Masi, Pozzolo, Reale, & Mancini, 2003). Gangerni et al. (2003) investigated the influence of intolerance of uncertainty in combination with fear of guilt. Both intolerance of uncertainty and fear of guilt are related to risk taking behaviors. The authors proposed that people with high intolerance of uncertainty direct their efforts at avoiding punishment or aversive experiences, thus they exhibit less risk taking behaviors.

Johanson (1999) investigated the relationship between risk aversion and three possible contributing constructs, one of which was intolerance of uncertainty. Varying versions of a gambling task targeted uncertainty avoidance, regret avoidance, and self-image protection as possible explanations for people's choices in the tasks. The results of the study indicated that intolerance of ambiguity was negatively correlated with risky choices.

Current experimental studies of intolerance of uncertainty have targeted interpretational processing biases and identification of behavioral markers of this construct. Research to date provides support for the hypothesis that intolerance of uncertainty is a construct that affects thought processes and results in observable behavioral manifestations.

Intolerance of Uncertainty and Depression

The relationship between IU and anxiety symptoms is well documented (Gentes & Ruscio, 2011). Anxiety, in turn, often co-occurs with depression, with comorbidity rates ranging from 15%-73% (Kaufman & Charney, 2000). Numerous studies have investigated underlying mechanisms, cognitive processes, and dimensional traits shared by anxiety and depression in the attempt to explain this comorbidity and develop better treatments (Querstret & Cropley, 2013; Bauer, Wilansky-Traynor, & Rector, 2012).

Yook et al. (2010) theorized that individuals with high IU may experience negative affect and low self-esteem due to their bleak outlook for the future and worry that they do not possess sufficient problem solving skills to manage this uncertain future. Anticipation of negative events is a feature associated with IU, anxiety, and depression. When faced with an uncertain future, individuals with anxiety engage in repetitive cognitions, also known as worry, focused on solving and preparing for the unknown problem waiting for them in the unknown future (Boswell, Thompson-Hollands, Farchione, & Barlow, 2013). Individuals with depression predict negative outcomes and use a very similar coping mechanism, repetitive cognitions focused on negative emotions, known as ruminations (Nolen-Hoeksema, 2000; Yook et al., 2010). Recent studies indicate that IU may be an important and shared factor in the etiology, maintenance, and treatment of emotional disorders (Boswell et al., 2013). High comorbidity indicates that depression is a correlate that may influence information processing biases.

Intolerance of Uncertainty and Need for Closure

Intolerance of uncertainty is comparable to need for closure - a construct that was developed and has been widely used in social psychology studies (Kruglanski & Webster, 1996). Similarly to intolerance of uncertainty, need for closure has been conceptualized as the drive to find definite answers and to avoid ambiguity. Need for closure has not been studied in association with information processing biases, as defined and operationalized in cognitive and clinical psychology studies. However, need for closure has been investigated in relation to impression formation and stereotyping, which are processes reliant on information processing (Dijksterhuis, Knippenberg, Kruglanski, & Schaper, 1996; Kruglanski, Webster, & Klem, 1993; Heaton & Kruglanski, 1991). An

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investigation of the relationship between intolerance of uncertainty and need for closure indicated statistical significant correlations between the subscales of the two scales (Berenbaum, Bredemeier, & Thompson, 2007).

Colbert, Peters & Garety (2005) investigated the effect of anxiety and need for closure on psychotic symptoms. The participants that met criteria for generalized anxiety disorder and those that had psychotic symptoms scored higher on the need for closure scale. Also, severity of state anxiety was positively correlated to the severity of need for closure. This positive correlation points to additional similarities between need for closure and intolerance of uncertainty.

Cognitive processing characteristics associated with need for closure have been investigated in the framework of consumer information processing and sale strategies (Choi, Koo, Choi, & Auh, 2008). High levels of need for closure were found to be associated with focus on attributes of products rather than considering alternatives and arriving to a decision after a smaller amount of information about the product.

Appendix B: Dot-probe task Photographs and Emotional Stroop

Word List

Photographs of a Face with a Fearful and Happy Expression Used in the Dot-Probe Task

Fearful Expression	Happy Expression

Emotional Stroop Task Word List

Threatening Words	Words Denoting Uncertainty	Matched Neutral Words
Furious	Inconclusive	Identifiable
Helpless	Possibility	Personality
Punishment	Uncertain	Unofficial
Vicious	Unsure	Uniform
Violent	Vague	Vivid

Appendix C: Instruments

Demographics Questionnaire

Please indicate your responses to the following questions, by checking the space before the appropriate answer.

Gender:
_____1. Male
_____2. Female

Age:
_____1. 18
_____2. 19
_____3. 20
_____4. 21
_____5. 22
_____6. 23
_____7. 24
_____8. 25

Ethnicity:
_____1. African/African American
_____2. Asian/Asian American
_____3. Caucasian/European American
_____4. Hispanic/Hispanic American
_____5. Native American
_____6. Pacific Islander/Pacific Islander American
_____7. Other

Education:
_____1. freshman
_____2. sophomore
_____3. junior
_____4. senior

Intolerance of Uncertainty Scale

You will find below a series of statements which describe how people may react to the uncertainties of life. Please use the scale below to describe to which extent each item is characteristic of you (please write the number that describes you best in the space before each item).

1	**2**	**3**	**4**	**5**
not at all characteristic of me	a little characteristic of me	somewhat characteristic of me	very characteristic of me	entirely characteristic of me

_____1. Uncertainty stops me from having a firm opinion.
_____2. Being uncertain means that a person is disorganized.
_____3. Uncertainty makes life intolerable.
_____4. It's not fair that there are no guaranties in life.
_____5. My mind can't be relaxed if I don't know what will happen tomorrow.
_____6. Uncertainty makes me uneasy, anxious, or stressed.
_____7. Unforeseen events upset me greatly.
_____8. It frustrates me not having all the information I need.
_____9. Being uncertain allows me to foresee the consequences beforehand and to prepare for them.
_____10. One should always look ahead so as to avoid surprises.
_____11. A small unforeseen event can spoil everything, even with the best of planning.
_____12. When it's time to act uncertainly it paralyses me.
_____13. Being uncertain means that I am not first rate.
_____14. When I am uncertain I can't go forward.
_____15. When I am uncertain I can't function very well.
_____16. Unlike me, others always seem to know where they are going with their lives.
_____17. Uncertainty makes me vulnerable, unhappy, or sad.
_____18. I always want to know what the future has in store for me.
_____19. I hate being taken by surprise.
_____20. The smallest doubt stops me from acting.
_____21. I should be able to organize everything in advance.
_____22. Being uncertain means that I lack confidence.
_____23. I think it's unfair that other people seem sure about their future.
_____24. Uncertainty stops me from sleeping well.
_____25. I must get away from uncertain situations.
_____26. The ambiguities in life stress me.
_____27. I can't stand being undecided about my future.

Penn State Worry Questionnaire

Enter the number that best describes how typical or characteristic each item is of you, putting the number next to the item.

1	**2**	**3**	**4**	**5**
Not at all typical		Somewhat typical		Very typical

_____1. If I don't have enough time to do everything, I don't worry about it.
_____2. My worries overwhelm me.
_____3. I do not tend to worry about things.
_____4. Many situations make me worry.
_____5. I know I shouldn't worry about things, but I just cannot help it.
_____6. When I am under pressure I worry a lot.
_____7. I'm always worrying about something.
_____8. I find it easy to dismiss worrisome thoughts.
_____9. As soon as I finish one task, I start to worry about everything else I have to do.
_____10. I never worry about anything.
_____11. When there is nothing more I can do about a concern, I don't worry about it anymore.
_____12. I've been a worrier all my life.
_____13. I notice that I have been worrying about things.
_____14. Once I start worrying, I can't stop.
_____15. I worry all the time.
_____16. I worry about projects until they are done.

Beck Anxiety Inventory

Below is a list of common symptoms of anxiety.   Please carefully read each item in the list. Indicate how much you have been bothered by that symptom during the **PAST WEEK**, including today, by circling the number in the corresponding space in the column next to each symptom.

	Not At All	Mildly but it didn't bother me much.	Moderately - it wasn't pleasant at times	Severely – it bothered me a lot
Numbness or tingling	0	1	2	3
Feeling hot	0	1	2	3
Wobbliness in legs	0	1	2	3
Unable to relax	0	1	2	3
Fear of worst happening	0	1	2	3
Dizzy or lightheaded	0	1	2	3
Heart pounding/racing	0	1	2	3
Unsteady	0	1	2	3
Terrified or afraid	0	1	2	3
Nervous	0	1	2	3
Feeling of choking	0	1	2	3
Hands trembling	0	1	2	3
Shaky / unsteady	0	1	2	3
Fear of losing control	0	1	2	3
Difficulty in breathing	0	1	2	3
Fear of dying	0	1	2	3
Scared	0	1	2	3
Indigestion	0	1	2	3
Faint / lightheaded	0	1	2	3
Face flushed	0	1	2	3
Hot/cold sweats	0	1	2	3

Instructions: This questionnaire consists of 21 groups of statements. Please read each group of statements carefully, and then pick out the one statement in each group that best describes the way you have been feeling this past week. Circle the number beside the statement you have picked. If several statements in the group seem to apply equally well, circle the highest number for that group. **Be sure that you do not choose more than one statement for any group, including Item 16 (Changes in Sleeping Pattern) or Item 18 (Changes in Appetite).**

1) Sadness
0. I do not feel sad.
1. I feel sad much of the time.
2. I am sad all the time.
3. I am so sad or unhappy that I can't stand it.

2) Pessimism
0. I am not discouraged about my future.
1. I feel more discouraged about my future than I used to be.
2. I do not expect things to work out for me.
3. I feel my future is hopeless and will only get worse.

3) Past Failure
0. I do not feel like a failure.
1. I have failed more than I should have.
2. As I look back, I see a lot of failures.
3. I feel I am a total failure as a person.

4) Loss of Pleasure
0. I get as much pleasure as I ever did from the things I enjoy.
1. I don't enjoy things as much as I used to.
2. I get very little pleasure from the things I used to enjoy.
3. I can't get any pleasure from the things I used to enjoy.

5) Guilty Feelings
0. I don't feel particularly guilty
1. I feel guilty over many things I have done or should have done.
2. I feel quite guilty most of the time.
3. I feel guilty all of the time.

6) Punishment Feelings
0. I don't feel I am being punished.
1. I feel I may be punished.
2. I expect to be punished.
3. I feel I am being punished.

7) Self-Dislike
0. I feel the same about myself as ever.
1. I have lost confidence in myself.
2. I am disappointed in myself.
3. I dislike myself.

8) Self-Criticalness
0. I don't criticize or blame myself more than usual.
1. I am more critical of myself than I used to be.
2. I criticize myself for all of my faults.
3. I blame myself for everything bad that happens.

9) Suicidal Thoughts or Wishes
0. I don't have any thoughts of killing myself.
1. I have thoughts of killing myself, but I would not carry them out.
2. I would like to kill myself.
3. I would kill myself if I had the chance.

10) Crying
0. I don't cry any more than I used to.
1. I cry more than I used to.
2. I cry over every little thing.
3. I feel like crying, but I can't.

11) Agitation
0. I am no more restless or wound up than usual.
1. I feel more restless or wound up than usual.
2. I am so restless or agitated that it's hard to stay still.
3. I am so restless or agitated that I have to keep moving or doing something.

12) Loss of Interest
0. I have not lost interest in other people or activities.
1. I am less interested in other people or things than before.
2. I have lost most of my interest in other people or things.
3. It's hard to get interested in anything.

13) Indecisiveness
0. I make decisions about as well as ever.
1. I find it more difficult to make decisions than usual.
2. I have much greater difficulty in making decisions than I used to.
3. I have trouble making any decisions.

14) Worthlessness
0. I do not feel I am worthless.
1. I don't consider myself as worthwhile and useful as I used to.
2. I feel more worthless as compared to other people.
3. I feel utterly worthless.

15) Loss of Energy
0. I have as much energy as ever.
1. I have less energy than I used to have.
2. I don't have enough energy to do very much.
16) I don't have enough energy to do anything

Changes in Sleeping Pattern
0. I have not experienced any change in my sleeping pattern.
1a. I sleep somewhat more than usual.
1b. I sleep somewhat less than usual.
2a. I sleep a lot more than usual.
2b. I sleep a lot less than usual.
3a. I sleep most of the day.
3b. I wake up 1-2 hours early and can't get back to sleep.

17) Irritability
0.   I am no more irritable than usual.
1.   I am more irritable than usual.
2.   I am much more irritable than usual.
3.   I am irritable all the time.

18) Changes in Appetite
0.   I have not experienced any changes in my appetite.
1a. My appetite is somewhat less than usual.
1b. My appetite is somewhat greater than usual.
2a. My appetite is much less than before.
2b. My appetite is much greater than usual.
3a. I have no appetite at all.
3b. I crave food all the time.

19) Concentration Difficulty
0.   I can concentrate as well as ever.
1.   I can't concentrate as well as usual.
2.   It's hard to keep my mind on anything for very long.
3.   I find I can't concentrate on anything.

20) Tiredness or Fatigue
0.   I am no more tired or fatigued than usual.
1.   I get more tired or fatigued more easily than usual.
2.   I am too tired or fatigued to do a lot of the things I used to do.
3.   I am too tired or fatigued to do most of the things I used to do.

21) Loss of Interest in Sex
0.   I have not noticed any recent change in my interest in sex.
1.   I am less interested in sex than I used to be.
2.   I am much less interested in sex now.
3.   I have lost interest in sex completely.

Appendix D: Protocol Script

Protocol Script: Assessment

Now I will give you a couple of questionnaires that you will fill out. After you have completed the questionnaires, I will ask you a few questions from a psychological diagnostic interview. The questions will be about your experiences and feelings. They are a standard set of questions that I ask to all participants. Do you have any questions?

Protocol Script: Task 1

Now you are ready to start with the first computer task. During this task, you will see a series of words on the screen. You must name the color of the printed word as quickly as you can. This will continue until this section of the experiment is complete. Before the task begins you will practice with a series of words. These words are not part of the experiment. After the practice session, you will start the first task. If you have any questions, please feel free to ask them now.

Protocol Script: Task 2

Now you are ready to start with the second computer task. During this task you will see two pictures on the screen. Both pictures will be of the same person showing different expressions. After the pictures will have been on the screen for a brief time, you will see an arrow oriented up or down in the place of one of the pictures. If the arrow is oriented up, you must press the up arrow key and if the arrow is oriented down you must press the down arrow key. You must press the correct key as quickly as possible. If you have any questions, please feel free to ask them now.

Appendix E: Debriefing

The purpose of this study is to investigate the relationship between intolerance of uncertainty and information processing biases that are typically observed in relation to anxiety. Information processing denotes the mental processes by which we take in, interpret, and store in our memory any information that we encounter. Biased information processing means different and selective processing. Biased information processing does not mean narrow or distorted processing. Research indicates that information processing in people with anxiety is different from that in people without anxiety. Some theories propose that people with anxiety devote more time or energy to process potentially threatening information and have better memory for such information.

Intolerance of uncertainty has been conceptualized as a component of anxiety. People with high intolerance of uncertainty perceive uncertain events as stressful and upsetting. They interpret such events as negative, threatening, and unfair and avoid or are unable to act in uncertain situations. People with high intolerance of uncertainty are unable to tolerate the possibility of a negative outcome, even if the probability of such outcome is very small.

There are numerous studies investigating information processing biases in relationship to anxiety. Currently, there is a need for research to better identify the information processing biases and the timeline in which the processing biases unfold in relationship to intolerance of uncertainty. This was the goal of the present study. Specifically, we are interested in the time difference that it takes to process or to make

decisions on stimuli, and if these time differences are different in people with different levels of intolerance of uncertainty.

To this end, you were asked to complete a number of questionnaires assessing intolerance of uncertainty and other related measures, as well as to complete two computer tasks. The first task was designed to measure the time you needed to name the color of print of words, some of which are considered to be threatening or anxiety provoking. The second task was designed to measure the time you needed to notice a sign that replaced one of two photographs presented on a computer screen. As you may have notices some of the pictures displayed faces with a fearful expression which are also deemed to be anxiety provoking.

Your participation in this study may help us discover ways in intolerance of uncertainty in related to information processing biases. This research may ultimately help in learning much more about the development and maintenance of anxiety, as well as the development of treatments aimed at reducing anxiety. If you have any questions, please ask the experimenter now, or contact Dr. Barry Smith at bdsmith@psyc.umd.edu or Earta Norwood at enorwood@psyc.umd.edu or (301) 405-5887.

Appendix F: Referral List

During or as a result of the assessment procedures completed in this study, you may realize that you have questions that you would like to discuss further with a mental health professional. Below you will find a list of referrals on and off campus in the case that you would like learn more information regarding any feelings of frustration, discomfort, or depression from a mental health professional. These referrals were obtained from an established referral list already in use at the University of Maryland Psychology Clinic:

Judith Sprei, Ph.D.	4701 Samgamore Rd. Ste. 1355 Bethesda, MD 20816	301-229-0065
Ruth Murray, M.D.	2340 University Blvd. E. Hyattsville, MD 20783	301-608-9205
Behavior Therapy Center (BTC) of Greater Washington	11227 Lockwood Dr., Silver Spring, MD 20901	301-593-4040, Fax: 301-593-9148
Dr. William Stixrud & Associates	8720 Georgia Ave., Suite 300 Silver Spring, MD 20910	301-565-0534, Fax: 301-565-2217
University of Maryland The Center for Health & Wellbeing	University Health Center University of Maryland College Park, MD 20742	301-314-5661
University of Maryland Psychology Clinic	Biology/Psychology Building, Ste. 2114, College Park, MD 20742	301-405-4808

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