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# Stress and Suicidal Behavior: A Cognitive, Behavioral, and Biological Integrative Approach

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**Stress and Suicidal Behavior: A Cognitive, Behavioral, and Biological Integrative  
Approach**

**by**

**Jorge Valderrama**

**A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the  
requirements for the degree of Doctor of Philosophy, The City University of New York**

**2016**

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This manuscript has been read and accepted for the  
Graduate Faculty in Psychology to satisfy the dissertation  
requirement for the degree of Doctor of Philosophy.

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## Abstract

Suicide is one of the leading causes of death in young adults in the United States. Previous research has established distal and proximal life stress as a strong risk factor for suicidal behavior. However, how stress impacts suicidal behavior via interactive cognitive and biological mechanisms has not been thoroughly examined. The present research sought to better understand the relationship between stress and suicidal behavior via altered neurobiological functioning, maladaptive cognitions, and deficits in executive functioning. The first study found a relationship between the brooding subtype of rumination and trait impulsivity in the forms of negative urgency, lack of premeditation, and lack of perseverance. Further, lack of premeditation and lack of perseverance mediated the relationship between brooding and suicide risk. The second study found no difference in physiological stress response (as determined by cortisol levels), measures of executive functioning, and semantic interference from suicide-related stimuli among suicide attempters and non-attempters following a social rejection task. However, there was a positive association between suicide attempt history and negative urgency, lack of perseverance, and lack of premeditation. The final study found that early life stress was positively associated with brooding, negative urgency, recent suicidal ideation, and previous suicide attempt history. Additionally, a positive relationship between early life emotional abuse and negative urgency was mediated by brooding among individuals with serotonin transporter low expressing genotypes but not among those with high expressing genotypes. Overgeneral autobiographical memory was not associated with brooding or negative urgency. Implications for future research and developing targeted clinical interventions are discussed.

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## **Introduction**

Suicide is among the top three leading causes of death among emerging adults (ages 18-29) (CDC, 2011). Ongoing research continues to reveal the complex and multi-dimensional nature of the risk factors that contribute to suicidal behavior. One such risk factor, stress, has long been viewed as a significant predictor of suicidal behavior (Paykel et al., 1975; Clum et al., 1979). Both cognitive and neurophysiological vulnerabilities associated with stress have been thoroughly studied. However, an integrative biological and psychological approach to examine stress and suicidal behavior has only recently emerged as a focus of research. This paper will review prevailing psychological theories of suicide, followed by a more in-depth examination of known biological and psychological risks for suicidal behavior. Finally, research that will attempt to better understand the relationship between stress, maladaptive cognitions, deficits in executive functioning, and abnormal neurophysiological functioning will be proposed.

## **Defining Suicidal Thoughts and Behavior**

Before introducing current psychological theories of suicide, it is important to define the varying degrees of suicidal behavior that these theoretical models seek to understand. Given the number of different approaches to studying suicidal behavior, it is not surprising that basic concepts and terms related to such behavior are often defined differently. Such contrasts negatively impact the reliability and validity of research findings. In an effort to make such terms generalizable across research, O'Carroll et al. (1996) set out to define the degrees of suicidality along with other aspects of suicidal behavior. These definitions were later revised (Silverman et al., 2007) and will be used in this paper. Suicidal ideation is defined as the thought process of weighing the option of suicide as a choice (i.e., an individual thinks about killing

him/herself). A suicide attempt is defined as an intentional, self-injurious behavior in which a person engages with the intention of killing him/herself. This description may further be delineated by a suicide attempt without injuries, with injuries, or with fatal injuries (suicide). A multiple suicide attempter can be defined as an individual who has attempted suicide (with or without injuries) and then proceeds with one or more additional suicide attempts.

### **Psychological Theories of Suicide**

Stress is a recognized component of psychological theories of suicide. On an individual level, stress is the outcome of a person's encounter with stressors. Stressors may be regarded as internal or external events that pose a threat to an individual's psychological or physical wellbeing (Selye, 1956). Internal stressors include unwanted negative thoughts, feelings, and emotions that may or may not be a result of facing a negative life event. External stressors include the experience of a negative life event, such as losing a loved one, financial difficulties, or other such events.

#### Interpersonal Theory of Suicide (IPT)

Joiner's (2005) interpersonal theory of suicide suggests that individuals become more at risk for suicidal behavior if they have experienced repeated painful and provocative life events. Repeated exposure to such stressful events may habituate individuals to the psychological and/or physical pain associated with harming themselves, and this exposure eventually generates an "acquired capability for suicide" (Joiner, 2005, p. 46). However, these experiences only trigger a suicidal episode when combined with factors that increase suicidal desire, or the wish to die. Joiner termed these factors perceived burdensomeness – or a person's belief that he or she is a burden to others, that his/her life is not contributing anything meaningful to others, and that

he/she is a liability to friends, family, and society – and thwarted belongingness –i.e., feelings of social alienation in which an individual feels no meaningful connection with other people, or in which any such connection is thought to be insincere.

Van Orden et al. (2008) tested the theory's hypothesis in three separate studies. The interaction between perceived burdensomeness and thwarted belongingness predicted current suicidal ideation in a sample of 309 undergraduates. Further, number of painful and provocative events (including the number of previous suicide attempts) predicted acquired capability for suicide (as determined by the presence of self-harm behavior in the previous year) in a sample of 228 psychology clinic outpatients. A third study further supported the IPT by demonstrating that the interaction of perceived burdensomeness and acquired capability for suicide predicted clinician-rated risk for suicidal behavior in a sample of 153 adult psychology clinic patients. Similar results were found in two studies of a larger and more diverse sample of young adults (Joiner et al., 2009). Perceived burdensomeness and thwarted belongingness predicted current suicidal ideation among 815 young adults. Further, the interaction between perceived burdensomeness, thwarted belongingness, and acquired capability for suicide predicted past number of suicide attempts in a sample of 313 young adults. Conversely, this finding was not replicated in a sample of 88 recently enlisted military members (Bryan et al., 2010) and in a sample of 185 inpatient veterans (Monteith et al., 2013). These studies did, however, lend support to the IPT by revealing that the interaction of perceived burdensomeness and thwarted belongingness predicted current suicidal ideation in both samples.

Importantly, perceived burdensomeness has been found to be a robust and stronger predictor of current suicidal ideation than has thwarted belongingness in the studies discussed above. Future research on the IPT should focus on the potential cognitive processes and specific

life events that might precede the onset of perceived burdensomeness. Additionally, how a person reacts to painful and provocative events may potentially be a result of both biological (e.g., stress response) and maladaptive cognitions. For instance, individuals with Post Traumatic Stress Disorder (PTSD) often have experienced repeated painful and provocative events in their lives and thus have a unique stress response (Miller et al., 2007). How this stress response relates to potential suicidal behavior has yet to be elucidated. However, studying the stress response alongside concurrent maladaptive cognitions may be a valuable avenue for understanding individual variation in the acquired capability for suicide. Future research should also focus on potential factors that may buffer against the interaction between acquired capability and suicidal desire.

#### The Cry of Pain Model of Suicide

The Cry of Pain model of suicide (Williams, 1997; Williams, 2001) suggests that suicidal behavior is a result of an individual's feelings of being trapped in an intolerable situation with no opportunity for escape or rescue. The individual judges how stressful the situation is, how escapable it is, and whether or not there is social support available to him or her during the crisis. Stressful situations that trigger these judgments are considered internal or external events that signify an extreme defeat in their lives. Escape potential is central to this model, such that the more an individual feels there is no potential for escape, the more likely he/she will attempt suicide. O'Connor (2003) tested the model by comparing an adult sample of 30 previous suicide attempters (assessed the day after admission to a hospital due to an attempt) and 30 matched hospital controls on measures assessing defeat, escape potential, and social support. Results confirmed the model's hypothesis, as previous attempters were significantly more likely to self-

report higher levels of defeat, and lower levels of escape potential and social support, compared to the matched controls.

Feelings of defeat may be more likely if an individual believes he or she must meet unrealistic high expectations. This socially prescribed perfectionism has been found to be higher among recent adult suicide attempters as compared to hospital and community controls (Hunter & O'Connor, 2003). Socially prescribed perfectionism has also been associated with suicidal ideation in a sample of 255 college students (O'Connor & Forgan, 2007). Further, a person's assessment of escape potential can be hindered by the inability to recall autobiographical events. Such memory deficit was found to interact with perfectionism to predict suicidal ideation in a hospital sample of 40 adults with a history of a recent suicide attempt (Rasmuseen et al., 2008). Importantly, autobiographical memory has been shown to be impaired directly after an experimentally induced defeating event in a sample of 74 college students (Johnson et al., 2008). Finally, bias in autobiographical memory recall may be acquired early in life in the face of stressful events (Williams et al., 2006). However, the mechanisms that mediate the relationship between early life stress and future memory deficits have yet to be elucidated but are likely to involve both biological mechanisms (e.g., HPA axis dysregulation, hippocampal neuronal atrophy) and cognitive factors, such as deficits in problem solving (McEwen, 2012; Guillaume et al., 2013; Yang & Clum, 2000).

### The Cognitive Model of Suicidal Behavior

Wenzel and Beck's (2008) cognitive model of suicidal behavior asserts that stress moderates the relationship between dispositional vulnerability factors and cognitive processes that can lead to a suicide attempt. Dispositional vulnerability factors include impulsivity,

problem solving deficits, overgeneral autobiographical memory, trait-like maladaptive cognitive style, and personality traits such as perfectionism and introversion. The theory separates cognitive processes into ones associated with psychiatric disturbance and those associated with suicidal acts. Both types of cognitive processes can be activated by stress and lead to biased information processing. Such attentional bias is thought to be a result of schemas (i.e., cognitive structures that give meaning to internal or external stimuli) related to psychiatric disturbance or suicidal behavior. For instance, a stressful life event may activate a depressive schema, and the cognitions associated with such a schema may trigger a suicidal schema. Suicidal schemas, such as those distinguished by chronic hopelessness, can trigger suicidal ideation and eventually a suicide attempt (Wenzel & Beck, 2008). Examining whether or not a person holds suicidal schemas has been tested by assessing interference from suicide-related stimuli in non-suicidal self-injurers, suicide ideators, and previous suicide attempters (Nock & Banjai, 2007a; Nock & Banjai, 2007b; Cha et al., 2010). The outcome of these studies will be discussed in detail later in a review of information processing among persons with a history of suicidal behavior.

### Conclusion

Stress is a main component of the theories discussed above. Certain stressful life events may decrease fear of pain or death, thereby increasing a person's acquired capability for suicide. Further, a person's judgment of how stressful and intolerable a situation is influences whether or not they believe they can escape the situation. Thus, low escape potential, along with low social support, may lead to suicidal behavior. Finally, stress may moderate the relationship between dispositional vulnerability factors (e.g., impulsivity, deficits in problem solving, overgeneral autobiographical memory, etc.) and cognitive processes associated with suicidal acts (e.g., state hopelessness and biased information processing). Taken together, these psychological theories



of suicide put forth the importance of understanding how stress directly and indirectly relates to suicidal behavior. To further understand how stress relates to suicidal behavior, findings related to the cognitive, behavioral, and biological components of stress and its impact on suicidal behavior will now be reviewed.

## **PART I: Cognitive, Behavioral, and Biological Components of Stress and its Relation to Suicidal Behavior**

### **Stress and Suicidal Behavior**

As noted earlier, stress is the psychological impact caused by internal or external events. Internal stress involves inner turmoil caused by negative thoughts or emotions that may or may not be a result of an immediate or past external stressful event. Previous research suggests that a person's experience with distal and proximal stressors may put him or her at risk for various psychopathologies, including suicidal behavior (Santa Mina et al., 1998; Yen et al., 2005; Wang et al., 2012). Early life stress has been examined via a variety of dimensions, including sexual abuse (unwanted sexual contact), physical abuse (physical contact with the intent to harm or injure), and emotional abuse (verbal communication that humiliates or degrades the victim) (Bremmer, 2007). A variety of instruments have been used to assess early life stress, including self-report surveys and structured interviews (Bernstein et al., 1994; Fink et al., 1995; Bremmer et al., 2000). Whether or not the age of onset of stress is accounted for depends on the instrument used. However, 18 years of age is the highest age limit considered for onset of stress among instruments that do not take into account specific age or age-ranges for when the stressor took place (Bremmer, 2007). Proximal life stress has been examined via the occurrence or frequency of stressful life events up to a year before assessment (Holmes & Rahe, 1967;

Dohrenwend et al., 1978). Dimensions of recent life events include, but are not limited to, interpersonal (e.g., argument with romantic partner), financial (e.g., job loss), health (e.g., medical concern), and traumatic event (e.g., death of a family member).

Studies with young adults suggest a relationship between stress, suicidal ideation, and suicide attempts. Yang & Clum (2000) studied 118 college students with or without suicidal ideation. Students who reported current suicidal ideation were more likely to have experienced early negative life events – such as child abuse, family instability, and poor family environment – compared to non-ideators. The link between early life stress and current suicidal ideation was mediated by cognitive difficulties, including low self-esteem, external locus of control, hopelessness, and difficulty with problem solving (Yang & Clum, 2000). A study of a community sample of 659 families found that young adults who were abused as children were more likely to have increased interpersonal conflict and stress in their lives in young adulthood than young adults who were not abused as children. In addition, the relationship between being abused as a child and having a history of suicide attempts was mediated by experiencing stress during young adulthood (Johnson et al., 2002). These findings suggest that individuals with a history of early life stress may be at a greater risk of suicidal behavior due to increased vulnerability to the harmful effects of stress later in life.

There is evidence that suicide attempts are often preceded by recent stressful life events. In a mixed clinical and community sample, Paykel et al. (1975) found that adult suicide attempters had 4 times as many major life events in the six months prior to their most recent attempt than did non-attempters in the general population. Further, the number of events peaked during the month prior to an attempt ( $M = 1.2$  as compared to  $M = 0.2$  in non-attempters). More recently, Yen et al. (2005) reported that a clinical sample of previous suicide attempters between

ages 18-45 ( $N = 61$ ) had at least one negative life event prior to an attempt. Given the association between stressful life events and suicidal behavior, researchers have also focused on the different characteristics of the types of events that often precede an attempt. Such events have been categorized and are most often related to financial/employment concerns, interpersonal/relationship disruptions, and shocking/traumatic events (Wang et al., 2012). Bagge et al. (2012) recruited 110 individuals (ages 18-64) who presented to an emergency room following a suicide attempt and interviewed them within a week of their attempt. The majority (63%) of the sample experienced a negative life event on the day they attempted suicide. Events close to the time of an attempt ( $< 48$  hours) were more likely to be interpersonal in nature, specifically related to romantic/partner events (e.g., break up, argument, divorce, etc.).

Importantly, research has also found a difference in the relationship between negative life events and current suicidal episodes among multiple suicide attempters, compared to single suicide attempters. Multiple attempters are significantly more likely to also have had negative life events early in life when compared to single attempters (Pompili et al., 2011). Further, Joiner and Rudd (2000) found that the severity of negative life events one year preceding a suicidal episode was not directly related to the intensity of the suicidal episode among multiple suicide attempters. However, the severity of negative life events was significantly associated with episode intensity among single attempters. The number or severity of negative life events may be necessary to trigger a suicidal episode in first-time attempters, while multiple attempters have a relatively low threshold to trigger a suicidal episode, given an encounter with internal or external stressors.

Taken together, these findings indicate that both distal and proximal stressful life events have an impact on the likelihood of a suicide attempt. However, the factors that mediate the

relationship between stress and suicidal behavior are not well known and sometimes conflicting (Clum & Febraro, 1994; Yang & Clum, 2000). The difficulty of predicting suicidal behavior based solely on a person's experience with specific events has contributed to the development of more dynamic models in which an individual's vulnerability to suicide is ever changing based on varying factors. For example, Rudd's (2006) Fluid Vulnerability Theory suggests that suicidal episodes, themselves, are short-lasting and become activated when cognitive, affective, behavioral, and physiological systems are triggered by internal or external events. Further, the threshold for activating the four domains becomes lower as the number of suicide attempts increases, such that multiple attempters are at higher risk of having stressors trigger a suicidal episode, as evidenced by Joiner and Rudd's (2000) study discussed above.

Rudd's theory importantly includes physiological systems that become activated by a person's encounter with internal or external stress. Previous research on stress and suicidal behavior has mostly concentrated on negative life events and the disruptive cognitions that may appear after experiencing such events. However, emerging evidence has revealed the importance of understanding neurophysiological responses to stress and the potential damage stress can have on the brain, cognitions, and executive functions. The next section will introduce how a person's physiological system responds to stress and review the potential relationship between abnormal stress reactivity and suicidal behavior.

### **The HPA Axis and Suicidal Behavior**

In response to stress, the brain activates neuroendocrine systems that promote physiological adaptation in a process called allostasis (McEwen, 2003). However, repeated exposure to stress can lead to allostatic load, characterized by a dysregulated stress response

(McEwen, 2003). One neuroendocrine system that governs the stress response, among other different physiological processes, is the Hypothalamic-Pituitary-Adrenal (HPA) axis. Various hormones are secreted along the HPA axis when stress is encountered. Neuroendocrine neurons in the hypothalamus secrete corticotropin releasing hormone (CRH), which in turn results in the secretion of adrenocorticotrophic hormone (ACTH) from the pituitary gland. ACTH will travel to and act upon the adrenal cortices, resulting in the secretion of cortisol. Cortisol is released throughout the bloodstream, and will act upon both the pituitary gland and hypothalamus in a negative feedback loop fashion, such that the secretion of CRH, ACTH, and ultimately cortisol is decreased (Carrasco & Van de Kar, 2003).

In addition to its role in the HPA axis negative feedback loop, cortisol will also affect many other different tissues in the human body, including the prefrontal cortex and hippocampal brain regions (McEwen, 1968; Radley et al., 2004; Warner-Schmidt & Duman, 2006). Cortisol binds to glucocorticoid receptors (GR) as well as mineralcorticoid receptors (MR). GRs are found throughout many different brain regions, including the prefrontal cortex neurons and hippocampal neurons. MRs are primarily found in the hippocampus (Jacobson and Sapolsky, 1991; Meijer & Dekloet, 1998). Increased cortisol levels as a result of HPA axis hyperactivity can cause structural damage to these brain regions via disruption of neuronal communication, cell atrophy, and suppression of neurogenesis (McEwen, 1999; Shanksy & Lipps, 2013). Importantly, neurons in the prefrontal cortex govern executive functions such as decision making, planning, problem solving, inhibition of behavior, and working memory. Additionally, the hippocampus is important for long-term memory storage of episodic events as well as emotion and mood regulation (McEwen, 2012).

Deficits in executive functioning, including impaired problem solving and impulsive behavior, as well as emotion dysregulation and dysfunctional autobiographical memory retrieval, have been associated with suicidal behavior (Schotte & Clum, 1982; Dougherty et al., 2004; Williams et al., 2006). Given that the areas of the brain known to be responsible for these various functions are still developing during emerging adulthood (Sowell et al., 2001), this period of life may be one of particular vulnerability to stress-induced suicidal behavior.

HPA axis dysregulation was first implicated as a characteristic of major depressive disorder in the late 1960s via the use of the dexamethasone suppression test (DST) (Carroll et al., 1972). Dexamethasone is an exogenous steroid that suppresses HPA axis activity. Non-suppression is an indication of HPA Axis hyperactivity, as cortisol levels remain unchanged even after the administration of dexamethasone to a human participant. Cortisol levels are usually tested via urinary or blood analysis after dexamethasone is administered. By the early 1990s, research began to reveal that dexamethasone suppression, in conjunction with unipolar depression, was a significant risk factor for completed suicide (Lester, 1992).

More recently, Coryell & Schlessler (2001) followed up on data from 78 mood disorder patients that had undergone the DST 15-20 years earlier. During follow-up, 27% of participants exhibiting high cortisol at the time of the DST were found to have completed suicide. By contrast, only 3% of participants exhibiting a normal response after administration of dexamethasone had completed suicide at follow-up. Recent research has also focused on the association between HPA axis activity and previous suicide attempts. Jokinen and Nordstrom (2009) utilized the DST to study 36 young adult inpatients with mood disorders, half of which had recently attempted suicide. Suicide attempters were found to be more likely to have high cortisol levels throughout the day, and exhibited significantly higher cortisol levels late in the

evening when compared to non-attempters. Such high cortisol activity may signify a HPA axis profile that is specific to previous attempters and may increase vulnerability to future suicidal behavior.

In contrast to the above findings, some studies have found no relationship between dexamethasone non-suppression and suicidal behavior. Black et al. (2002) found that there was no significant link between high cortisol and suicidal ideation or completed suicides in a retrospective study that followed up on 423 mood disorder patients that were given the DST between 2 and 5 years previously. Further, Pfennig et al. (2005)'s DST study of 310 adult inpatients found low HPA Axis activity among current suicide ideators and previous suicide attempters when compared to non-ideators and non-attempters. Despite research revealing an absence of a relationship between HPA axis hyperactivity and suicidal behavior, Mann's (2007) review of DST studies revealed that individuals who have high cortisol levels after dexamethasone administration have at least a 4.5 fold risk for suicide, compared to individuals who have a suppressed cortisol response after being given dexamethasone. In summary, DST studies have advanced our understanding of the relationship between the neurophysiological stress response and suicidal behavior and, specifically, how HPA axis hyperactivity might be a significant vulnerability to suicidal behavior.

The DST has been used to assess the efficacy of examining cortisol via saliva. Research has revealed that salivary cortisol is more sensitive to detecting cortisol than both urinary or blood tests after dexamethasone administration (Laudat et al., 1988; Gozansky et al., 2005; Putignano et al., 2003). Independent salivary cortisol testing (without the DST) has been used to measure an individual's cortisol awakening response, cortisol activity throughout the day, as well

as cortisol level changes as a response to a stressor (Dorn et al., 2007; Hucklebridge et al., 2005; Miller et al., 2007).

De Usabel Guzmán (2011) found that among 106 college students who reported a high number of depressive symptoms, those who were currently thinking about suicide had significantly higher salivary cortisol levels than did other participants in the study. Another recent study focused on individuals diagnosed with bipolar disorder with and without a history of suicide attempts (Kamali et al., 2012). Both groups had similar cortisol levels in the morning. However, previous suicide attempters were more likely to have elevated cortisol at bedtime and thus were more likely to experience HPA axis hyperactivity throughout the day. However, these results conflict with findings from an earlier salivary cortisol study that found that low evening levels of cortisol were associated with previous suicide attempts (Lidqvist et al., 2008). Despite some similar findings to the DST studies, more research is necessary to reveal specific HPA axis profiles among suicide ideators, single attempters, and multiple attempters.

Individuals who have a history of childhood life adversity are more likely to have a hyperactive HPA axis later in life than those without early life adversity (Von Werne Baes et al., 2012; Cheknita et al., 2012). Accordingly, emerging evidence has revealed that early life stress may lead to increased vulnerability to suicidal behavior via epigenetic mechanisms. Individuals who were abused as children and completed suicide later in life have been found to have decreased hippocampal glucocorticoid receptor (GR) expression in post mortem studies of their brains. However, there were no differences in GR expression between individuals who died by suicide with no history of child abuse and controls that died of natural causes. GR takes part in the negative feedback loop that inhibits the HPA axis, such that reduced expression results in HPA axis hyperactivity (McGowan et al., 2009). Further, Guillaume et al. (2012) studied a



clinical sample of 218 previous suicide attempters and found that participants abused as children were more likely to exhibit maladaptive decision making and to express specific genes that are known to regulate the HPA axis. Taken together, these studies reveal that experiencing stressful events may alter gene expression at a young age, and this altered gene expression may disrupt neurobiological systems such as the HPA axis.

Less information is known about whether an individual's current experience with stress induces chronic HPA axis hyperactivity. However, increased cortisol secretion has been associated with deficits in executive functioning (e.g., poor working and long term memory, deficits in cognitive set shifting/mental flexibility, and selective attention) that are found in individuals who have previously engaged in suicidal behavior (Wolf, 2003; Otte et al., 2007; Hinkelmann et al., 2009). Importantly, the relationship between stress and HPA axis activity may partly rely on serotonin transporter gene variants.

### **Serotonin Transporter Gene Variants and Suicidal Behavior**

Serotonin is a neurotransmitter that is functionally important for various physiological and psychological processes, including sleep, emotional processing, and mood regulation (Barnes & Sharp, 1999). Serotonin is widely found in the upper brain stem, with projections terminating throughout the brain, including the cerebral cortex, hypothalamus, and amygdala (Moore et al., 1978). Abnormal serotonergic functioning has been implicated in depressed mood and suicidal behavior (Mann, 1999). Much of the research establishing an association between serotonin dysfunction and suicidal behavior has focused on the serotonin transporter (5-HTT).

During serotonin neural transmission, serotonergic neurons release serotonin onto receptors of the postsynaptic neuron. 5-HTT is responsible for reuptaking serotonin from the

synaptic cleft back to the presynaptic neuron, thus terminating the action of serotonin and recycling it for future neural transmission (Fuller & Wong, 1990). The 5-HTT gene (SLC6A4) has recently become the focus of many studies with respect to the relationship between depression and suicidal behavior. The promoter region of the 5-HTT gene is named the 5-HTT gene-linked polymorphic region (5-HTTLPR). Variants of 5-HTTLPR include short and long forms (Heils et al., 1996). The short allele has been associated with abnormal and decreased serotonergic functioning, including lower serotonin reuptake (Karg et al., 2011).

Courtet et al. (2001) found a significant and positive association between the short allele and violent suicidal behavior in a sample of previous suicide attempters with and without a history of major depressive disorder and non-attempters with and without a history of major depressive disorder. No significant differences in allelic frequency were found between the non-attempter groups. However, the short allele was most common in the group of previous attempters with a history of major depressive disorder. This finding suggests that the short allele may relate to other variables that confer risk for depressive symptoms and suicidal behavior. Indeed, stressful life events were positively associated with increased rates of depression and suicidal behavior in a sample of 847 young adults (Caspi et al., 2003). However, this association was significantly more likely to occur in individuals possessing 5-HTT low expressing genotypes (one or two copies of the short allele) than 5-HTT high expressing genotypes (two copies of the long allele). Thus, 5-HTT genotypes might interact with stressful life events to moderate the association between stress and depression and/or suicidal behavior. Indeed, a meta-analysis of 54 studies reported the short allele to be significantly associated with increased stress sensitivity and subsequent greater likelihood of developing depression (Karg et al., 2011). Importantly, another recent meta-analysis revealed a significant and positive

association between 5-HTT low expressing genotypes and HPA axis hyperactivity (Miller et al., 2013). The nature of this relationship has yet to be fully elucidated. However, given the interaction between stressful life events and 5-HTTPLR, carrying a 5-HTT low expressing genotype might increase the likelihood that stressful life events would induce HPA axis hyperactivity. This dynamic interaction may occur via serotonin pathways that interact with corticoid receptors in the midbrain, hippocampus, hypothalamus, and/or amygdala (Moore et al., 1978; Sher, 2007). Taken together, data suggest that HPA Axis hyperactivity and 5-HTTPLR might be biological markers associated with suicidal behavior. However, further research is necessary to understand the potential mediators between stress, 5-HTTPLR, hyperactive cortisol activity and suicidal behavior. Executive functions and cognitions that may be impacted by stress, HPA axis hyperactivity, and 5-HTT genotypes will be reviewed in the next section.

## **PART II: Executive Functioning Deficits, Cognitive Risk, and Suicidal Behavior**

### **Impulsivity and Suicidal Behavior**

Impulsivity has been conceptualized as being both trait-dependent and state-dependent (Frosch & Wortis, 1954). As a trait, impulsivity is viewed as a stable component of an individual's personality. That is, an individual with high impulsivity displays a pattern of impulsive behavior throughout his or her daily life across different situations or circumstances. By contrast, state-dependent impulsivity describes impulsive behavior that can arise when encountering specific situations and is not a stable characteristic of the individual, i.e., any person is capable of impulsive behavior, but it will only occur under certain environmental circumstances. In addition to trait versus state conceptualizations, impulsivity has also been recognized as having different dimensions (i.e., motor impulsiveness, sensation

seeking, self-control, etc.). The various definitions, conceptualizations, and how impulsivity itself is measured in a given sample have made the relationship between impulsivity and suicidal behavior difficult to establish in a consistent manner. However, self-report measures, psychological autopsies, and more recently, laboratory-based measures have revealed impulsive behavior to be an important characteristic in the study of suicidal behavior.

Self-report measures such as the Barratt Impulsiveness Scale (BIS: Patton et al., 1995) and UPPS Impulsiveness Scale (UPPS-P: Whiteside & Lynam, 2001; Cyders et al., 2007) are used to study various dimensions of impulsivity from a trait perspective. The BIS assesses cognitive, motor, and non-planning impulsiveness. Brodsky et al. (2001) found that depressed patients recruited from a hospital setting who had previously experienced physical or sexual abuse as a child had significantly higher scores in the BIS and were more likely to have a previous suicide attempt than depressed individuals who had not experienced abuse as a child. Further, Zouk et al.'s (2006) review of 164 suicide cases found that suicide completers who had experienced child abuse had significantly higher BIS scores than completers who had not been abused as children. In addition, a study of 52 patients with bipolar disorder revealed significantly higher non-planning impulsiveness (i.e., careful thinking and planning of challenging mental tasks) BIS scores for previous attempters when compared to non-attempters. However, no differences were found between groups when the cognitive and motor impulsivity subscale scores were assessed (Michaelis et al., 2004). Interestingly, a study assessing 278 suicide attempts in a hospital setting found no differences in BIS scores between individuals who made impulsive attempts versus those who had pre-meditative attempts (Baca-Garcia, et al., 2004). The differential results from the studies discussed suggest that impulsivity may be better understood by an even more specific portrayal of how it relates to an individual's

behavior across a variety of situations.

Originally conceived in order to assess impulsivity across the Five-Factor Model of personality, the UPPS-P measures lack of premeditation (i.e., not thinking through the consequences of one's actions), lack of perseverance (i.e., not following through with a task), sensation seeking (i.e., the tendency to seek excitement), and urgency (i.e., the tendency to act rashly under conditions of negative or positive affect) (Whiteside & Lynam, 2001; Cyders et al., 2007). These 4 aspects of impulsivity are considered to be distinct traits that an individual may possess; an individual may have one or more of these traits, and each trait may be related to specific maladaptive cognitions and/or behaviors (Whiteside & Lynam, 2001). For example, Verdejo-Garcia et al. (2007) found negative urgency to have a greater association with substance dependence problems than other aspects of the UPPS-P, whereas the specific traits of sensation seeking and positive urgency predict higher alcohol consumption in first-year college students (Cyders et al., 2009). Lack of premeditation and negative urgency have been identified as potential risk factors for suicidal behavior. Yen et al.'s (2009) analysis of data from up to a 7-year follow up found that lack of premeditation prospectively predicted suicide attempts in a sample of 701 adults. However, the other three dimensions from the UPPS did not independently predict suicide attempts. Other recent research has established an association between negative urgency and suicidal behavior. As discussed earlier, Joiner's (2005) interpersonal theory of suicide suggests that the capability for suicide is partially a result of one's experience with repeated painful and provocative life events. High negative urgency has been associated with higher acquired capability for suicide and predicts the number of suicide attempts made by previous attempters (Anestis & Joiner, 2011). Further, repeated stressful painful and provocative life events have been found to mediate the relationship between negative urgency and the

acquired ability to engage in suicidal behavior (Bender et al., 2011). Indeed, multiple suicide attempters are more likely to report that they engage in reactive impulsive behaviors when experiencing distress than single-attempters and non-attempters (Miranda et al., 2013a). The association between negative urgency and other risk factors for suicidal behavior will be further discussed below.

Recent research has also utilized laboratory behavioral measures to objectively assess impulsivity. Such measures, unlike self-report assessments, are more sensitive to state-dependent changes in impulsivity (Dougherty et al., 2003). Paradigms most often used include rapid-decision tasks that assess reaction time to measure disinhibition, tasks that measure risky decision making, as well as tasks that measure an individual's ability to delay a response in order to receive a reward of greater value. Greater disinhibition has been associated with higher degrees of suicidality (Dougherty et al., 2004). Further, previous suicide attempters who report current suicidal ideation have been found to be more disinhibited on laboratory measures than non-ideating previous attempters and healthy controls (Westheide et al., 2008). Interestingly, performance on such behavioral tasks among adolescents who engage in non-suicidal self injury (NSSI) may be related to previous suicide attempt history. Janis & Nock (2009) reported high levels of self-reported impulsivity among adolescent self-injurers, compared to matched controls, but there were no differences in performance on laboratory-based measures of impulsivity that provided assessments of risky behavior, disinhibition, and delayed reward. By contrast, Dougherty et al.'s (2009) study of adolescent self-injurers found significant differences in behavioral impulsivity between self-injurers with a history of a suicide attempt versus those with no attempt history. Specifically, self-injurers with no attempt history had significantly higher ability to delay their responses to achieve a greater reward when compared to self injurers with a

history of a suicide attempt. Moreover, self-injurers with an attempt history self-reported greater levels of impulsivity than did non-attempters, but there were no differences between groups on measures of disinhibition. Taken together, these findings suggest that measures of risk for suicidal behavior should examine behavioral impulsivity. However, further research is needed to understand the specific types of self-reported trait impulsivity and the forms of behavioral impulsivity that best predict risk for suicide attempts.

### **Problem Solving and Suicidal Behavior**

Problem solving deficiencies have been regarded as an important component of theoretical models that seek to explain why an individual begins to think about suicide as an option. Assessment of problem solving skills has varied across investigations due to the different conceptualizations. Schotte and Clum's (1982) diathesis-stress-hopelessness model operationally defines poor problem solving skills as an individual's failure to generate solutions to interpersonal problems they encounter. The model proposes that when individuals encounter stressful events/problems, poor interpersonal problem-solving skills can cause increased feelings of hopelessness due to the inability to generate solutions to problems. Increased hopelessness, in turn, increases the likelihood of depression, and ultimately, suicidal behavior. One common way to assess interpersonal problem solving is through the Means-Ends Problem-Solving task (MEPS: Platt & Spivak, 1975). The MEPS task presents individuals with a series of situations in which a desired outcome to a problem is provided. The solutions people generate can be rated for the number of relevant and irrelevant means they provide (see Lyubomirsky & Nolen-Hoeksema, 1995), and also how active versus passive their solutions are (see, e.g., Linda et al., 2012). College students with high suicidal intent were found to have recently experienced a higher number of negative life events and to have poorer interpersonal problem solving skills

when compared to students with low or moderate suicidal intent (Schotte & Clum, 1982). Moreover, suicidal psychiatric patients were found to have experienced more negative life events in the year preceding inquiry, and also exhibited more deficits in interpersonal problem-solving, when compared to non-suicidal psychiatric patients (Schotte & Clum, 1987). Pollock & Williams (1998) found that individuals with current suicidal ideation exhibited more passive problem solving skills than did matched non-psychiatric controls.

The association between interpersonal problem solving skills and current suicidal ideation may also be reflective of an individual's suicide attempt history. Linda et al. (2012) examined interpersonal problem solving skills, negative life events, and current suicidal ideation among previous suicide attempters and non-attempters. In support of Schotte and Clum's model, previous attempters who exhibited high and average interpersonal problem solving skills had a weaker association between negative life stress and suicidal ideation than did those with low interpersonal problem solving skills. However, this relationship was not present among non-attempters. Interestingly, even having passive problem solving skills was beneficial to previous suicide attempters by buffering the positive association between life stress and suicidal ideation. Thus, problem-solving, even if passive, may protect individuals with a history of suicide attempts from experiencing suicidal ideation following stressful life events.

While there is evidence that a lack of interpersonal problem-solving skills, as measured by the MEPS, is associated with risk for suicidal behavior, there have been concerns about whether or not the MEPS exhibits construct validity (Butler & Meichenbaum, 1981). As such, problem-solving skills have also been assessed by an individual's perceived ability to solve problems. Similar to deficits with interpersonal problem solving, a person's lack of confidence in solving problems is associated with current suicidal ideation. Dixon et al. (1991) utilized the



Problem Solving Inventory (PSI; Heppner & Peterson, 1982) to assess problem-solving self-appraisal in two different samples of college students. The PSI conceptualizes problem-solving appraisal as having three components: confidence in problem solving, whether a person believes they have personal control when facing a problem, and whether or not a person approaches or avoids problems. Dixon et al.'s study revealed that college students who perceived themselves as poor problem solvers were more likely to experience feelings of hopelessness and to experience current suicidal ideation. Lack of confidence in problem solving accounted for most of the association between problem solving appraisal and hopelessness and ideation. Interestingly, perceived lack of problem solving skills and high levels of life stress were independent predictors of hopelessness and suicidal ideation. Rudd et al. (1996) expanded upon Dixon et al.'s findings by assessing a clinical sample that included 43 current suicide ideators and previous attempters. As expected, the association of perceived lack of problem solving skills, hopelessness, and suicidal ideation was much stronger in this sample. However, the cross sectional nature of these studies makes it difficult to assess the direction of the relationship between the variables. Nevertheless, the results do add another dimension of problem solving (perceived problem solving skills) that can be included in Schotte and Clum's diathesis-stress-hopelessness model.

Problem solving can also be assessed using laboratory-based measures of cognitive inflexibility. Cognitively flexibility involves the ability to switch thoughts or ideas in response to changes in environmental circumstances (Schotte & Clum, 1982). Studies evaluating the association between laboratory-based measures of cognitive inflexibility and suicidal behavior have yielded mixed outcomes. One measure of cognitive inflexibility is the Wisconsin Card Sorting Task (WCST; Heaton et al., 1993). The task tests abstract reasoning and the ability to

shift cognitive strategies when presented with changes in sorting rules. Perseverative errors occur when individuals continue to use an old sorting rule despite receiving feedback that their responses are incorrect. Clinical samples have shown both positive associations between cognitive inflexibility and suicidality (Marzuk et al., 2005, McGirr et al., 2012) and no relationship (Bartfai et al., 1990; Ellis et al., 1992; Keilp et al., 2012). However, these studies were limited by their cross-sectional nature. Miranda et al. (2012) demonstrated that cognitive inflexibility at baseline prospectively predicted suicidal ideation six months later in a college-student sample of suicide attempters but not among non-attempters. In a related study, Miranda et al. (2013) found that cognitive inflexibility at baseline predicted suicidal ideation 2-3 years later, even after adjusting for suicide attempt history at baseline, with brooding rumination – the tendency to repetitively dwell on one’s negative mood (Treynor et al., 2003) – mediating the relationship, and with hopelessness also mediating the relationship between brooding rumination and suicidal ideation. These findings lend support to Schotte and Clum’s model by revealing the relationship between the inability to generate solutions to a problem and suicidal ideation. In this case, the role of hopelessness was potentiated by its relation to brooding rumination. Cognitive inflexibility may lead to responses to stress that involve difficulty disengaging from negative moods, rather than attempting to generate solutions to problems. Rumination and its subtypes will be further discussed in the next section.

### **Rumination and Suicidal Behavior**

Rumination, defined as self-focused, perseverative thinking about one’s negative mood, as well as its causes and consequences, has been linked to suicidal ideation and behavior (Nolen-Hoeksema, 1991; Smith et al., 2006; Surrence et al., 2009). Rumination, as measured by the Ruminative Responses Scale (RRS: Nolen-Hoeksema, 1991), has been found to be associated

with the onset, duration and maintenance of depressive symptoms (Nolen-Hoeksema, 1991). Recent studies suggest that rumination can be adaptive or maladaptive, depending on the type of rumination in which a person engages and depending on other characteristics of individuals who ruminate. Treynor et al. (2003) assessed the association between rumination and depression in a community sample of 1,131 adults over two different time periods. The authors eliminated overlapping items from the RRS and the Beck Depression Inventory (BDI: Beck et al., 1961) in their analysis and defined two subscales of rumination. The first, termed brooding, was defined as a “passive comparison of one’s current situation with some unachieved standard” (Treynor et al., 2003, p.256). The second, termed reflective pondering (or reflection) was defined as “a purposeful turning inward to engage in cognitive problem solving to alleviate one’s depressive symptoms.” Items on the RRS that reflected brooding significantly predicted an increase of depression over the two time periods, while items measuring reflection were associated with decreases in depressive symptoms over time (Treynor et al., 2003). These findings suggested that brooding was maladaptive, while reflection was either benign or adaptive.

Given the association between depression and suicidal behavior, recent research on rumination has focused on its subtypes and potential association with different degrees of suicidality. Miranda & Nolen-Hoeksema (2007) found that both brooding and reflective rumination predicted future suicidal ideation. Brooding was a stronger predictor, but unlike Treynor et al.’s findings with depressive symptoms, reflection was also found to be associated with suicidal ideation over time. Brooding’s association with future ideation was partially mediated by depression at baseline and completely mediated by depression at follow-up. Reflective rumination’s association with future ideation was not mediated by depression scores. Thus, the maladaptive nature of reflective rumination found in this sample was a result

of a mechanism other than depression. Contrary to these findings, O'Connor & Noyce's (2008) three-month follow-up of a community sample of 232 adults found that brooding was a significant predictor of future suicidal ideation, but reflection was not. Reflection was, nonetheless, still associated with ideation at baseline.

The differential association between the subtypes of rumination and suicidal ideation was further established in a study assessing rumination, depressive symptoms and the impact of negative life events on current suicidal ideation in a sample of 1011 college students (Chan et al., 2009). As discussed earlier, the experience of negative life events has been associated with suicidal behavior. Cross sectional analysis yielded a stronger association between brooding and ideation than reflection and ideation. Further, brooding was found to partially mediate the relationship between negative life events and ideation. No such mediation was found between reflection and concurrent ideation.

Reflection's impact on ideation may be a result of whether or not an individual has previously attempted suicide. Surrence et al.'s (2009) study of a college student sample of 37 previous suicide attempters and 59 non-attempters revealed a significant interaction between reflection and previous attempts on current ideation, even after adjusting for levels of depression and hopelessness. No such interaction existed between brooding and previous attempts on current ideation. However, as noted earlier, the maladaptive nature of brooding was established in its mediation between cognitive inflexibility and ideation at a 2-3 year follow up after adjusting for suicide attempt history at baseline (Miranda et al., 2013). Interestingly, recent research has revealed that ruminative thought and negative urgency are associated with a specific brain area — the ventromedial prefrontal cortex (Wang et al., 2013; Cyders et al., in press). Future research should further examine the differential cognitive and behavioral

mechanisms through which brooding and reflection act upon different degrees of suicidality.

### **Disrupted Cognitive Processing and Suicidal Behavior**

Understanding how specific cognitive processes relate to suicidal behavior has been important in assessing future suicide risk. Previous suicide attempters may have biased information processing that can activate suicidal schemas. As defined earlier, schemas are cognitive structures that give meaning to internal or external stimuli (Bartlett, 1932). For example, a suicidal schema may involve feelings of hopelessness when a person is experiencing a stressful life event or when a depressed mood is present (Wenzel and Beck, 2008). Suicidal schemas are important to understand as they may trigger suicidal ideation and eventually a suicide attempt (Wenzell & Beck, 2008). Previous research has assessed such schemas by examining semantic interference from suicide-related cognitions via modified versions of the Stroop task (Stroop, 1935) and implicit cognitions via the Implicit Association Test (IAT; Greenwald et al., 2003). Both tasks are resistant to an individual attempting to falsify an outcome, which is important given the difficulty of observing thoughts related to suicide.

The Emotional Stroop Task (EST) is an objective measure of semantic interference from emotionally salient linguistic stimuli. Participants are presented with words one at a time and asked to name the color of the word. Words can be suicide-related, neutral, or negative in valence. Increased response latency to name the color of a word indicates greater interference from the meaning of the word. The EST was first employed to assess interference from suicide related words in a study that included 25 hospital patient suicide attempters, 25 patient non-attempters and 25 non-patient controls (Williams & Broadbent, 1986). All participants took longer to name general negative words than neutral words. However, the response latency for

previous suicide attempters was significantly longer for general negative words and suicide related words than both non-patient controls and non-attempters.

Becker et al. (1999) included positive words in the EST in their comparison of 31 previous suicide attempters and 31 non-attempters. Previous attempters showed a highly specific interference from suicide-related words when compared to the time taken to name neutral, positive, or negatively valenced words. Further, previous attempters that were currently ideating during the time of the task displayed the strongest interference from suicide-related words. Similarly, interference from suicide-related stimuli has been found to be strongest in individuals who had recently attempted suicide in a sample of 124 adults presenting to a psychiatric emergency department (Cha et al., 2010). In addition, interference from suicide-related words predicted suicide attempts in a 6-month follow up in this sample even after adjusting for history of a mood disorder, previous suicide attempts, and severity of suicidal thoughts. By contrast, interference from suicide-related words was not found in previous attempters compared to non-attempters in a recent study of 736 college students (Chung & Jeglic, 2015).

Implicit association tests (IATs) are reaction-time-based measures of automatic associations between concepts. The Self Injury IAT (SI-IAT; Nock & Banaji, 2007a) was specifically developed in effort to overcome the difficulty of observing self injurious thoughts that are often withheld in persons who have a history of self injury. Two different versions of the test were utilized to assess implicit thoughts in a sample of 89 adolescents (53 NSSI, 36 controls) (Nock & Banaji, 2007a). The first version of the SI-IAT assessed the association between self-injury and the individuals, themselves (Identity version). The second version assessed the association between self-injury and the individuals' own attitudes toward self injury (Attitude version). There were significant differences between both groups on both tests. Self injurers

were more likely to associate “cutting” with “me” than were controls. In addition, while both groups associated self-injury with negative attitudes, the association was significantly stronger in non-injurers. Further, both versions predicted previous NSSI history while adjusting for demographic and psychiatric factors. However, the Identity version was a stronger predictor.

These results were further expanded upon with an adolescent sample that included 38 non-suicidal controls, 37 current ideators, and 14 recent suicide attempters (Nock & Banaji, 2007b). The SI-IAT results revealed significant differences by degree of suicidality, such that non-suicidal participants exhibited a strong negative association between self injury and themselves, ideators showed a small positive association, and previous attempters exhibited a large positive association. The test also predicted current suicidal ideation, current suicide attempt status, and future suicidal ideation in a 6 month follow-up.

An IAT has also been developed to analyze the implicit association previous attempters have between life and death and suicide (Nock et al., 2010). Adult previous attempters ( $N = 157$ ) presenting to a psychiatric emergency department completed this version of the IAT that uses words related to “death”, “life”, “me”, and “not me”. Participants presenting to the emergency department because of an attempt held a significantly stronger association between themselves and death/suicide than did those presenting because of NSSI. Further, there was no significant difference found between NSSI participants and participants who did not engage in self-injury. Importantly, IAT results prospectively predicted future suicide attempts in a 6 month follow-up and were found to be a better predictor of future attempts than both clinician and patient predictions about whether the individual would make a future attempt.

The EST and the IAT have revealed that recent previous suicide attempters are more likely to have interference from suicide-related stimuli and to hold implicit associations between suicide and themselves. Moreover, both tasks prospectively predict future suicidal behavior. Understanding how disrupted information processing or implicit cognitions develop and potentially activate suicidal schemas is important, given the difficulty in assessing suicide risk. The strength of such cognitions is most likely related to an individual's history of suicidal behavior, which is ultimately related to how they mentally and behaviorally cope with distress. Future research is necessary in order to assess which cognitive and behavioral mechanisms might explain the relationship between disrupted information processing, implicit cognitions, and suicidal behavior.

## **Memory and Suicidal Behavior**

### **Overgeneral Autobiographical Memory and Suicidal Behavior**

Suicidal behavior has been previously associated with overgeneral autobiographical memory recall (Williams & Broadbent, 1986; Williams et al., 2001; Evans et al., 1992; Sidley et al., 1997; Williams, 2006). Autobiographical memories lie within long-term memory storage and consist of personal memories that are necessary to live everyday life in order to learn from experiences. The hierarchical model of “descriptions” describes autobiographical memory to have a hierarchy that consists of general memories at the “top” and more specific memories at the “bottom” (Norman & Bobrow, 1979). Normally, individuals are thought to retrieve memories first in a more general manner followed by remembering specific details of an event. Both individuals diagnosed with depression and those who have exhibited suicidal behavior have been shown to be less likely to generate specific memories when asked to recall an autobiographical memory (Williams & Broadbent, 1986; Williams & Scott, 1988; Williams et



al., 2001; Evans et al., 1992; Sidley et al., 1997; Williams, 2006). As discussed earlier, overgeneral memory affects the judgment of stress factors, escape potential, and social support in the Cry of Pain Model of suicide (Williams; 1997, 2001). Overgeneral memory has been associated with deficits in problem-solving, hopelessness, and may be likely to occur in the face of life stress or negative mood (Evans et al., 1992; Kaviani et al., 2011; Williams, 2006).

Williams and Broadbent (1986) examined autobiographical memory in 25 recent suicide attempters admitted to a hospital, 25 hospital controls, and 25 community controls. Autobiographical memory was assessed by presenting individuals with emotional cue words and having them respond with a specific memory after the presentation of each word. Previous attempters were significantly more likely to respond with general memories than the other 2 groups. Further, previous attempters were more likely to have delayed retrieval of positive memories as measured by latency to respond to a positively valenced word. There were no differences between groups in the latency to respond to negatively valenced words. These findings suggest that previous attempters have difficulty in producing specific memories. This overgeneral memory may result in poor problem solving skills due to an inability to recall memories that can be used to generate solutions to problems.

These findings were partially replicated in a sample of 12 previous attempters and 12 hospital controls (Evans et al., 1992). There were no differences between groups in latencies to respond to positive or negative words. However, previous suicide attempters were significantly more likely to produce overgeneral memories. The tendency to produce overgeneral memories was also associated with poor problem solving ability, such that the attempters who produced the more overgeneral memories were increasingly more likely to produce ineffective solutions to problems. In addition, currently depressed ideators have also been found to produce less specific

memories, exhibit poor problem solving skills and have increased feelings of hopelessness when compared to depressed non-ideators in a clinical sample of 44 participants (Kaviani et al., 2011).

Problem solving by its nature involves retrieval of memories to aid in the generation of problem-solving solutions. Thus, poor specific autobiographical memory retrieval may be a significant contributor to inadequate problem solving skills. As noted earlier, poor problem solving skills in the face of negative life stress may increase feelings of hopelessness that may exacerbate feelings of depression and/or thoughts of suicide. Indeed, overgeneral autobiographical memories have been found to moderate the relationship between the induction of a negative mood and subsequent worsening of problem solving in previous suicide attempters (Williams et al., 2000). Further, overgeneral memory has also been associated with the generation of non-specific imagined events that could happen in the future. Such general future thinking may result in feelings of hopelessness and may also be associated with ruminative thought patterns in persons suffering from depression (Williams et al., 1996; Watkins & Teasdale, 2001). Indeed, previous research has shown rumination to be a significant contributor to overgeneral memory (Williams, 2006; Sutherland & Bryant, 2007).

Importantly, mindfulness-based cognitive therapy (therapy that focuses on strengthening individuals' ability to live in the present moment without judging their current mental content) has been found to increase the retrieval of specific autobiographical memories in patients who have previously been diagnosed with depression (Williams et al., 2000). Future research should attempt to expand these findings in persons that have exhibited suicidal behavior. Further, longitudinal research can help explain when/or how people begin to produce general memories versus specific memories in the course of their lives. Early-life adversity has been associated with future overgeneral memory. However, possible neurobiological or cognitive mediators have

yet to be fully examined and should be studied in populations vulnerable to suicidal behavior, e.g., young adults (Henderson et al., 2002, Williams et al., 2006).

### **Working Memory and Suicidal Behavior**

Working memory is an executive function that refers to memory that contains information that is currently being used and is immediately available to an individual (Baddeley & Hitch, 1974). An oft-cited example of working memory is when an individual is given a phone number to call, and the number is considered to be in working memory as the person dials the number. However, unless rehearsal of the numbers occurs, the numbers will not be transferred and stored into long-term memory. Brain imaging has revealed that working memory is primarily functionally located in the prefrontal cortex (Owen, 1997).

As reviewed earlier, the stress response includes an influx of stress hormones that promote adaptation in a process called allostasis (McEwen, 1998). Repeated exposure to stress can lead to allostatic load characterized by a dysregulated stress response that can harm certain brain regions (de Kloet et al., 2005). Animal models of chronic stress have revealed decreased synaptic density and dendritic spine loss in the prefrontal cortex. Such atrophy caused by stress is associated with deficits in executive functioning (see McEwen, 2012 for a review). Further, both acute and chronic stress have been shown to impair working memory in humans (Luethi et al., 2008; Evans & Schamberg, 2009). Importantly, deficits in working memory have been found in persons with a history of suicidal behavior (Keilp et al., 2001; Keilp et al., 2012).

Keilp et al. (2001) compared executive functioning between 50 unmedicated depressed adult patients (21 with no suicide attempt history, 12 low-lethality attempters, and 15 high lethality attempters) and 22 adult nonpatient controls. High-lethal attempts were differentiated

from low-lethal attempts as an attempt that involved, “at minimum, coma and intensive care” (p. 736). High-lethality attempters performed significantly worse in a measure of working memory than did the other groups. No significant differences were found in working memory between the low-lethality, depressed nonattempters, and nonpatient groups. The authors suggested that the working memory deficits found in the high-lethality attempters were most likely not due to brain injury caused by the suicide attempt itself; high-lethality attempters performed similarly to other subjects in tests that are usually sensitive to potential brain damage that can be a result of an attempt-induced coma (Spreen, 1998; Lezak, 1998). Non-depressed individuals with a history of suicidal behavior have also been shown to perform poorly on working memory tasks. However, a study comparing 30 previous suicide attempters and 39 controls found that this deficit was more associated with motor impulsivity than with attempt history in a sample comparing 30 previous attempters and 39 control subjects (Raust et al., 2006). More recently, a study of 72 previous suicide attempters and 80 non-attempters found that previous suicide attempters again showed deficits in working memory, but no significant differences were found between high-lethality and low-lethality attempters. Additionally, current suicidal ideation was not associated with working memory deficits in previous attempters (Keilp et al., 2012).

Further studies are needed to appropriately assess the association between deficits in working memory and suicidality. No research to date has examined whether or not there are differences in working memory between suicide ideators, single attempters, and multiple attempters. Moreover, young adults – a group that may be more susceptible to the effects of stress on a still developing prefrontal cortex (Lupien et al., 2009) – should be assessed with respect to associations between working memory and degree of suicidality. Finally, given the importance of working memory in the process of encoding long-term memory, future studies

should examine the potential association between working memory deficits and the overgeneral memory that has been found in previous suicide attempters.

### **Specific Aims Overview**

The research discussed below sought to understand the relationship between the various cognitive, behavioral, and biological vulnerabilities associated with stress and suicidal behavior. Part one of the first study assessed the relationship between rumination and impulsivity. Part two of the first study assessed the relationship between rumination, impulsivity, and suicide risk. These studies sought to differentiate the subtypes of rumination with respect to a known risk factor for suicidal behavior—impulsivity (Figure 1). Whether impulsivity is associated with physiological stress hyperactivity, and stressful life events was examined in the second study, along with whether such stress hyperactivity and cognitive risk factors would explain the relationship between life stress and semantic interference from suicide-related words (Figure 2). The third study sought to examine whether early life stress would be associated with brooding, negative urgency (a dimension of impulsivity) and suicidal behavior, and also whether the relationship between early life stress and negative urgency would be mediated by overgeneral autobiographical memory and brooding. Finally, this study examined whether early life stress would interact with 5-HTTLPR genotype to predict brooding and negative urgency (Figure 3). The three studies examined various components of a holistic model (Figure 4), which hypothesizes that stress (distal or proximal life events) predicts physiological stress hyperactivity and subsequent cognitive and behavioral deficits (problem-solving deficits, disrupted cognitive processing, impulsivity) that increase risk for suicidal behavior. The model further posits that these relationships are moderated by 5-HTTLPR genotype, such that they are stronger for low expressing 5-HTTLPR genotype than for high expressing 5-HTTLPR genotype. It is our hope

that by integrating cognitive, behavioral, and biological perspectives, we will gain a greater understanding of the complex nature of risk factors that contribute to suicidal behavior. Such understanding can aid in the development of targeted approaches to suicide prevention.

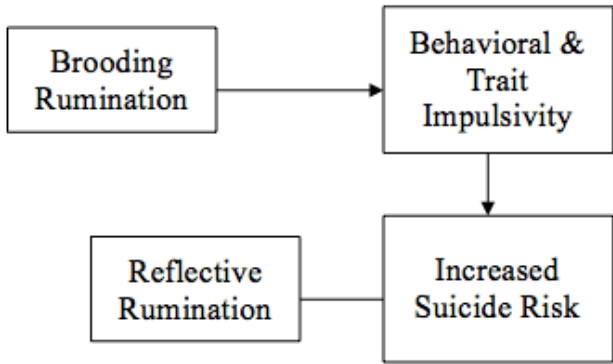


Figure 1. Study 1 Description: We hypothesized that brooding would be a more maladaptive form of rumination than reflection and that brooding would predict behavioral and trait impulsivity. Further, we expected that the relationship between brooding and increased suicide risk would be mediated by impulsivity, and this relationship would be moderated by reflection.

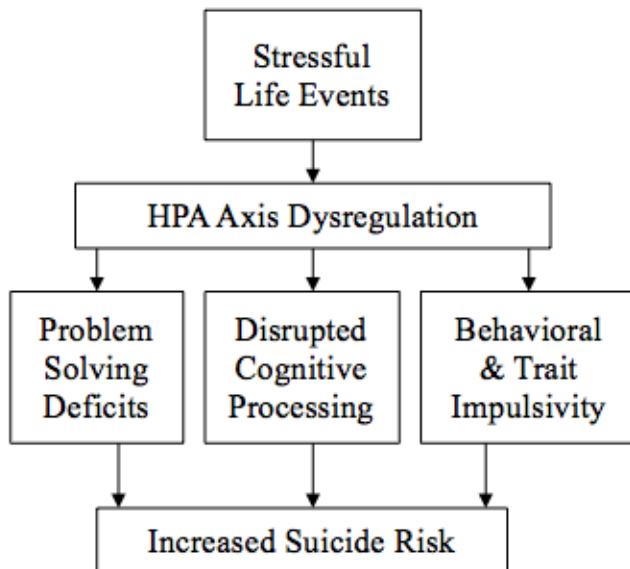


Figure 2. Study 2 Description: We hypothesized that stressful life events would predict HPA Axis hyperactivity. Further, we expected that this overly active stress response would be positively related to poor problem solving, impulsivity, disrupted cognitive processing, and previous suicide attempt history.

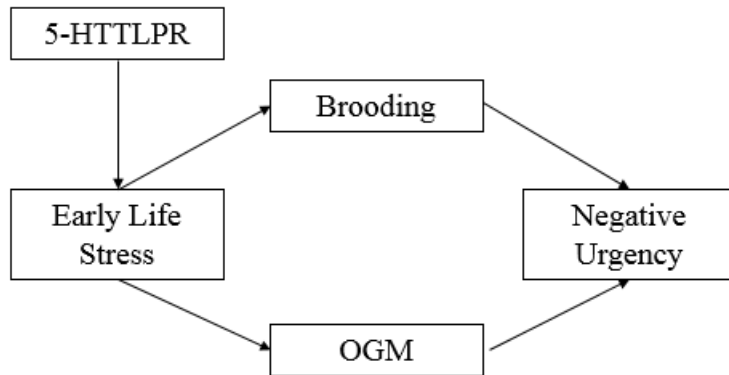


Figure 3. Study 3 Description: We hypothesized that early life stress would predict brooding, negative urgency, and overgeneral autobiographical memory (OGM), that brooding and OGM would mediate the relationship between early life stress and negative urgency, and that these relationships would be moderated by 5-HTTLPR genotypes. We also examined whether these variables would be associated with suicidal ideation (not shown here).

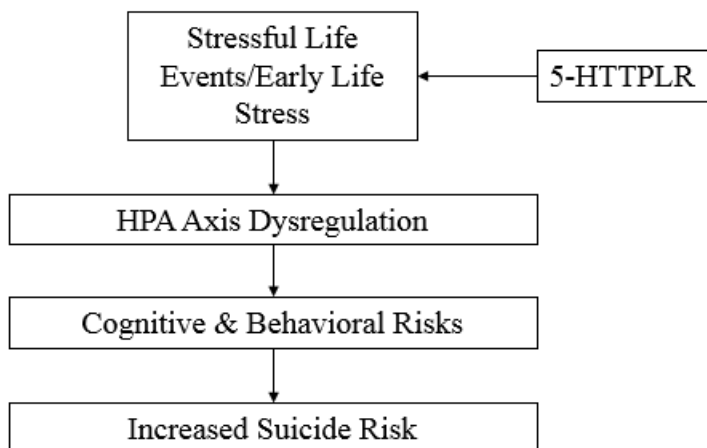


Figure 4. Model examined in the present research. Study 1 examined the relationship between ruminative subtypes, impulsivity, and suicide risk. Study 2 examined the relationship between stressful life events, HPA Axis Dysregulation, maladaptive cognitions and behaviors (problem solving deficits, impulsivity) and previous suicide attempt history. Study 3 examined the moderating role of HTTPLR genotypes in the relationship between early life stress, cognitive/behavioral responses (i.e., overgeneral autobiographical memory, rumination, impulsivity), and increased risk for suicidal behavior.



Running head: Rumination, Impulsivity, and Suicide Risk

(in press), *Psychiatry Research*

### **Ruminative Subtypes and Impulsivity in Risk for Suicidal Behavior**

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## Abstract

Rumination has been previously linked to negative psychological outcomes, including depression and suicidal behavior. However, there has been conflicting research on whether or not two different subtypes of rumination – brooding and reflection – are more or less maladaptive. The present research sought to (1) examine whether individuals high in brooding but lower in reflection would show higher trait and behavioral impulsivity, relative to individuals low in brooding and low in reflection; and (2) examine impulsivity as a mediator of the relation between ruminative subtypes and suicidal ideation. In Study 1, participants ( $N = 78$ ) were recruited based on high, average, and low scores on a measure of brooding and reflective rumination. Individuals who scored high in brooding and average in reflection scored significantly higher in negative urgency, that is, in the tendency to act rashly in an attempt to reduce negative affect, than did those who scored low in brooding and low in reflection. Study 2 ( $N = 1638$ ) examined the relationship between ruminative subtypes, impulsivity, and suicide risk. We found an indirect relationship between brooding and suicide risk through lack of premeditation and lack of perseverance, independently of reflection. These findings are discussed in relation to cognitive risk for suicide.

Keywords: rumination; negative urgency; suicidal ideation

## 1. Introduction

Rumination is a form of perseverative thinking involving continual thoughts about the causes, meaning and consequences of one's negative mood (Nolen Hoeksema et al., 2008). Rumination has been linked with the onset and maintenance of depressive symptoms and also with suicidal ideation over time (Treynor et al., 2003; Miranda and Nolen-Hoeksema, 2007; Nolen-Hoeksema et al., 2008; Miranda et al., 2013). Furthermore, rumination is associated with other cognitive correlates of depression and suicidal behavior, such as impaired social problem solving (Lyubomirsky and Nolen-Hoeksema, 1995), overgeneral autobiographical memory (Williams, 2006), and impulsivity (Denson et al., 2011). Although originally considered maladaptive (Nolen-Hoeksema, 1991), recent studies suggest that how maladaptive rumination is depends on the type of rumination in which a person engages and on other individual characteristics (e.g., previous suicide attempt history) (Surrence et al., 2009). The present research sought to better understand the circumstances under which rumination is most maladaptive by examining whether two ruminative subtypes differentially relate to impulsivity and whether such links relate to risk for suicidal behavior.

Research conducted in the past decade has attempted to subtype rumination into more and less maladaptive forms of perseverative thinking, with two types identified. One is brooding, which involves dwelling on the reasons for one's negative mood. Brooding has been found to be associated with increases in depressive symptoms (Treynor et al., 2003) and suicidal ideation over time (Miranda and Nolen-Hoeksema, 2007; Miranda et al., 2013). On the other hand, reflection involves trying to understand the reasons for one's negative mood and is associated with decreases in depressive symptoms (Treynor et al., 2003) but with increased risk of suicidal ideation over time (Miranda and Nolen-Hoeksema, 2007). While the relationship

between brooding and suicidal ideation has been found to be mediated by depressive symptoms, the relation between reflection and suicidal ideation seems to be independent of depression (Miranda and Nolen-Hoeksema, 2007). In contrast, a 3-month follow-up study of a community sample of 232 adults found that brooding was a significant predictor of future suicidal ideation, but reflection was not, adjusting for depressive symptoms (O'Connor and Noyce, 2008). Thus, while brooding has consistently been found to be maladaptive, there is inconsistent evidence on whether reflection is adaptive or maladaptive.

Whether or not reflection is more or less maladaptive (or adaptive) may depend partly on the characteristics of people who ruminate. One study found a positive relation between reflection and depressive symptoms among individuals low in active coping but not among those high in active coping (Marroquín et al., 2010). Another study found a positive relation between reflection and suicidal ideation among individuals with a suicide attempt history but not among individuals without a suicide attempt history (Surrence et al., 2009). Understanding the psychological correlates of brooding and reflection may shed light on this question. For instance, previous research suggests that impulsivity may exacerbate the deleterious nature of rumination (Dvorak et al., 2011). The present research seeks to build upon such previous work by examining the association between subtypes of rumination, impulsivity, and risk for suicidal behavior.

Impulsivity has been conceptualized as a trait involving 4 dimensions: lack of premeditation (i.e., not thinking through the consequences of one's actions), lack of perseverance (i.e., not following through with a task), sensation seeking (i.e., the tendency to seek excitement), and negative urgency (i.e., the tendency to act rashly when experiencing negative affect) (Whiteside and Lynam, 2001; Cyders et al., 2007). Both lack of premeditation and negative

urgency have been identified as potential risk factors for suicidal behavior (Yen et al., 2009; Anestis and Joiner, 2011; Klonsky and May, 2010; Bender et al., 2011; Miranda et al., 2013). Studies examining impulsivity among separate samples of high school and college students found that whereas suicide ideators and attempters had higher negative urgency scores than did non-ideators/non-attempters, suicide attempters had higher lack of premeditation scores than did both ideators and non-ideators/non-attempters (Klonsky and May, 2010, Studies 2 and 3). Such findings suggest that negative urgency may be associated with having thoughts about suicide, while lack of pre-meditation may be associated with actually engaging in suicidal behavior.

Impulsivity has also been conceptualized as a behavioral response. Dougherty and colleagues have operationalized behavioral impulsivity as involving disinhibited responding (i.e., difficulty inhibiting an already initiated response) and lack of sensitivity to consequences (i.e., inability to delay rewards) as measured by computer-based tasks (Dougherty et al., 2004). Both types of behavioral impulsivity have been associated with suicidal behavior (Dougherty et al., 2004; Westheide et al., 2008; Dougherty et al., 2009). For instance, a study of adolescents who had a history of both non-suicidal self-injury (NSSI) and a suicide attempt scored higher on a laboratory measure of behavioral impulsivity involving consequence insensitivity (i.e., a preference for an immediate, smaller reward over a delayed larger reward), compared to adolescents who had a history of NSSI without a suicide attempt history. Another study revealed that individuals with a previous suicide attempt history who reported current suicidal ideation had more disinhibited responses on laboratory measures compared to individuals with a previous suicide attempt history but no current suicidal ideation and also compared to healthy controls (Westheide et al., 2008). However, a recent meta-analysis (Hamza et al., 2015) found that laboratory measures of impulsivity are not consistently related to self-harm. Rather, individuals

that engage in NSSI are more likely to self-report impulsivity, and specifically have high negative urgency scores. These results are consistent with research showing that different measures of impulsivity are likely assessing different characteristics of the trait and behavior (Dick et al., 2010; Cyders & Coskunpinar, 2011). Bagge et al. (2013) found that of four different computer-based measures of impulsivity, only the Go-Stop Impulsivity task (Dougherty et al., 2004), which measures disinhibited responding, was related to negative urgency in a community sample of adults. However, there was no overlap between the results of the Go-Stop task and lack of premeditation, lack of perseverance, and sensation seeking.

Previous research has linked general rumination and different dimensions of impulsivity with negative psychological outcomes. One study found that a negative mood induction resulted in a greater negative emotional response among individuals who exhibited both high trait impulsivity and high rumination than among those who exhibited low trait impulsivity and low rumination (Herrera and McChargue, 2011). Selby et al., (2008) found a positive association between rumination and negative urgency and have proposed the Emotional Cascade Model to explain this relationship. The model proposes that experiencing both rumination and negative emotions produces synergistic effects on subsequent ruminative thoughts and negative emotions. This positive feedback loop, in turn, leads to dysregulated behaviors, such as acting in a rash manner when experiencing negative emotions (i.e., negative urgency). Indeed, the combination of rumination and negative emotions have been found to predict subsequent increases in rumination, negative emotions, and number of impulsive behaviors over a two week period in a sample of impulsive adults (Selby et al., 2015). Alternatively, other research suggests that rumination may lead to increased behavioral dysregulation through the reductions in executive control that characterize impulsivity. In attempting to explain the relationship between anger

rumination and aggression, Denson et al. (2011) suggested that the self-regulatory efforts required by rumination deplete a person's self-control and thus increase the likelihood of behavioral dysregulation in the form of aggression. A series of 4 studies examining this possibility found that after an anger-inducing provocation, anger rumination did, in fact, increase aggression through reductions in self-control (Denson et al., 2011). Such findings suggest that rumination may not only act in combination with impulsivity to increase dysregulated behaviors, but that rumination may also increase such behaviors through the reductions in self-control that characterize impulsivity. When applied to suicide, perhaps one avenue through which rumination increases risk for suicidal behavior is by increasing impulsivity, as a result of depletions in cognitive resources.

At the same time, past research does not explain whether the rumination-impulsivity relationship may vary by ruminative subtype, and whether these relationships have different consequences for suicide risk. If reflection is more adaptive than brooding, we should expect that the presence of reflection should mitigate the impact of brooding on impulsivity and on the impulsivity-suicide risk relationship. Thus, we sought to examine, via two studies, whether level of brooding in relation to reflection would be differentially related to behavioral and trait measures of impulsivity and whether impulsivity would statistically mediate the relation between ruminative subtypes and risk for suicidal behavior. Study 1 involved four groups of young adults pre-selected based on their level of brooding and reflection. We hypothesized that an overreliance on brooding (i.e., high levels of brooding without correspondingly high levels of reflection) as a response style would be most strongly associated with impulsivity, such that individuals high in brooding—but not in reflection—would exhibit higher impulsivity than would individuals high in reflection, individuals high in both brooding and reflection, and also

compared to individuals low in both brooding and reflection. Study 2 involved a larger sample of individuals who completed self-report measures of rumination, impulsivity, and risk for suicidal behavior. We expected that an overreliance on brooding would be most strongly related to impulsivity and to risk for suicidal behavior and that impulsivity would explain the relation between brooding and risk for suicidal behavior. We also sought to determine whether reflection would attenuate the indirect relationship between brooding and risk for suicidal behavior through impulsivity.

## **2. Method (Study 1)**

### **2.1 Participants**

Seventy-eight young adults (43 females), aged 18-24 ( $M = 18.5$ ,  $SD = 1.2$ ) recruited from a public university campus in New York City took part in this study for monetary compensation (\$25). The racial/ethnic composition of the sample was 33% Asian, 19% Hispanic, 19% White, 9% Black, and 20% of other ethnicities (approximately representative of the campus from which participants were recruited). Participants were recruited from a larger sample of 2423 individuals who took part in a study of cognitive risk factors associated with suicidal ideation and attempts.

### **2.2 Procedure**

Individuals were selected based on their scores on the Ruminative Responses Scale (RRS) (see below) administered in the screened sample. An analysis of 1124 (from the sample of 2423 individuals) participants who had completed the RRS yielded the mean brooding and reflection scores that determined high and low values. High brooding scores were those greater than 14 (1 SD above the mean) and low brooding scores were those lower than 9 (1 SD below the mean). High reflection scores were those above 13 (1 SD above the mean) and low reflection



scores were those below 8 (1 SD below the mean). Participants who scored high, average, or low on brooding and/or reflection alone or high/low on both brooding and reflection, and who gave their permission to be contacted for future studies, were recruited in person or via email after their participation in the initial study. The scores in our sample resulted in four different groups: low brooding/low reflection ( $n = 20$ ), high brooding/high reflection ( $n = 18$ ), high brooding/average reflection ( $n = 19$ ), and high reflection/average brooding ( $n = 21$ ). Initially, we intended to recruit a “high brooding” group consisting of individuals high in brooding and low in reflection, in addition to a “high reflection” group consisting of individuals high in reflection and low in brooding. However, there were insufficient numbers of individuals who met those criteria, and thus, the groups were modified to include high brooding/average reflection and high reflection/average brooding, respectively.

Participants completed two assessments – the initial screening and another study session within about 2 weeks of the screening, in which participants completed the RRS again, along with measures of behavioral and trait impulsivity. Baseline rumination scores were used to create groupings.

## **2.3. Measures**

**2.3.1. Rumination.** Rumination was assessed via the brooding and reflection subscales of the Ruminative Responses Scale (RRS; Nolen-Hoeksema, Larson, and Grayson, 1999). The brooding subscale, consisting of 5 items (Cronbach’s  $\alpha = .80$  in the present sample), assesses the tendency to focus passively on the reasons for a person’s distress, while reflection, consisting of 5 items (Cronbach’s  $\alpha = .79$  in the present sample), assesses the tendency to engage in cognitive problem-solving to improve one’s mood (Nolen-Hoeksema et al., 1999; Treynor et al.,

2003). The RRS was used to pre-select participants and classify them based on levels of brooding and reflection, as described above, and was also re-administered at the time of the study. The test-retest reliability of RRS scores for the current study was .78 for brooding and .66 for reflection.

**2.3.2. Trait Impulsivity.** Trait impulsivity was assessed via the UPPS Impulsive Behavior Scale-Short Form (UPPS-P SF) (Whiteside and Lynam, 2001; Cyders et al., 2007). The UPPS-P SF is a 31-item scale that assesses impulsivity across four different dimensions (as discussed above): sensation seeking, lack of perseverance, lack of premeditation, and negative urgency. Participants are asked to rate how much they agree with each of the 31 items (1 = Agree Strongly, 4 = Disagree strongly). The UPPS-P SF has been correlated with other measures of clinical symptoms and measures that predict risky behavior (Cyders et al., 2009; Anestis et al., 2011) and has been shown to be internally consistent (Whiteside et al., 2005). Cronbach's alphas in the present sample were .78, .60, .74, and .70 for lack of premeditation, negative urgency, sensation seeking, and lack of perseverance, respectively.

**2.3.3 Behavioral Impulsivity.** Behavioral impulsivity was assessed using the Two-Choice Impulsivity Paradigm (TCIP; Dougherty et al., 2004) and the Go-Stop Impulsivity Paradigm (GSIP; Dougherty et al., 2004). The TCIP assesses the degree to which individuals are able to tolerate delayed rewards. Participants are asked to click a button on one or the other side of a computer screen. One side is associated with a smaller reward after a brief delay, while the other is associated with a larger reward after a longer delay. Scores show the percentage of times a participant selects an immediate choice versus a delayed choice. A higher percentage of immediate choices indicates a lower tolerance for delayed awards. The TCIP has been validated in a sample of adolescents (Bjork et al., 2000).

The GSIP assesses an individual's ability to inhibit an already initiated behavior. Participants are presented with a series of 5-digit numbers and asked to respond when a "go" signal appears and to not respond when a "stop" signal appears. Disinhibition is conceptualized as difficulty inhibiting a response that has already been initiated (e.g., if presented with a series of "go" trials and then followed by a "stop" trial). The timing of the appearance of the "stop" signal varies and can occur 50, 150, 250, or 350-milliseconds following the "go" stimulus onset. Disinhibited responses are most likely to occur after the 350-millisecond "stop" signal, as participants are less likely to inhibit a response that has been initiated in the quicker "stop" signal trials (Dougherty et al., 2003). Disinhibition scores (the percentage of disinhibited responses out of total responses) found in the 50, 150, and 250 millisecond trials indicate difficulty in inhibiting an already initiated response. The GSIP is significantly correlated with other tasks that measure response inhibition (Marsh et al., 2002).

### **3. Results and Discussion**

#### **3.1. Relationship between Ruminative Subtypes and Trait Impulsivity**

One-way ANOVAs were conducted to examine differences across the 4 ruminative subtype groups in trait impulsivity (UPPS) scores. There was a statistically significant effect of group on the negative urgency dimension of the UPPS,  $F(3, 74) = 3.67, p < .05$ . Bonferroni-corrected comparisons revealed that the high brooding/average reflection group (i.e., overreliance on brooding relative to reflection) had significantly higher negative urgency scores than did the low brooding/low reflection group,  $t(74) = 2.76, p < .05$ . However, there were no significant differences in the other UPPS dimensions by rumination group (see Table 1).

#### **3.2. Rumination and Behavioral Measures of Impulsivity**

A one-way ANOVA did not reveal a significant difference among the four rumination groups (low brooding/low reflection, high brooding/high reflection, high brooding/average reflection, high reflection/average brooding) in number of immediate and/or delayed choices made on the TCIP,  $F(3, 74) = 1.82, p = .15$ , nor were there any differences among groups in the number of disinhibited responses across the different intervals of stop signals in the go-stop task (see Table 1).

Findings from Study 1 suggest differential relationships between subtypes of rumination and one particular dimension of trait impulsivity: negative urgency. Individuals who scored high in brooding and had average reflection scores had significantly higher negative urgency scores than did those who scored low in brooding and low in reflection. However, there were no significant differences in behavioral measures of impulsivity. Study 2 sought to 1) replicate the finding of a relationship between an overreliance on brooding and negative urgency from Study 1 with a larger sample; 2) examine whether brooding and trait impulsivity would be associated with a measure of suicide risk; and 3) examine whether trait impulsivity – specifically, negative urgency and lack of premeditation (given Study 1 findings and previous research; Yen et al., 2009; Klonsky and May, 2010) – would statistically mediate the relationship between brooding and risk for suicidal behavior and whether this indirect relationship would be moderated by reflection.

## **1. Method (Study 2)**

### **4.1 Participants**

Participants were sixteen hundred and thirty-eight adults (1169 females), aged 18-61 ( $M = 20.5, SD = 4.0$ ) recruited from a different public university campus in New York City and who

took part in the study for research credit in introductory psychology courses. The racial/ethnic composition of the sample was 46% Hispanic, 21% White, 17% Black, 11% Asian, and 5% of other ethnicities (approximately representative of the campus from which the sample was recruited).

## **4.2 Procedure**

Participants were selected from a larger sample of 1900 individuals who took part in an online survey examining risk factors associated with suicidal ideation and behavior. Individuals were selected based on whether they completed the RRS. There were no gender or racial/ethnic differences for those who did and did not complete the RRS.

## **4.3 Measures**

The UPPS-P SF (Cronbach's alphas in the present sample: .84, .76, .77, and .79 for lack of premeditation, urgency, sensation seeking, and lack of perseverance, respectively) and RRS (Cronbach's alphas for brooding and reflection in the present sample: .85 and .78, respectively) were used to assess trait impulsivity and rumination, respectively. Descriptions of these measures can be found in the Measures section of Study 1. *Suicide risk* was assessed via the Suicidal Behaviors Questionnaire-Revised (SBQ-R) (Osman et al., 2001). The SBQ-R is a 4-item questionnaire that assesses risk for future suicidal behavior, based on whether an individual endorses a lifetime history of suicidal ideation or a suicide attempt, self-reported frequency of suicidal ideation in the previous 12 months, whether the individual has ever threatened to attempt suicide, and the person's self-reported likelihood of making a suicide attempt in the future. Total scores range from 3 to 18. The questionnaire has been found to have good internal consistency reliability in an undergraduate sample and has been validated with other measures of suicide risk

(Osman et al., 2001). Cronbach's alpha in the present study was .81, and total scores ranged from 3 to 16, with an average of 4.23 ( $SD = 2.26$ ).

## **5. Results and Discussion**

### **5.1 Correlations among Study Measures**

Given that participants in Study 2 were not pre-selected based on rumination scores, variables were examined as continuous scores rather than via group differences. Pearson correlations were conducted to assess relationships between ruminative subtypes, trait impulsivity (UPPS-P SF), and risk for suicidal behavior (SBQ). Brooding was positively associated with the negative urgency, lack of premeditation, and lack of perseverance dimensions of the UPPS-P SF. Reflection was positively associated with negative urgency. Both brooding and reflection were positively associated with total SBQ scores. In addition, negative urgency, lack of premeditation, and lack of perseverance were positively associated with suicide risk (see Table 2).

### **5.2. Examining Impulsivity as a Mediator of the Relationship between Brooding and Risk for Suicidal Behavior and Reflection as a Moderator**

Analyses were conducted to examine whether impulsivity mediated the relationship between brooding and risk for suicidal behavior and whether this relationship was moderated by reflection. We hypothesized that the relationship between brooding and risk for suicidal behavior would be mediated by impulsivity (particularly negative urgency and lack of premeditation), but that this indirect relationship would be attenuated at higher levels of reflection. Mediation may be tested when a predictor (brooding) relates to a mediator (impulsivity) and the mediator (impulsivity) relates to an outcome variable (suicide risk). A

relation between the predictor (brooding) and outcome (suicide risk) may or may not be present (Mackinnon et al., 2002). We examined whether the relationship between brooding and suicide risk was mediated by the four dimensions of the UPPS-P SF and whether this indirect relationship was moderated by reflection (Figure 1). Moderated mediation conditional direct effects were estimated using model 8 of the PROCESS procedure (Hayes, 2013), and conditional indirect effects were tested using bias-corrected 95% confidence intervals calculated using a bootstrapping procedure (with  $n = 1000$  resamples). Conditional indirect effects were considered statistically significant when their confidence intervals did not include zero. The following indirect effects were tested: (1) the indirect effect of brooding on suicide risk through negative urgency; (2) the indirect effect of brooding on suicide risk through sensation seeking; (3) the indirect effect of brooding on suicide risk through lack of premeditation; (4) the indirect effect of brooding on suicide risk through lack of perseverance (see Figure 1). There was an indirect effect of brooding (95% CI = 0.01 – 0.02) on suicide risk through lack of perseverance (standardized indirect effect = 0.31), along with an indirect effect of brooding (95% CI = 0.01 – 0.02) on suicide risk through lack of premeditation (standardized indirect effect = 0.33). No indirect effects were found through negative urgency (95% CI = -0.01 – 0.01) nor sensation seeking (95% CI = -0.01 – 0.01).

We then examined whether reflection would moderate the mediating effect of lack of perseverance and lack of premeditation on the relation between brooding and suicide risk. First, we examined the indirect effect of lack of premeditation on the relation between brooding and suicide risk at low (1 *SD* below the mean), average, and high (1 *SD* above the mean) levels of reflection. We found a statistically significant indirect effect of brooding on suicide risk—through lack of premeditation at low, 95% CI [0.01, 0.03]; average, 95% CI [0.01, 0.02]; and

high levels of reflection, 95% CI [0.01, 0.01]. Second, we examined the indirect effect of lack of perseverance on the relation between brooding and suicide risk at low (1 *SD* below the mean), average, and high (1 *SD* above the mean) levels of reflection. We found a statistically significant indirect effect of brooding on suicide risk—through lack of perseverance at low, 95% CI [0.01, 0.03]; average, 95% CI [0.01, 0.02]; and high levels of reflection, 95% CI [0.01, 0.02]. Thus, reflection did not appear to moderate the indirect relation between brooding and suicide risk through lack of premeditation or perseverance. It should be noted that the interaction between brooding and reflection was not significant as a statistical predictor of suicide risk ( $b = .003$ ,  $p = .38$ ), such that brooding predicted risk for suicidal behavior, regardless of reflection level.

Finally, we tested whether reflection predicted suicide risk at different levels of brooding. No conditional direct effects were found between reflection and suicide risk at low, average, and high brooding scores.

Our results provide further evidence of the maladaptive nature of brooding rumination. Brooding was associated with risk for suicidal behavior at low, average, and high reflection levels. However, contrary to our hypotheses, negative urgency did not mediate the relationship between brooding and suicide risk. The relationship between brooding and suicide risk was mediated by lack of premeditation (consistent with hypotheses) and lack of perseverance. Reflection did not statistically predict suicide risk independently of brooding.

## **6. General Discussion**

Previous research has suggested that whether rumination is maladaptive depends on the type of rumination in which a person engages (e.g., Surrence et al., 2009). The present studies sought to examine how brooding and reflective rumination differed in their relationship to (trait



and behavioral) impulsivity and risk for suicidal behavior. Our first study revealed that individuals who scored high in brooding and had average reflection scores (i.e., “high brooders”) had significantly higher negative urgency scores than did those who scored low in brooding and low in reflection. Importantly, both brooding and negative urgency have been previously linked to mood disorders, deficits in emotional regulation, and suicidal behavior (Treyner et al., 2003; Anestis and Joiner, 2011; Miranda et al., 2013). However, we found no differences between an overreliance on brooding, relative to low levels of brooding and reflection, and computer-based measures of impulsivity. These results are consistent with findings that show computer-based measures and self-report measures tap into different facets of impulsivity (Cyders & Coskunpinar, 2011). Indeed, self-report measures of impulsivity are more likely to differentiate individuals at risk for self-injurious behavior than computer-based measures (Hamza et al., 2015).

Results from our second study revealed that brooding statistically predicted risk for suicidal behavior regardless of reflection levels, and this relationship was mediated by lack of premeditation and lack of perseverance. In contrast, reflection did not predict risk for suicidal behavior, when adjusting for brooding. The present studies are the first to establish a relationship between brooding, specifically, and trait impulsivity in the forms of negative urgency, lack of premeditation, and lack of perseverance.

While the present data are cross-sectional, thus limiting conclusions about directionality, they do lead to speculation about the direction of the relation between brooding and impulsivity. One possibility is that brooding – by preventing disengagement from a negative mood and depleting cognitive resources – leads individuals to respond rashly to negative affect, fail to consider the consequences of their actions, and fail to follow through with their actions in the

face of obstacles. That is, brooding may prevent people from thinking about ways they can solve their problems, making them more vulnerable to perform actions without thinking during times of distress. Accordingly, reflection may either be benign or lead people to think about ways they can alleviate their distress. Indeed, rumination without negative emotion has been suggested to represent reflection and is less likely to predict subsequent impulsive behaviors than when both rumination and negative emotion are present (Selby et al., 2015). Reflection may potentially short circuit this emotional cascade and prevent dysregulated behaviors. At the same time, while the present findings suggest that brooding combined with average levels of reflection is associated with higher negative urgency than low levels of both brooding and reflection, whereas high brooding combined with high reflection is not, negative urgency does not explain the relationship between brooding and risk for suicidal behavior.

Future studies should examine potential mediators of the relation between brooding and impulsivity. Interestingly, recent research has revealed that ruminative thought and negative urgency are associated with the ventromedial prefrontal cortex, a brain area that is involved in decision making and memory recall (Bechara and Damasio, 2000; Euston et al., 2012; Wang et al., 2013; Cyders et al., 2014). Future research should examine whether the impact of rumination on impulsivity and suicide risk might be explained by its effects on parts of the brain involved in memory and decision-making. Further, future studies should also investigate how lack of premeditation, lack of perseverance, and negative urgency differ in their association with suicide risk. These three aspects of impulsivity have recently been associated with self-injurious behavior, previous suicide attempts, and suicide potential in a sample of inpatients seeking help for substance use disorders (Anestis et al., 2014). Interestingly, our second study did not reveal an association between negative urgency and suicide risk. Given that both Studies 1 and 2

suggested a relationship between brooding and negative urgency, and that previous research suggests an association between negative urgency and suicidal ideation (Klonsky and May, 2010), further research is necessary to understand the circumstances under which negative urgency might also be associated with risk for suicidal behavior.

Some study limitations should be noted. Both samples were non-clinical and consisted primarily of females, and findings may not generalize to clinical samples nor to males. Second, the samples from both studies were racially and ethnically different, and it is unclear how this variability would affect results. Third, the relationships examined were concurrent rather than prospective, thus limiting any conclusions about causality. Fourth, we intended to examine a group of participants that scored high in brooding and low in reflection (Study 1), but no such group arose from either of our samples. A response style characterized by high brooding and low reflection may either be rare or not exist. In addition, Study 1 may have been limited in statistical power to detect group differences due to sample size. Finally, our measure of suicide risk combined suicidal ideation and attempt histories and thus did not differentiate between risk for suicidal ideation vs. attempts. Future research should use a more precise measure that makes this differentiation. Despite these limitations, the present study provides further evidence that subtypes of rumination are differentially related to cognitions and behavior known to be associated with suicidal ideation and attempts.

These findings have several clinical implications. Wenzel and Beck's (2008) cognitive model of suicidal behavior asserts that stress impacts the relationship between dispositional vulnerability factors and cognitive processes that can lead to a suicide attempt. Dispositional vulnerability factors include maladaptive cognitive styles (e.g., an overreliance on brooding), as well as behaviors (e.g., impulsivity). Cognitive processes associated with suicide attempts (e.g.,

hopelessness), may lead to biased information processing that can trigger suicidal ideation and eventually a suicide attempt (Wenzel and Beck, 2008). Cognitive therapy focused on limiting brooding may improve how people respond to their negative moods by decreasing their tendency to engage in impulsive behaviors. Decreased brooding may also increase the mental capacity necessary for individuals to think about solutions to problems in the face of distress. Such interventions may ultimately decrease the likelihood that stress will trigger cognitive processes associated with suicidal behavior. Clinical interventions may also encourage a low ruminative response style (brooding and reflection), in general. Importantly, these findings can guide future research to improve our understanding of how brooding may lead to higher suicide risk through impulsivity. Potential findings may aid in developing targeted approaches to suicide prevention.

Table 1. Means and Standard Deviations of Behavioral and Self-Report Measures for the Four Ruminative Subtypes in Study 1

		Group					
	Low Brood/Ref (n = 20)	High Brood/Ref (n = 18)	High Brooding (n = 19)	High Reflection (n = 19)			
Measures	<i>M (SD)</i>				<i>p</i>	$\eta^2$	
Two-Choice Impulsivity							
Immediate Choice	24.35 (12.79)	18.00 (11.70)	16.84 (13.43)	16.48 (10.80)	.15	.07	
Delayed Choice	25.65 (12.79)	32.00 (11.70)	33.16 (13.43)	33.52 (10.80)	.15	.07	
Go-Stop Impulsivity							
50 Msec	20.39 (19.90)	18.59 (15.62)	15.79 (23.32)	19.96 (19.33)	.89	.01	
150 Msec	41.54 (23.40)	34.19 (20.77)	34.41 (21.89)	36.81 (22.97)	.72	.02	
250 Msec	53.27 (25.31)	53.21 (21.73)	54.86 (18.84)	54.40 (19.16)	.99	.001	
350 Msec	68.65 (19.30)	73.07 (17.84)	74.90 (13.65)	74.73 (13.95)	.60	.03	
UPPS-P SF Impulsivity Scale							
Lack of Premeditation	1.73 (0.43)	1.77 (0.70)	2.07 (0.65)	1.71 (0.51)	.19	.06	
Negative Urgency*	2.39 (0.61)	2.83 (0.65)	2.92 (0.58)	2.48 (0.58)	< .05	.13	
Sensation Seeking	2.73 (0.73)	2.83 (0.77)	2.74 (0.80)	2.82 (0.68)	.95	.004	
Lack of Perseverance	1.68 (0.61)	1.74 (0.47)	1.82 (0.54)	1.64 (0.36)	.71	.02	

\*Univariate Analysis of Variance; Brood = Brooding; Ref. = Reflection

\*  $p < .05$

Table 2. Means, Standard Deviations, and Correlations among Study 2 Self-Report Measures

	M	SD	1	2	3	4	5	6	7
1. Brooding	10.61	3.83	...						
2. Reflection	10.26	3.46	.65**	...					
3. Lack of Premeditation	1.81	0.70	.11**	.03	...				
4. Negative Urgency	2.46	0.74	.29**	.13**	.05*	...			
5. Sensation Seeking	2.71	0.77	-.06*	-.01	-.06*	.23**	...		
6. Lack of Perseverance	1.73	0.66	.13**	.05	.66**	-.43	-.21**	...	
7. Suicide Risk	4.23	2.26	.32**	.22**	.17**	.10**	-0.02	.17**	...

\*  $p < 0.05$ ; \*\*  $p < 0.01$ . Suicide Risk = Total score on Suicidal Behaviors Questionnaire (SBQ)

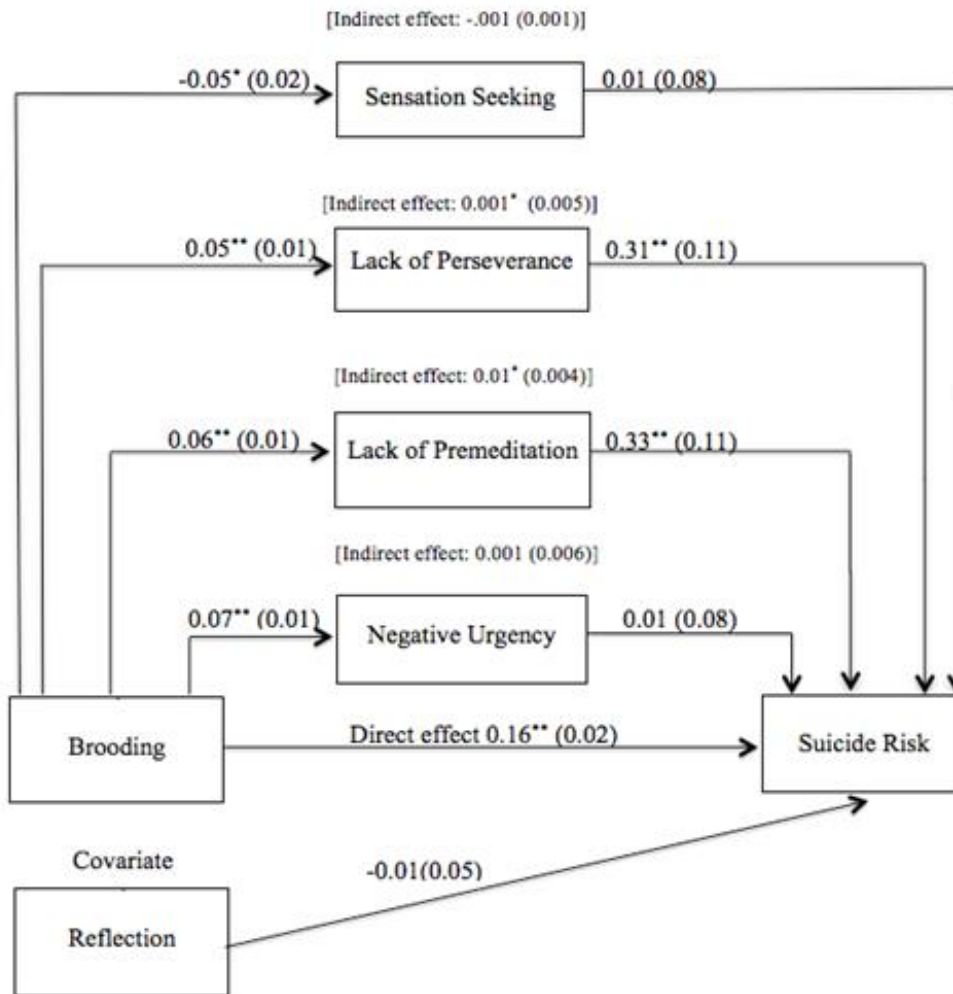


Figure 1. Brooding is significantly associated with sensation seeking, lack of perseverance, lack of premeditation, and negative urgency. There was an indirect effect of brooding on suicide risk through lack of perseverance and lack of premeditation. Values shown are unstandardized regression coefficients, with standard errors in parentheses.  $^* p < 0.05$ ;  $^{**} p < 0.01$ .

## **Study 2: Stress Reactivity, Executive Functioning, and Biased Cognitions among Suicide Attempters and Non-Attempters**

### **SPECIFIC AIMS**

Suicide is one of the top three leading causes of death among emerging adults (ages 18-29) in the United States. Previous research indicates that stressful life events increase risk for suicidal ideation and attempts. However, the mechanisms that mediate the relation between stress and suicide risk have received little attention. The present study aimed to examine:

1. Whether such risk may result from an overly active physiological stress response.

Specifically, this study examined differences between individuals with and without a SA history in cortisol response following a stressor. We hypothesized that previous suicide attempters would have significantly greater cortisol reactivity in response to a stressor (vs. no stressor), compared to non-suicide-attempters.

2. Whether an overly active stress response is related to biased cognitive responses – including impulsivity and poor problem solving. We hypothesized that an overly active stress response would be significantly and positively associated with increased impulsivity and deficits in problem solving.

3. Whether physiological stress hyperactivity and cognitive deficits explain the relation between the experience of life stress and interference from suicide related cognitions. We hypothesized that physiological stress hyperactivity and cognitive deficits would mediate the relationship between 1) the experience of previous life stress and interference from suicide related words and between 2) suicide attempt history and interference from suicide related words.



## **Significance**

Both early life stress and recent life stress have been linked to suicidal thoughts and behavior and also to an altered stress response (hyperactive Hypothalamic-Pituitary-Adrenal (HPA) axis) (Checknita et al., 2012; De Usabel Guzman et al., 2011). HPA axis hyperactivity is characterized by elevated cortisol. Cortisol has direct and indirect actions on specific brain regions that are associated with executive functioning (McEwen, 2012). Deficits in executive functions, such as difficulty with impulse control and problem solving, have been associated with suicidal thoughts or actions (Dougherty et al., 2004, Bender et al., 2011; Patsiokas et al., 1979; McAuliffe et al., 2003).

Given that the areas of the brain known to be responsible for impulse control and problem solving are still developing during emerging adulthood (Sowell et al., 2001), this period of life may be one of particular vulnerability to stress-induced suicidal behavior, due to its impact on cognitive functioning. Examining the interplay between biological and cognitive risk factors for suicidal behavior may lead to greater understanding of what leads to suicidal behavior in emerging adults — who are at a particular risk of experiencing stress-induced impairments in executive functioning. By discovering the impact stress has on HPA Axis activity and executive functioning, clinicians will be better equipped to develop targeted approaches to suicide intervention.

## **Method**

This study consisted of a 2 x 2 Factorial Design (Previous Suicide Attempt History/No Suicide Attempt History x Inclusion/Exclusion in a social stressor task). Participants with and without a SA history were randomly assigned to a social stressor condition or to a control

condition. Self-report measures of life stress history, impulsivity, and perseverative thinking were measured before the social stressor task. In addition, saliva samples were taken before and after the stressor task, and self-reported affect was measured before and after the stressor. Behavioral measures of impulsivity, problem solving, working memory, and interference from suicide related words were assessed after post-stressor assessment of affect.

## Participants

Seventy-six young adults (58 females), aged 18-29 ( $M = 20.8$ ,  $SD = 2.05$ ) recruited from a public university campus in New York City, took part in this study for monetary compensation. The racial/ethnic composition of the sample was 34% Asian, 16% Black, 16% White, 12% Hispanic, and 22% of other ethnicities. Participants were recruited from two larger samples of individuals who took part in a study of cognitive risk factors associated with suicidal ideation and attempts. Forty-four participants in the current study were recruited from a sample of 285 individuals, and the remaining participants ( $n = 32$ ) were recruited from a sample of 2423 individuals, both of which were screened for a history of suicide attempts. Individuals were recruited based on whether they reported a history of one or more previous suicide attempts ( $n = 37$ ) and whether they had no previous history of an attempt ( $n = 39$ ).

## Procedure

After providing informed consent, participants completed self-report questionnaires. This was followed by a 10-minute rest period. After the rest period, the first saliva sample was taken (SS1). Participants then completed the PANAS (described below), followed by the Cyberball Task (either the exclusion or no-exclusion condition). After Cyberball, the second saliva sample was taken (SS2). The PANAS was administered again before participants

completed either the Go-Stop or the TOL (counterbalanced condition). After this task, the third saliva sample was collected (SS3). The Digit Span task and the SST were completed before the 4<sup>th</sup> and final saliva sample was collected (SS4).

### Saliva Collection

Saliva samples were collected via passive drool. Participants were instructed to allow saliva to pool in the mouth, and then drool down a saliva collection aid into a 2ml cryovial until a minimum of 1ml of saliva was collected. Saliva samples were collected between 12:30pm and 2:30pm to control for diurnal fluctuations in cortisol concentrations. Samples were maintained at 4°C for no longer than 1 hour before freezing them at or below -20°C. On the day samples were assayed, the samples were brought to room temperature and then centrifuged for 15 minutes at approximately 3,000rpm. Standard enzyme-linked immunosorbent assays were performed to detect cortisol.

### Measures

#### *Participant Information Questionnaire*

A Participant Information Questionnaire (PIQ) was used to collect demographic data. Further, data that is typically collected in experiments that utilize salivary cortisol samples were also gathered: participants are asked whether or not they had been previously diagnosed with Cushing's syndrome, to list any current medications being taken, and if female, whether or not they were currently menstruating.

### **Measures of Life Stress**

#### *Perceived Stress Scale (PSS; Cohen et al., 1983)*

The PSS is a 10-item questionnaire used to assess people's perception of general life stress. Participants indicate how often they have found their lives unpredictable, uncontrollable, and overloaded in the last month. Sample items include: "In the last month, how often have you been upset because of something that happened unexpectedly?" and "In the last month, how often have you felt nervous and stressed?" (Cronbach's  $\alpha = .89$  in the present sample). PSS scores have been found to correlate with scores from the Life Events Scale in 3 different samples of college students (coefficient reliabilities of .84, .85, and .86 in the respective samples) (Cohen et al., 1983). High PSS scores have also been found to be significantly associated with elevated cortisol levels (Roberti et al., 1999, van Eck et al., 1996).

*Life Events Checklist (LEC; Blake et al., 1995)*

The LEC is a 17-item survey that is used to screen for potential traumatic events in an individual's lifetime. For each item, participants are asked whether the event happened to them, or whether they witnessed the event, learned about the event, or if the event does not apply to them. Sample items include: "Natural disaster (for example, flood, hurricane, tornado, earthquake)" and "Life-threatening illness or injury." Items for which the respondent endorses that the event happened to him/her personally receive a score of 1; all other responses receive a score of 0. Item scores are summed for a total score. The LEC has shown good reliability and validity in a sample of college students (Gray et al., 2004).

*Life Events Stress Scale (LES; Holmes & Rahe 1967)*

The LES is a 42-item survey that is used to assess the number of major life events an individual has encountered over the previous 12 months. Participants respond with a "yes" or

“no” to each item. Sample items include: “Death of close family member” and “Revision of personal habits.” Each event is assigned a number that indicates “Life Change Units (LCU),” such that an event that is more life changing has a higher LCU value (e.g., “Death of close family member” = 100 LCU) than does one that is less life changing (e.g., “Minor violation of the law” = 11 LCU). Previous research suggests that the higher the score, the higher the risk of a stress-related illness (Rahe & Author, 1978).

*PTSD CheckList - Civilian Version (PCL-C; Weathers et al., 1993)*

The PCL-C is a 17-item checklist used to assess symptoms of post-traumatic stress disorder. Participants are asked how much they have been bothered by each event listed on a scale of 1 (*Not at all*) to 5 (*Extremely*). Sample items include: “Repeated, disturbing memories, thoughts, or images of a stressful experience from the past?”; “Avoid activities or situations because they remind you of a stressful experience from the past.” A total symptom severity score (range = 17 - 85) can be obtained by summing the scores from each of the 17 items. The PCL-C has been found to be internally reliable (Cronbach’s alpha = .91, in the present sample), have good test-retest reliability ( $r = .66$ ,  $n = 316$ ), and to significantly correlate with other measures of psychopathology in an undergraduate sample (Conybeare et al., 2012).

**Trait Impulsivity**

*UPPS Impulsive Behavior Scale-Short Form (UPPS-SF) (Cyders et al., 2007; Whiteside & Lynam, 2001)*

Please refer to previous description. Cronbach’s alphas in the present sample were .78, .72, .79, and .71 for lack of premeditation, negative urgency, sensation seeking, and lack of perseverance, respectively.

## **Mood**

*Positive Affect and Negative Affect Scale. (PANAS; Watson, Clark, & Tellegen, 1988)*

The PANAS is a self-report measure consisting of 20 adjectives – 10 reflecting positive affect (PA) – or subjective feelings of being alert or enthusiastic (e.g., interested, excited), and 10 reflecting negative affect (NA), or subjective distress (e.g., irritable, scared). Individuals are asked to rate each item for the extent to which they generally feel that way, on a Likert scale ranging from 1 (“very slightly or not at all”) to 5 (“extremely”). Both positive affect items (Cronbach’s alpha ranging from .86 - .90) and negative affect items (Cronbach’s alpha ranging from .84 - .87) have been found to be internally reliable in a sample of 164 undergraduates. The scale has also been found to be significantly and positively correlated with measures of distress and psychopathology (Watson & Clark, 1988). Cronbach’s alpha for the first administration of the PANAS was .86 and .91 for positive affect and negative affect, respectively. Cronbach’s alpha for the second administration of the PANAS was .89 and .79 for positive affect and negative affect, respectively.

## **Social Stressor Task**

*Cyberball* (Williams & Jarvis 2006).

Participants were randomly assigned to experience a laboratory-based social stressor using the Cyberball task. In this task, participants were either included or excluded from a virtual ball-throwing game. Participants were told that were going to play an interactive ball-tossing game used for mental visualization with three other individuals. The following instructions were given to them: “In a few moments, you will be playing a ball tossing game with other students over our network. The game is very simple. When the ball is tossed to you, simply click on the

name of the player you want to throw it to. When the game is over, just go on to the next page of the survey. What is important is not your ball tossing performance, but that you mentally visualize the entire experience. Imagine what the others look like. What sort of people are they? Where are you playing? Is it warm and sunny or cold and rainy? Create in your mind a complete mental picture of what might be going on if you were playing this game in real life.”

Each player, including the participant, was portrayed with animated avatars that share the same likeness. The participant was unaware that the other players in the game were part of the computer program and not individuals playing the game with them. In the non-stress condition, a total of twenty ball tosses by the three computer programmed players occurred during the course of the task, seven of which were thrown to the participant. In the stress condition, a total of twenty-six ball tosses by the three computer programmed players occurred during the course of the task, three of which were thrown to the participant (the three tosses thrown to the participant occurred during the first nine tosses of the game).

In the present study, 38 participants were randomly assigned to the exclusion condition (stress condition), and 38 were randomly assigned to the inclusion condition (no stress condition). Excluded participants in Cyberball tend to self-report higher feelings of stress and lower mood when compared to included participants (Zadro et al., 2004). Self-report measures of affect were administered following the task (measuring feelings of exclusion, sadness, anger, etc...). In the present study, data from the Cyberball task were available from 73 of 76 participants (three participants did not have data due to computer error).

### **Interference from Suicide-Related Words**

*Suicide Stroop Test (SST; Cha et al., 2010))*

The SST is a modified version of the Emotional Stroop Test, which is an objective measure of interference from emotionally salient linguistic stimuli. Participants are presented with words one at a time on a computer screen and asked to name the color of the word (either red or blue). Some words are suicide-related (e.g., dead), some words are neutral (e.g., paper), and some words are negative in valence (e.g., alone). Increased response latency to name the color of a word indicates greater interference from the meaning of the word. The SST reaction times to suicide-related words have been found to distinguish between suicide attempters and non-attempters and to predict suicide attempts at 6-month follow-up (Williams & Broadbent, 1986; Becker et al., 1999; Cha et al., 2010). The SST was administered with response latencies recorded using Empirisoft DirectRT, v2004, software (Jarvis, 2004). Following Cha et al.'s (2010) procedure, trials with incorrect responses were excluded in the analyses. In the analyses below, four participants were excluded due to having an error rate 2 *SD* above the error rate for the sample. Trials with response latencies  $\pm 2$  *SD* from each participant's mean response latency were eliminated. Data from three further participants were excluded from the analyses for having a mean response latency 2 *SD* above the mean response latency for the sample. Interference from suicide related stimuli is calculated by subtracting latencies for neutral words from latencies for suicide-related words. Interference from negatively-valenced stimuli is calculated by subtracting latencies for neutral words from latencies for negatively-valenced words.

### **Behavioral Impulsivity**

*Go-Stop Impulsivity Paradigm (Dougherty et al., 2004)*

Please refer to previous description.



## **Problem Solving**

### *Tower Test* (Shallice, 1982)

The Tower Test measures planning, problem solving, and attention. Participants were shown discs of varying sizes distributed among three pegs on a computer screen and were asked to organize a stack of discs by increasing size on one of the pegs. There are a predetermined number of minimum moves to complete the 36 trial sessions. Extra moves indicate a lack of planning. The Tower Test has been shown to have high test-retest reliability ( $r = .70$ ) and has been concurrently validated with brain regions that are functionally important in planning and strategy use (Schnierman et al., 1998; Sullivan, et al., 2009).

## **Stress Response**

Stress response was assessed via cortisol analyses detected from saliva samples using standard enzyme-linked immunosorbent assays (See below for saliva collection procedures). In blood, cortisol is mostly bound to serum proteins. However, unbound cortisol is found in saliva, making it possible to measure cortisol in saliva samples. Studies have frequently shown that salivary cortisol is highly correlated to serum cortisol (Eatough et al., 2009; Dorn et al., 2007). Cortisol levels peak approximately 20 minutes after exposure to an acute stressor (Kirschbaum & Hellhammer, 2000). The difference scores between saliva sample 3 and saliva sample 2 (saliva sample 3 was taken 20 minutes after saliva sample 2) represented cortisol response in our present analyses. We also calculated area under the curve scores with respect to ground ( $AUC_G$ ; measuring total cortisol output) and with respect to increase ( $AUC_I$ ; measuring total cortisol response to our stressor).  $AUC_G$  and  $AUC_I$  scores were calculated using formulas provided by Pruessner et al. (2003).

## Results

### **Difference in Stress Response Between Previous Suicide Attempters and Non-Attempters.**

Participants in the stress condition reported significantly higher levels of rejection ( $M = 3.32$ ), sadness ( $M = 3.65$ ), and anger ( $M = 1.89$ ) than did those in the control condition ( $M = 1.69, 1.57, \text{ and } 1.28$ , respectively,  $p < .01$ ) (Table 2). However, our stress condition did not elicit a physiological stress response, as measured by cortisol response,  $AUC_G$ , and  $AUC_I$ . Mean cortisol concentrations lowered across all four groups throughout the duration of the study (Table 3). There was a significant group difference in the decrease of cortisol concentration between the second and third sample,  $F(3, 70) = 3.01, p < .05$ . There was no significant difference between groups in  $AUC_G$ ,  $F(3, 69) = 1.05, p = .38$ , and  $AUC_I$ ,  $F(3, 69) = 0.61, p = .61$  (Table 4). The non-attempt + stress group had a greater mean decrease in cortisol. However, post-hoc  $t$ -tests with Bonferroni corrections did not reveal a significant difference between the non-attempt + stress group and any other group. In addition, while previous attempters had lower mean cortisol concentrations than non-attempters, these differences were not statistically significant,  $t(73) = 1.22, p = .23$ . There was no significant difference between groups in  $AUC_G$ ,  $F(3, 69) = 1.05, p = .38$ , and  $AUC_I$ ,  $F(3, 69) = 0.61, p = .61$  (Table 4).

### **Stress Response and its Relationship to Impulsivity and Problem-Solving.**

Our stress condition did not yield a physiological stress response. Thus, we could not analyze whether or not an overly active stress response related to biased cognitive responses.

### **The Relationship between Life Stress, Impulsivity, and Problem-Solving among Suicide Attempters and Non-Attempters**

Previous suicide attempters had higher scores in three of the four self-report measures of life stress, although none of these differences were statistically significant (Table 5). There were also no significant differences between previous attempters and non-attempters in behavioral measures of problem-solving (Tower Test) and behavioral impulsivity (Go-Stop Task). Previous attempters did, however, score significantly higher on three subscales of the UPPS-P SF; lack of premeditation,  $t(72) = 3.72, p < .01$ , negative urgency,  $t(72) = 2.80, p < .01$ , and lack of perseverance,  $t(72) = 2.11, p < .05$  (Table 6, Figure 2). Life stress, across both groups, was not significantly associated with increased impulsivity or deficits in problem solving (Table 7).

### **The Relationship Between Life Stress and Interference from Suicide Related Words among Suicide Attempters and Non-Attempters**

We found no positive relationship between the experience of life stress and interference from suicide related words (Table 7). Total scores from the Life Events Scale were significantly and negatively associated with interference from suicide related words,  $r(65) = -.26, p < .05$ . Non-attempters took longer to react to suicide related words than to neutral words ( $M = 17.36$ ). Previous attempters took longer time to react to neutral words than suicide related words ( $M = 4.12$ ). This difference emerged as a non-significant trend,  $t(67) = 1.18, p = .06$  (see Table 8).

### **Discussion**

The present study sought to examine the relationship between life stress, HPA axis reactivity, executive functioning, and suicidal behavior. Experiencing social exclusion provoked subjective feelings of rejection, sadness, and anger in both previous suicide attempters and non-attempters. However, regardless of suicide attempt history, social exclusion did not elicit a physiological stress response, as measured by salivary cortisol. Previous suicide attempters did not demonstrate deficits in behavioral measures of problem solving and impulsivity, nor did they demonstrate interference from suicide-related words on the Suicide Stroop test. Finally, while

previous suicide attempters in our sample reported experiencing more life stress than non-attempters, this difference was not statistically significant.

Previous research and the present study have shown that our stressor condition—exclusion during Cyberball—provokes subjective negative responses, e.g., low self-esteem, rejection, anger, sadness, etc. (Bastian & Haslam, 2010; Eisenberger et al., 2003; Peterson et al., 2010). However, research examining Cyberball exclusion and cortisol response has yielded mixed results (Zoller et al., 2010; Geniole et al., 2011; Jobst et al., 2015). The lack of cortisol response post-Cyberball exclusion has been suggested to be a defensive response described as emotional analgesia. Emotional analgesia occurring after experiencing social pain has been hypothesized to work similarly to the adaptive physiological analgesic response that occurs after experiencing physical pain (DeWall & Baumeister, 2006; Bass et al., 2014). Indeed, emotional analgesia may be produced by the endogenous opioid system that also produces physical analgesia (DeWall et al., 2010). Similarly to the present study, Bass et al.'s (2014) study involving a sample of 68 undergraduates found that participants excluded in Cyberball exhibited a decrease in cortisol concentrations. However, contrary to our findings, their participants in the Cyberball inclusion condition exhibited a significant increase in cortisol concentrations. The authors speculated that those included in Cyberball might have used greater attention and effort, which may have resulted in a cortisol response. Our present study showed an opposite relationship, such that individuals in the inclusion group exhibited a decrease in cortisol concentrations post-Cyberball. Further research is necessary in order to investigate the mixed findings examining Cyberball conditions and cortisol response. Importantly, the present study found no interaction between suicide attempt history and Cyberball exclusion with respect to subjective reports of negative affect. Regardless of suicide attempt history, individuals in the

Cyberball exclusion condition reported significantly greater negative affect than individuals in the inclusion condition. Thus, previous suicide attempt history did not moderate the relationship between self-reported negative affect as a result of exclusion, versus inclusion.

Contrary to our hypotheses, there were no significant differences between previous suicide attempters and non-attempters on behavioral measures of impulsivity and problem-solving. However, previous attempters did exhibit significantly higher scores in three dimensions of trait impulsivity: lack of premeditation, lack of perseverance, and negative urgency. Similarly to Study 1 (Part I), there was no association between performance on the Go-Stop task and the UPPS-P SF. As noted earlier, these two different paradigms for assessing impulsivity are tapping into different facets of impulsive behavior (Cyders & Coskunpinar, 2011). The association between disinhibited responding (as measured by the Go-Stop task) and suicidal behavior may be dependent on the degree of suicidality in a given sample, with positive associations more likely occurring in clinical settings, as has been noted above. By contrast, previous research and our present studies have shown previous attempters, as well as past and present ideators, to exhibit significantly greater levels of lack of premeditation, lack of perseverance, and negative urgency than controls (Hamza et al., 2015). Tower Tests results assessing problem solving in the present sample showed no significant differences between previous attempter and non-attempters. This finding may also be attributed to the non-clinical nature of our sample. Indeed, degree of lethality in a clinical sample differentiated the number of extra moves needed to complete the Tower Test in a study examining executive functioning differences between high lethality attempters and low lethality attempters (Williams et al., 2015). In addition, results from the Tower Test may be dependent on present mood, versus whether or not an individual has a suicide attempt history. Goddard et al. (2012) found that performance on

the Tower Test improved significantly over a 12-month period as depressive symptoms decreased in a clinical sample of individuals diagnosed with major depressive disorder or bipolar disorder. Thus, problem-solving, as assessed by the Tower Test, may be a state-dependent phenomenon.

The present study found no significant differences between previous suicide attempters and non-attempters in interference from suicide related words, relative to neutral words, on the SST. In fact, there was a trend for non-attempters to show interference from suicide related words, as compared to previous attempters. Previous attempters had faster reaction times to suicide-related, negatively valenced, and positively valenced words, compared to non-attempters. These findings are in contrast to Cha et al.'s (2010) results that revealed interference from suicide related words by previous attempters, with the most recent attempters showing the greatest interference from suicide related words. Importantly, participants (including controls) from the aforementioned study were recruited from a psychiatric emergency department. Interference from suicide related words might only occur in clinical settings. Indeed, across groups, participants in the Cha et al. study had a mean reaction time towards suicide related words of 788.16 milliseconds, compared to 499.40 milliseconds in the present study. Further, in a recent sample of 736 college students, no interference from suicide related words was found in previous suicide attempters, compared to non-attempters. However, previous attempters did take significantly longer to react to the word "suicide" than did non-attempters (Chung & Jeglic, 2015). We did not find significant differences between groups in reaction time towards "suicide" or any other specific words in the present study. This difference between studies may be based on severity of depressive symptoms in our sample; reaction times to the word "suicide" were no longer significant in the Chung & Jeglic sample after adjusting for depressive

symptoms. Future studies should further examine whether or not SST outcomes are indicative of previous, present, or future suicidal behavior in different clinical and non-clinical settings.

We did not find significant associations between life stress and stress reactivity, problem solving, behavioral impulsivity, suicide attempt history, or interference from suicide-related words. Given that our stressor task did not elicit a physiological stress response, we cannot ascertain whether or not life stress was associated with greater HPA axis reactivity in the present sample. Previous research has indicated life stress to be associated with deficits in problem solving (Schotte & Clum, 1982). However, our findings are similar to a recent study that established no association between early life stress and planning behavior as assessed by the Tower Test (Gamber et al., 2014). As previously stated, results from the Tower Test appear to be state-dependent. Therefore, Tower Test outcomes may not be sensitive to previous life stress. Future research should examine the impact of life stress on different behavioral tests of problem-solving. Life stress was not associated with results from the Go-Stop tasks, although PLC-C scores were significantly and positively associated with two dimensions of the UPPS-P SF; lack of premeditation and negative urgency. The PLC-C is unique among the life stress measures used in the current study, as it measures the effects from life stress as it relates to symptoms of post-traumatic stress disorder (PTSD), versus quantifying specific life events or perceived stress. Indeed, the PLC-C was the only measure of life stress in the present study that demonstrated a trend toward higher scores among previous suicide attempters versus non-attempters. Moreover, symptoms of PTSD are reflective of early life stress (Yehuda et al., 2010; Pechtel & Pizzagalli, 2011). The relationship between early life stress, trait impulsivity, and suicidal behavior was further investigated in Study 3.

Several study limitations should be noted. First, as discussed above, the present sample was non-clinical, and results may not generalize to a clinical setting. Second, the present sample was primarily female, and results may not generalize to males. Third, our results are cross-sectional, thus limiting conclusions regarding the direction of relationships. Fourth, we intended to induce a physiological stress response with our stressor task, but the lack of stress response negated our ability to assess any association between stress reactivity and primary study measures. Future studies should utilize stressor tasks that have consistently elicited a cortisol response when assessing stress reactivity and its relationship to cognitions or behaviors. Despite these limitations, our study further established the relationship between specific dimensions of trait impulsivity—including negative urgency—and suicidal behavior. Additionally, our results provide further evidence differentiating certain aspects of impulsivity, as measured by a computer-based task (Go-Stop), and trait impulsivity as measured by self-report. Our study also provides additional evidence that Tower Test performance may be a state dependent phenomenon not associated with previous life stress or suicide attempt history. Finally, the present study further establishes the inability of the SST to suicide differentiate attempters and non-attempters in a non-clinical setting.

Our overall findings might be reflective of the non-clinical nature of the sample studied. A clinical sample of individuals with more recent suicide attempts may have yielded differences in biased cognitive responses. Contrary to predictions, previous suicide attempters had lower baseline and mean cortisol levels than non-attempters. Previous research has indicated that individuals who have experienced severe life stress (e.g., suffer from PTSD) may demonstrate low cortisol activity and a blunted cortisol response. Such a physiological profile may be due to excessive cortisol activity during previous times of trauma, including early life stress.



Importantly, whether or not early life stress influences future negative psychological and behavioral outcomes may be dependent on epigenetic mechanisms. Previous research has indicated that 5-HTTLPR variants may interact with early life stress to subsequently impact cognitions and behaviors later in life (Roy et al., 2007; Uher & McGuffin, 2008; Mann & Currier, 2010). Further, 5-HTTLPR variants that result in lower serotonin transporter transcription have been associated with HPA axis dysregulation (for a review, please see Miller et al., 2012). Study 3 further examines the relationship between rumination and negative urgency established in Study 1. Additionally, Study 3 examines the impact of early life stress and 5-HTTLPR variants on rumination, negative urgency, overgeneral autobiographical memory, and suicidal behavior.

Table 1. Demographic Characteristics

Participants ( <i>N</i> = 78)				
Sex	X (%)	Female	43	(55%)
		Male	35	(45%)
Ethnicity		Asian	26	(33%)
		White	15	(19%)
		Hispanic	15	(19%)
		Black	7	(9%)
		Other		
Age	M (SD)		18.5	(1.2)

Table 2. Post-Cyberball Self-Report Measures of Affect

	Stressor ( <i>n</i> = 37)	No Stressor ( <i>n</i> = 36)		
	<i>M</i> ( <i>SD</i> )		<i>p</i>	<i>d</i>
Disconnected**	3.38 (1.32)	2.47 (1.13)	< .01	0.74
Rejected**	3.32 (1.31)	1.69 (1.06)	< .01	1.37
Self-Esteem**	1.73 (0.96)	2.81 (1.10)	< .01	1.05
Bad**	2.46 (1.12)	1.53 (0.77)	< .01	0.97
Angry**	1.89 (0.81)	1.28 (0.66)	< .01	0.83
Sad**	3.65 (1.34)	1.57 (0.89)	< .01	1.83

\**p* < .05, \*\**p* < .01

Table 3. Mean Cortisol Concentrations (ug/dL) in Each Group Across the 4 Saliva Samples

	SA+ Stressor ( <i>n</i> = 17)	SA + No Stressor ( <i>n</i> = 19)	NA + Stressor ( <i>n</i> = 20)	NA + No Stressor ( <i>n</i> = 19)
	<i>M (SD)</i>			
Saliva Sample 1				
	0.225 (0.07)	0.218 (0.09)	0.241 (0.10)	0.250 (0.11)
Saliva Sample 2				
	0.213 (0.07)	0.186 (0.07)	0.219 (0.07)	0.234 (0.11)
Saliva Sample 3				
	0.199 (0.07)	0.181 (0.06)	0.209 (0.08)	0.193 (0.08)
Saliva Sample 4				
	0.166 (0.07)	0.160 (0.07)	0.216 (0.13)	0.158 (0.05)

Table 4. Means and Standard Deviations of Cortisol Response, AUC<sub>G</sub>, and AUC<sub>I</sub>

	SA+ Stressor ( <i>n</i> = 17)	SA + No Stressor ( <i>n</i> = 19)	NA + Stressor ( <i>n</i> = 20)	NA + No Stressor ( <i>n</i> = 19)		
Measures	<i>M (SD)</i>				<i>p</i>	$\eta^2$
Cortisol Response						
	-0.01 (0.04)	-0.005 (0.05)	-0.01 (0.04)	-0.05 (0.04)	<.05	0.11
AUC <sub>G</sub>						
	13.11 (4.28)	11.95 (4.13)	14.65 (4.58)	13.54 (5.56)	0.38	0.04
AUC <sub>I</sub>						
	-1.52 (2.56)	-2.24 (2.76)	1.61 (3.57)	-2.73 (3.40)	0.61	0.03

Table 5. Life Stress Measures and Suicide Attempt Status

	Previous Attempter (n = 35)	Non-Attempter (n = 39)		
	<i>M (SD)</i>		<i>p</i>	<i>d</i>
LEC <sup>1</sup> Score				
	4.20 (2.11)	3.33 (2.08)	0.08	0.41
LES <sup>2</sup> Score				
	280.51 (116.21)	286.05 (117.49)	0.84	0.05
PLC-C <sup>3</sup> Score				
	40.11 (12.79)	34.82 (12.79)	0.08	0.41
PSS <sup>4</sup> Score				
	32.11 (3.30)	30.95 (2.58)	0.09	0.40

\* $p < .05$ , \*\* $p < .01$ <sup>1</sup>Life Events Checklist, <sup>2</sup>Life Events Stress Scale, <sup>3</sup>PTSD Checklist-Civilian Version, <sup>4</sup>Percieved Stress Scale

Table 6. UPPS-P SF and Suicide Attempt Status

	Previous Attempter (n = 35)	Non-Attempter (n = 39)		
	<i>M (SD)</i>		<i>p</i>	<i>d</i>
UPPS-P SF				
Lack of Premeditation**				
	2.18 (0.71)	1.69 (0.54)	< .01	0.78
Negative Urgency**				
	2.76 (0.63)	2.31 (0.74)	< .01	0.65
Sensation Seeking				
	2.60 (0.90)	2.86 (0.75)	0.83	0.31
Lack of Perseverance*				
	1.90 (0.60)	1.64 (0.45)	< .05	0.49

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

Table 7. Life Stress Measures, Tower Test, Go-Stop Task, Suicide Stroop Test

	1	2	3	4	5	6	7	8	9
1. LEC	...								
2. LES	.23*	...							
3. PLC-C	.40**	.28*	...						
4. PSS	-0.02	-0.19	.31**	...					
5.150msec <sup>1</sup>	0.01	-0.09	-0.07	-0.06	...				
6. TOL <sup>2</sup>	0.12	-0.06	0.14	0.12	0.13	...			
7. Neg <sup>3</sup>	0.01	-0.03	0.14	0.19	-0.14	0.21	...		
8. Sui <sup>4</sup>	-0.05	-0.26*	-0.01	0.08	-0.10	0.12	.65**	...	
9. Pos <sup>5</sup>	-0.03	-0.01	0.18	0.08	-0.13	0.10	.51**	.53**	...

\* $p < .05$ , \*\* $p < .01$ , <sup>1</sup>Go-Stop task, <sup>2</sup>Tower Test Extra Moves, <sup>3</sup>Interference from Negatively Valenced Words

<sup>4</sup>Interference from Suicide Related Words, <sup>5</sup>Interference from Positively Valenced Words

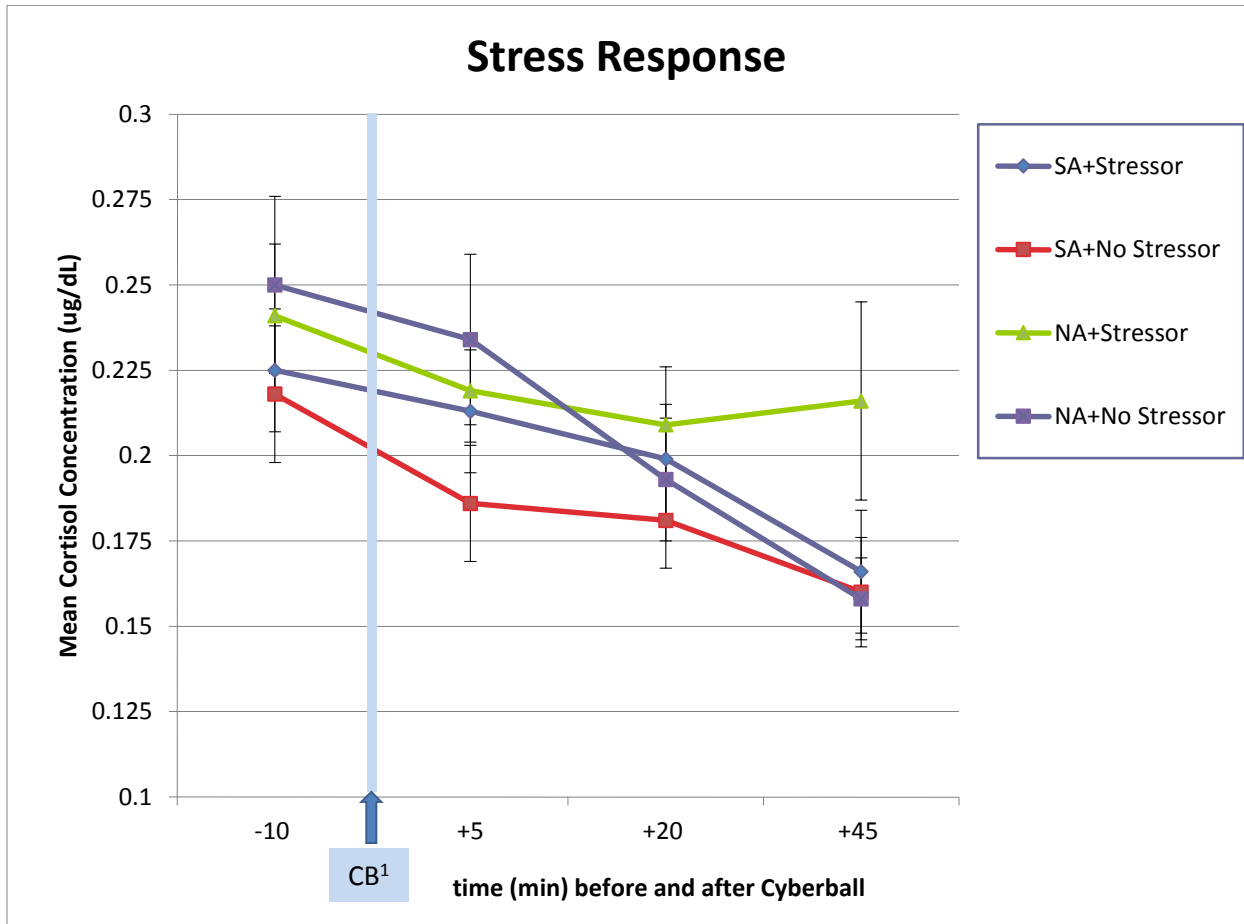


Table 8. Interference from Suicide Related words, Negatively Valenced words, Positively Valenced Words and Attempt Status

Previous Attempter (n = 35)	Non-Attempter (n = 34)		
<i>M (SD)</i>		<i>p</i>	<i>d</i>
Suicide Related words			
-4.12 (39.19)	17.36 (52.72)	0.06	0.46
Negatively Valenced words			
-6.07 (37.76)	8.31 (61.41)	0.24	0.28
Positively Valenced words			
1.59 (35.43)	-3.27 (50.71)	0.65	0.11

Figure 1.

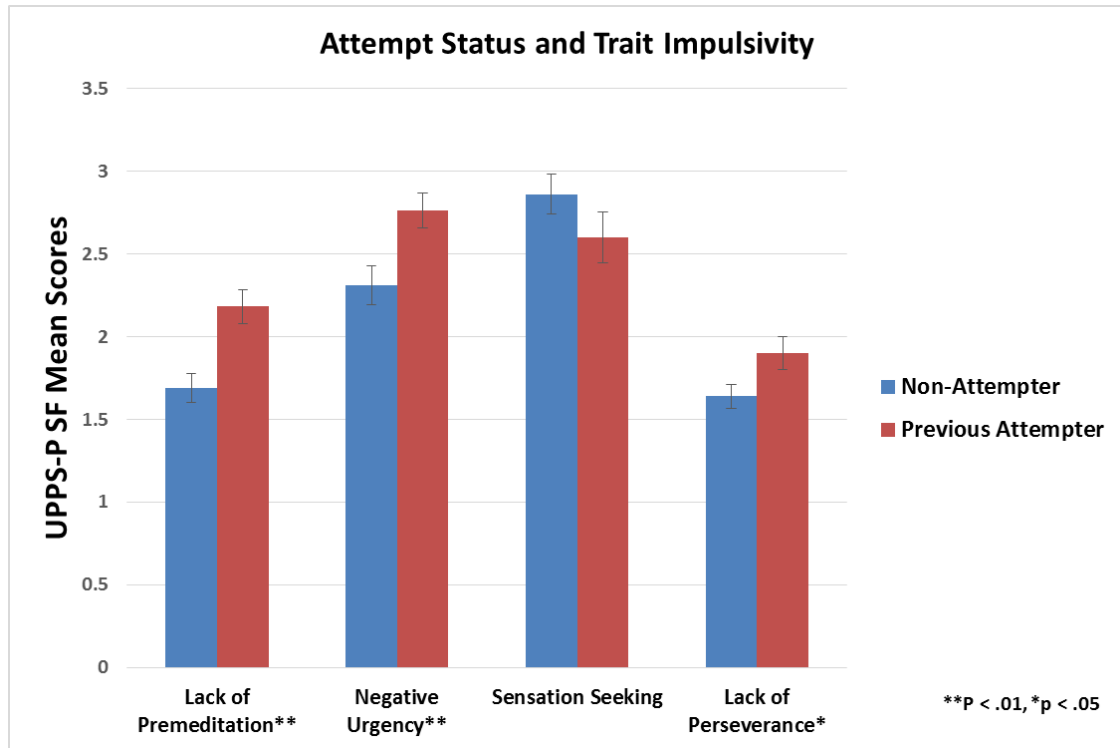
Mean Cortisol Concentrations (ug/dL) in Each Group Across the 4 Saliva Samples



<sup>1</sup>Cyberball

Figure 2.

UPPS-P SF and Suicide Attempt Status



### **Study 3: The Role of Early Life Stress and Memory in the Relationship between Brooding and Negative Urgency**

#### **SPECIFIC AIMS**

Study 1 revealed a relationship between brooding and negative urgency — the tendency to act rashly in moments of distress. However, potential mechanisms in the relationship between brooding and negative urgency have yet to be elucidated. Study 3 sought to examine:

1. Whether early life stress would be associated with brooding, negative urgency, and suicidal ideation.
2. Whether the relationship between early life stress and negative urgency would be mediated by overgeneral autobiographical memory — i.e., the tendency to recall non-specific memories when prompted to recall autobiographical events – and by brooding.
3. Whether the indirect relationship between early life stress and negative urgency through brooding would be moderated by 5-HTTLPR, a serotonin transporter-linked polymorphic region.
4. Whether early life stress, brooding, and negative urgency would combine to predict suicidal ideation at 6-month follow up.

#### **Significance**

Both brooding and negative urgency have been associated with negative psychological and behavioral outcomes, including suicidal behavior (Treyner et al., 2003; Miranda et al., 2013, Anestis & Joiner, 2011). Further, deficits in working memory, early-life adversity, and specific 5-HTTLPR genotypes have been associated with suicidal behavior (Keilp et al., 2001; Von

Werne Baes et al., 2012; Chekinata et al., 2012). Individuals who possess 5-HTTLPR genotypes that result in lower 5-HTT transcription, thus lower serotonin reuptake, are more likely to have a dysregulated HPA-Axis stress response later in life if they have experienced early-life stress (Miller et al., 2012; Antypa et al., 2013). Such HPA-Axis dysregulation is potentially harmful to areas of the brain that functionally encode, store, and retrieve memory (De Kloet et al., 2005; McEwen, 2012). Working memory is the first stage in the process of encoding long-term memories. Thus, deficits in working memory may lead to deficits in long-term memory that may be manifested in overgeneral autobiographical memories. An individual that lacks the capability to retrieve specific memories when encountering life stress may be more likely to act rashly in the face of such distress. Brooding rumination may lead individuals to act rashly in response to stress due to an inability to access adaptive alternative solutions to problems. Indeed, past research has indicated a strong relationship between rumination and overgeneral memory and that rumination is a significant contributor to overgeneral autobiographical memory, itself (Williams, 2006; Sutherland & Bryant, 2007). Examining the relationship between brooding and negative urgency through overgeneral autobiographical memory may lead to a better understanding of the impact of stress and deficits in memory in relation to suicidal behavior.

## **Method**

### **Participants**

A sample of 50 individuals with and without a history of early life stress – selected from a larger sample that completed an initial survey – took part in a 6-month follow up study. At baseline, the larger sample of participants consisted of four hundred and fifty-two adults (351 females), aged 17-43 ( $M = 19.1$ ,  $SD = 3.28$ ) recruited from a public university campus in New

York City and who took part in the study for research credit in introductory psychology courses. The racial/ethnic composition of the sample was 39% Asian, 23% White, 19% Hispanic, 7%, Black, and 12% of other ethnicities. From this sample, participants selected for the follow-up study included 50 adults (44 females), aged 18-27 ( $M = 19.3$ ,  $SD = 1.83$ ), who received a \$20 Amazon gift card for their participation. The racial/ethnic composition of the follow-up sample was 46% Asian, 23% Hispanic, 16% White, 6%, Black, 9% of other ethnicities.

## Procedure

At baseline, participants completed measures assessing early life stress, impulsivity, rumination, suicide attempt history, and current suicidal ideation. At follow-up, participants were recruited based on their early life adversity scores on a trauma inventory (described below). At follow-up, participants completed measures assessing impulsivity, working memory, overgeneral autobiographical memory, and suicidal ideation. Further, saliva samples were collected to indicate which 5-HTTLPR polymorphism individuals possessed.

## Measures

### Early Life Stress

*Early Trauma Inventory – Self Report-Short Form Revised (ETISR-SF) (Bremner, 2007)*

The ETISR-SF, administered at baseline, is a self-report questionnaire that assesses physical, emotional, sexual, and other trauma experienced before the age of 18. Sample items include: “Did you experience the divorce or separation of your parents?”, “Were you often put down or ridiculed?” The ETISR-SF has been shown to have both good internal consistency

reliability and validity (Bremmer et al., 2007). Cronbach's alpha was .56, .73, .78, and .63 for general physical trauma, physical punishment, emotional abuse, and sexual abuse, respectively.

An analysis of the 452 participants at baseline yielded the mean ETISR-SF score ( $M = 7.45$ ). High ETISR-SF scores were those at or higher than 1 SD above the mean of 12. At baseline, 374 participants scored in the low/average range, and 78 participants scored in the high range. The scores in our baseline sample resulted in 2 different groups to be invited for a 6-month follow up: high early life adversity ( $N = 24$ ) and low/average early life adversity ( $N = 26$ ).

### **Suicide Attempt History/Recent Current Suicidal Ideation**

#### *Suicidal Behavior Screening (SBS)*

The SBS is a self-report tool used to screen for history of suicide attempts and recent/current suicidal ideation. The SBS was administered at baseline and at a follow-up. Suicide attempt history was determined by the question, “Have you ever, in your whole life, tried to kill yourself or made a suicide attempt?” Suicidal ideation was determined by the question, “In the past 6 months, have you thought about killing yourself?” At baseline, thirty-eight out of 452 participants (8%) reported a history of a previous suicide attempt. Sixty participants (13%) (12 previous suicide attempters) reported suicidal ideation in the previous six months. At follow-up, thirteen out of 50 participants (26%) reported a history of a previous suicide attempt (Of those 13, 12 had previously reported a suicide attempt at baseline).

Seventeen (out of 50) participants with suicidal ideation in the previous six months at baseline participated in the study at follow-up. Eight of those participants also reported suicidal ideation at follow-up. Nine individuals no longer reported suicidal ideation, and five participants

who did not report suicidal ideation at baseline reported suicidal ideation at follow-up (Ideators at follow up;  $N = 13$ ).

## **Rumination**

*Ruminative Responses Scale (RRS; Nolen-Hoeksema, Larson, & Grayson, 1999)*

Please refer to previous description. The RRS was administered at baseline and at follow-up. Cronbach's alphas at baseline were .82 and .76 for brooding and reflection, respectively. Cronbach's alpha at follow-up was .80 and .78 for brooding and reflection, respectively.

## **Impulsivity**

*UPPS Impulsive Behavior Scale- Short Form (UPPS-P SF) (Cyders et al., 2007; Whiteside & Lynam, 2001)*

Please refer to previous description. The UPPS-P SF was administered at baseline and follow-up. Cronbach's alphas at baseline were .75, .75, .78, and .73 for lack of premeditation, negative urgency, sensation seeking, and lack of perseverance, respectively. Cronbach's alphas at follow up were .86, .79, .86 and .82 for lack of premeditation, negative urgency, sensation seeking, and lack of perseverance, respectively.

## **Overgeneral Autobiographical Memory**

*Autobiographical Memory Test (AMT) (Williams & Broadbent, 1986)*

At follow up, participants were asked to recall specific events in their lives in response to five positive (e.g., proud) and five negative (e.g., hopeless) cue words. Two neutral practice



words were given (with feedback) before the start of the experimental session. Responses were audio recorded for later coding. Overgeneral (non-specific) memories were coded as such if the memory recalled lasted more than a day and did not occur at a specific time or place. The outcome measure was the percentage of overgeneral memories recalled from the total number of memories recalled. Responses were excluded if 1) they were given 20 or more seconds after the cue word was stated and 2) the memory was from the day of the experimental session. Coding of the AMT was done by a single rater (JV), as previous research has established that a single rater can reliably rate memory specificity (Barnhofer et al., 2007; Haddad et al., 2009).

## **Working Memory**

### *Digit Span task (Kirchner, 1958)*

Participants were presented a sequence of stimuli and asked to indicate whether the currently presented stimuli were the same as the ones presented in previous trials. This task has been concurrently validated with activation in brain regions that are functionally important for working memory (Owen et al., 2005). The digit span task was administered at follow-up.

## **5-HTTLPR Genotyping**

Saliva samples were collected and sent to DNA Genotek for DNA extraction and genotyping. DNA was extracted from 700µL of saliva for genotyping one Single Nucleotide Polymorphism (SNP); rs25531, and the long versus short 5-HTTLPR polymorphism, both found in the SLC6A4 gene. The SLC6A4 gene encodes the serotonin transporter (5-HTT) responsible for terminating the action of serotonin in the synaptic cleft and reuptaking serotonin to the presynaptic neuron. Quality checks, including PicoGreen analysis, Nandrop A260/280

absorbance readings, and agarose gel electrophoresis, were completed for each sample. One sample was not analyzed due to insufficient DNA yield. 5-HTTLPR genotypes using the rs25531 full genotype (triallelic); High Expressing 5-HTT: LA/LA, LA/LG, SA/LA and Low Expressing 5HTT: SA/LG, SA/SA, LG/LG (Lonsdorf et al., 2009). 5-HTTLPR low expressing genotypes have been found to be associated with suicidal behavior (Mann et al., 2000; Apter et al., 2013).

## **Results**

### **Relationship between Early Life Stress, Rumination, and Impulsivity at Baseline**

Bivariate correlations between early life stress and primary study measures at baseline are shown in Table 2. The early life stress subscales of general trauma, physical punishment, and emotional abuse were significantly and positively associated with brooding, reflection, and negative urgency. Physical punishment was also positively associated with sensation seeking. Sexual abuse history was not associated with either brooding or reflection. However, sexual abuse history was significantly and positively associated with negative urgency and lack of perseverance. Brooding and reflection were significantly and positively associated with negative urgency.

Independent-samples t-tests were conducted to examine the differences between the two early life stress groups at baseline (Low/Average versus High) on study measures (see Table 3, Figure 1). The high early life stress group had significantly higher brooding,  $t(450) = .4.24, p < .01$ , and reflection scores,  $t(450) = 4.35, p < .01$ , than the low/average early life stress group. Further, there was a statistically significant effect of group on the negative urgency dimension of the UPPS-SF; the high early life stress group had significantly higher negative urgency scores

than the low/average early life stress group,  $t(450) = 4.42, p < .01$ . However, there were no significant differences between groups in the other dimensions of the UPPS-SF (Figure 2).

### **Relationship between Early Life Stress and Suicidal Behavior at Baseline**

A one-way ANOVA was conducted to assess differences in early life stress by history of suicidal ideation or attempts: controls (no history of suicide attempt or recent/current suicidal ideation,  $N = 366$ ), individuals with history of a suicide attempt with no recent/current ideation ( $N = 25$ ), individuals with recent/current suicidal ideation but no history of a suicide attempt ( $N = 48$ ), and individuals with recent/current ideation and a history of a suicide attempt ( $N = 12$ ). There were significant differences across groups for all dimensions of the ETISR-SF (see Table 4, Figure 3). Post-hoc Bonferonni-corrected comparisons revealed that the no ideation/no attempt group had significantly lower total early life stress scores than each of the other three groups. Further, the ideation/attempt group had significantly higher total early life stress scores than the ideation-only group,  $t(58) = 2.63, p < .05$ , but not significantly higher than the attempt-only group,  $t(35) = 1.58, p = .12$ . There were no significant differences across each of the dimensions of the ETISR-SF between the ideation/attempt group and the attempt-only group. However, the ideation/attempt group did have significantly higher emotional abuse scores,  $t(58) = 2.62, p < .05$ , and sexual abuse scores,  $t(58) = 2.77, p < .01$ , than the ideation-only group.

### **Relationship between Early Life Stress, Working Memory, and Overgeneral Memory at Follow-up**

Bivariate correlations revealed no significant relationships between early life stress and working memory or early life stress and overgeneral autobiographical memory (see Table 5).

Working memory was significantly and negatively associated with negative autobiographical memory recall.

### **Examining Overgeneral Memory as a Mediator of the Relationship between Brooding and Negative Urgency**

Bivariate correlations revealed that positive, negative, and total autobiographical memory recall were not significantly associated with either brooding or negative urgency (see Table 5). Thus, we did not further examine overgeneral autobiographical memory as a mediator of the relationship between brooding and negative urgency.

### **Examining Brooding as a Mediator of the Relationship between Early Life Stress and Negative Urgency and the Moderating Role of 5-HTTLPR Genotypes**

Given that early life emotional abuse was associated with negative urgency at follow-up (see Table 5), analyses were conducted to examine whether brooding, in association with 5-HTT low expressing genotypes, would mediate the relationship between early life emotional abuse and negative urgency (Note that early life stress total scores did not predict brooding at follow-up and were thus were not used in these analyses). We hypothesized that the relationship between early life emotional abuse and negative urgency would be mediated by brooding among individuals with the 5-HTT low expressing genotypes and not among individuals with the 5-HTT high expressing genotypes. Mediation may be tested when a predictor (early life emotional abuse) relates to a mediator (brooding) and the mediator (brooding) relates to an outcome variable (negative urgency). A relation between the predictor (early life emotional abuse) and outcome (negative urgency) may or may not be present (Mackinnon et al., 2002). Moderated

mediation conditional direct effects were estimated using model 8 of the PROCESS procedure (Hayes, 2013), and conditional indirect effects were tested using bias-corrected 95% confidence intervals, calculated using a bootstrapping procedure (with  $n = 1000$  resamples). Conditional indirect effects were considered statistically significant when their confidence intervals did not include zero. The indirect effect of early life emotional abuse on negative urgency through brooding was tested. There was an indirect effect of early life emotional abuse (95% CI = 0.01 – 0.13) on negative urgency through brooding (standardized indirect effect = 0.05).

We then examined whether this indirect relationship was moderated by the triallelic 5-HTTLPR genotypes. We found an indirect effect of early life emotional abuse [95% CI = 0.02 – 0.19] on negative urgency through brooding among individuals with the 5-HTT low expressing genotypes (Figure 1). However, we did not find an indirect effect of early life emotional abuse [95% CI = - 0.08 – 0.07] on negative urgency through brooding among individuals with the 5-HTT high expressing genotypes. Thus, 5-HTT low expressing genotypes moderated the indirect relationship between early life emotional abuse and negative urgency through brooding.

### **Suicidal Ideation at 6-month follow-up**

Independent Samples t-tests were conducted to examine differences between non-ideators and ideators at follow-up (see Table 6). Current ideators had significantly higher lack of premeditation and negative urgency scores. No other significant differences were found on measures of early life stress, trait impulsivity, rumination, and overgeneral autobiographical memory. A logistic regression was performed to assess the effects of early life stress, baseline brooding, baseline negative urgency, and baseline ideation on the likelihood of ideation at follow-up. The model explained 49.6% (Nagelkerke  $R^2$ ) of the variance in ideation at follow-up

and correctly classified 80% of cases. Both negative urgency ( $p < .01$ ) and baseline ideation ( $p = .01$ ) significantly contributed to the model (see Table 7). Each unit increase in negative urgency was associated with 16.2 times higher odds of reporting suicidal ideation at follow-up, versus no ideation. Baseline suicide ideation was associated with 13.8 times higher odds of reporting suicidal ideation at follow up, versus no ideation. Brooding and early life stress were not significantly associated with likelihood of suicidal ideation at follow-up, after adjusting for baseline suicidal ideation.

Current suicide ideators with a previous suicide attempt history ( $N = 4$ ) had significantly higher early life stress scores ( $M = 15.50$ ,  $SD = 3.11$ ) than did current ideators without a suicide attempt history ( $M = 9.44$ ,  $SD = 3.81$ ),  $t(11) = 2.77$ ,  $p < .05$ . No other significant differences were found in measures of trait impulsivity, rumination, and overgeneral memory between current ideators with and without a suicide attempt history. Of note, three of the four current ideators with a previous suicide attempt history possessed 5-HTT low expressing genotypes and had a history of high early life stress (there were five total individuals with 5-HTT low expressing genotypes and high early life stress among the 13 current ideators).

## **Discussion**

The present study sought to examine the relationship between early life stress and negative urgency through brooding and overgeneral memory, whether 5-HTTPLR variants would moderate this relationship, and whether these variables would predict suicidal ideation. At baseline, we found that individuals with high early life stress were significantly more likely to engage in brooding, reflection, and to be characterized by negative urgency than individuals with low or average early life stress. In addition, degree of early life stress was related to suicidal

behavior. Suicide ideators with a previous suicide attempt history reported more early life stress than did individuals with only a previous suicide attempt history, individuals presently ideating without a suicide attempt history, and controls. At follow-up, we found no association between overgeneral autobiographical memory and early life stress, brooding, or negative urgency. Suicide ideators at follow-up had significantly higher levels of brooding, reflection, and impulsivity in the forms of lack of premeditation and negative urgency. Finally, we found an indirect effect of early life emotional abuse on negative urgency through brooding for individuals possessing 5-HTT low expressing genotypes, but not for individuals possessing 5-HTT high expressing genotypes.

To our knowledge, the present study is the first to reveal an association between early life stress and negative urgency. To further investigate this relationship we examined whether overgeneral autobiographical memory mediated the relationship between early life stress and negative urgency. Certain forms of early life stress have been previously associated with overgeneral autobiographical memory in clinical and non-clinical settings (Kuyken & Brewin, 1995; Henderson et al., 2002; Valentino & Toth, 2009). However, contrary to our hypothesis, early life stress was not associated with overgeneral autobiographical memory at follow-up. Moreover, overgeneral autobiographical memory was not associated with rumination or negative urgency in our sample. The CARFAX model proposes that deficits in working memory may contribute to overgeneral retrieval of memories (Williams et al., 2007). The present study found no differences in working memory between individuals with or without high early life stress. It is possible that we found no relationship between overgeneral autobiographical memory and rumination or negative urgency as a result of comparable working memory across the sample.

The present study found early life emotional abuse, general trauma, and physical punishment to be significantly and positively associated with both brooding and reflection. Similarly, Raes & Hermans (2008) found early life emotional abuse to be associated with both brooding and reflection in a sample of 101 college students. By contrast, brooding, not reflection, was associated with childhood emotional, physical, and sexual abuse in a sample of 144 low-income, pregnant women. Further, only childhood emotional abuse prospectively predicted brooding among these women. (O'Mahen et al., 2015). Early life emotional abuse also proved to be unique among the different aspects of early life stress in the present study, with respect to its association with 5-HTT genotypes, brooding, and negative urgency.

We found an indirect relationship between early life emotional abuse and negative urgency via brooding among individuals possessing 5-HTT low expressing genotypes. We found no such relationships with the other forms of early life stress assessed in our study. Importantly, higher negative urgency, not brooding, was significantly related to increased likelihood of being a suicide ideator at follow-up in the present study. Our findings suggest that rumination, in the form of brooding, and impulsivity, in the form of negative urgency, may result from the interaction between early life emotional abuse and 5-HTT low expressing genotypes. Moreover, 5-HTT high expressing genotypes may provide a buffer, such that early life emotional abuse may have less of an impact on emotion regulation strategies later in life. The interaction between 5-HTT low expressing genotypes and early life stress has previously been linked with depression, anxiety sensitivity, suicidal behavior, PTSD, smaller hippocampal volume, and deficits in cognitive and emotional processing (Caspi et al., 2003; Kaufman et al., 2006; Stein et al., 2007; Gibb et al., 2006; Roy et al., 2007; Xie et al., 2009; Frodl et al., 2010; Owens et al., 2012). Previous research also indicates that 5-HTT may interact with certain types of stress and



specific outcomes such as history of suicide attempt and depressive symptoms (Gibb et al., 2006; Grabe et al., 2012).

For example, Gibb et al. (2006) found that the interaction between 5-HTT low expressing genotypes and early life physical and sexual abuse, but not emotional abuse, predicted history of suicide attempts in a clinical sample of 30 participants. Further, emotional abuse contributed the most to an interaction found between 5-HTT low expressing genotypes, a BDNF polymorphism, child abuse, and depressive symptoms in adulthood (Grabe et al., 2012). Previous research and our present study have found no direct relationship between 5-HTTLPR allele groups and rumination (Beevers et al., 2009). However, ruminative cognitive style in young adulthood was found to be associated with early life emotional abuse and 5-HTT low expressing genotypes in a sample of 250 university students (Antypa & Van der Does, 2010). How exactly 5-HTT low expressing genotypes and early life stress confer risk to negative psychological outcomes such as brooding or negative urgency have yet to be fully determined. Serotonin's important role in modulating emotional behavior has been previously established (see Hariri & Holmes, 2006 for a review), but further research is necessary to understand the relationship between specific types of early life stress, 5-HTT genotypes, brooding, and negative urgency.

Early life stress has been linked to suicidal ideation and suicide attempts in young adulthood (Yang & Clum, 2000; Johnson et al., 2002). Previous research has found that variables such as low self-esteem, external locus of control, hopelessness, problem solving, depression, present life stress, and HPA axis hyperactivity act as mediators between early life stress and suicidal behavior in young adulthood (Yang & Clum, 2000; Dube et al., 2001; Johnson et al., 2002; Von Werne Baes et al., 2012; Cheknita et al., 2012). At baseline, the present study

found significant differences in early life stress between controls and individuals currently ideating and/or who had a previous history of a suicide attempt. Individuals who were currently ideating and had a previous attempt history did not significantly differ in early life stress scores from individuals with only a suicide attempt history (but no current ideation). However, individuals presently ideating and who had a previous suicide attempt history reported significantly more early life emotional abuse and sexual abuse than individuals presently ideating without an attempt history. Additionally, at follow-up, current suicide ideators with a suicide attempt history had reported significantly greater overall early life stress than ideators without an attempt history. These findings suggest differential relationships between different forms of early life stress and degree of suicidal behavior. Our findings are in line with previous research that has established early life stress as a potent risk factor for attempting suicide later in life (Dube et al., 2001; Johnson et al., 2002; Pompili et al., 2011).

Some study limitations should be noted. First, the present samples were non-clinical and primarily female, and thus, our results may not generalize to a clinical setting or to males. Second, our measure of early life stress did not examine the exact year(s) in which early life adversity occurred. Thus, we could not assess how stress interacted with any potential critical time periods of central nervous system, behavioral, or cognitive development. Third, we intended to examine differences between non-attempters and previous suicide attempters on our main study measures at follow-up, but we did not recruit enough previous suicide attempters to have enough power to conduct the analyses.

Consistent with our hypotheses, the present study found associations between early life stress, brooding, negative urgency, 5-HTT genotypes, and suicidal behavior. However, we did

not find a relationship between overgeneral autobiographical memory and our main study measures. Importantly, we found early life emotional abuse to contribute to negative urgency via its relationship to brooding and low-expressing 5-HTT genotypes. Further, early life emotional abuse differentiated previous suicide attempters who reported current/recent suicidal ideation and suicide ideators without an attempt history. Early life emotional abuse has been related to depressive symptoms later in life more than other types of early life stress. This unique relationship has been speculated to be a result of individuals adopting a negative attributional style due to the nature of emotional abuse (Antypa & Van der Does, 2010). Feeling unworthy or being ignored may be antecedents of a brooding ruminative response style that includes perseverating on reasons for one's negative mood.

Additionally, the present study further establishes serotonin's role in emotion regulation. Specifically, the interaction between early life emotional abuse and 5-HTT low expressing genotypes predicted brooding and negative urgency. No such relationship was found between the interaction of early life emotional abuse and 5-HTT high expressing genotypes. These findings have both clinical and research implications. Clinical interventions will benefit from understanding the type of early life stress a person has experienced. Further, cognitive therapies should focus on limiting brooding and negative urgency in an effort to prevent suicidal behavior in at-risk individuals. From a research perspective, future investigations should continue to examine the relationship between serotonergic circuitry in corticolimbic structures, emotion regulation, and epigenetic mechanisms.

Table 1. Demographic Characteristics at Baseline and Follow-Up

		Baseline Participants ( <i>N</i> = 452)			Follow-Up Participants ( <i>N</i> = 50)	
Sex	X (%)	Female	351	(76%)	44	(76%)
		Male	101	(24%)	6	(24%)
Ethnicity		Asian	174	(39%)	23	(46%)
		White	105	(23%)	8	(16%)
		Hispanic	84	(19%)	10	(23%)
		Black	33	(7%)	3	(6%)
		Other	56	(12%)	6	(9%)
Age	M (SD)		19.1	(3.28)	19.3	(1.83)

Table 2.

Means, Standard Deviations, and Correlations among Study 3 Baseline Self-Report Measures

	M	SD	1	2	3	4	5	6	7	8	9	10	11
1. Brooding	11.37	3.62	...										
2. Reflection	9.56	3.36	.50**	...									
3. Lack of Premeditation	1.78	0.50	0.06	-0.09	...								
4. Negative Urgency	2.66	0.70	.38**	.17**	.29**	...							
5. Sensation Seeking	2.65	0.74	-0.02	.10*	0.09	.13**	...						
6. Lack of Perseverance	1.76	0.51	.15**	.11*	.37**	0.09	0.03	...					
7. General Trauma	2.13	1.79	.14**	.17**	-0.03	.10*	0.04	-0.04	...				
8. Physical Punishment	2.42	1.64	.20**	.13**	0.02	.22**	.12**	0.04	.27**	...			
9. Emotional Abuse	1.80	1.70	.36**	.20**	0.03	.26**	-0.03	0.09	.35**	.35**	...		
10. Sexual Abuse	0.53	0.98	0.04	0.09	0.08	.13**	0.07	.10*	.30**	.12**	.20**	...	
11. ETI Total	7.45	4.52	.31**	.24**	0.03	.28**	0.08	0.05	.73**	.66**	.74**	.51**	...

\*  $p < 0.05$ ; \*\*  $p < 0.01$

Table 3. Means and Standard Deviations of Self-Report Measures for the Early Life Stress Groups

Group				
Low/Average Stress ( <i>n</i> = 374)	High Stress ( <i>n</i> = 78)			
Measures	<i>M (SD)</i>	<i>p</i>	<i>d</i>	
RRS				
Brooding**	11.05 (3.50)	12.92 (3.81)	< .01	0.51
Reflection**	9.25 (3.22)	11.04 (3.66)	< .01	0.52
UPPS SF Impulsivity Scale				
Lack of Premeditation	1.77 (0.51)	1.81 (0.49)	.62	0.08
Negative Urgency**	2.60 (0.69)	2.97 (0.66)	< .01	0.55
Sensation Seeking	2.64 (0.74)	2.71 (0.74)	.44	0.09
Lack of Perseverance	1.75 (0.51)	1.86 (0.51)	.08	0.22

\*Univariate Analysis of Variance

\*  $p < 0.05$ ; \*\*  $p < 0.01$

Table 4. Means and Standard Deviations of Self-Report Measures for Attempt/Ideation Groups

	Group					
	Controls ( <i>n</i> = 366)	Attempt Only ( <i>n</i> = 25)	Ideation Only ( <i>n</i> = 48)	Attempt + Ideation ( <i>n</i> = 12)		
Measures	<i>M (SD)</i>				<i>p</i>	$\eta^2$
ETISR-SF						
General Trauma**	1.96 (1.70)	3.12 (2.05)	2.63 (1.96)	3.17 (1.99)	< .01	0.04
Physical Punishment*	2.30 (1.64)	2.72 (1.77)	2.83 (1.51)	3.50 (1.45)	< .05	0.02
Emotional Abuse**	1.59 (1.60)	2.48 (2.10)	2.46 (1.68)	3.83 (1.40)	< .01	0.08
Sexual Abuse**	0.41 (0.79)	1.28 (1.57)	0.73 (1.11)	1.92 (2.02)	< .01	0.10
ETISR-SF Total**	6.79 (4.18)	10.28 (5.28)	9.40 (4.27)	13.25 (1.59)	< .01	0.10

\*Univariate Analysis of Variance

\*  $p < 0.05$ ; \*\*  $p < 0.01$

Table 5. Means, Standard Deviations, and Correlations at Follow-Up

	M	SD	1	2	3	4	5	6	7	8	9
1. Early Life Stress <sup>1</sup>	10.92	4.73	...								
2. Emotional Abuse <sup>1</sup>	3.06	1.65	0.69**	...							
3. Working Memory	7.16	1.60	0.15	-0.04	...						
4. Overall OGM	32.74	23.97	-0.08	0.03	-0.28	...					
5. Positive OGM	29.75	31.94	-0.06	0.07	-0.06	.70**	...				
6. Negative OGM	33.62	29.67	-0.04	0.01	-0.43	.78**	0.19	...			
7. Brooding	12.88	3.99	0.06	0.27	0.21	0.21	0.20	0.10	...		
8. Reflection	12.24	3.62	0.07	0.12	0.04	0.04	0.14	0.01	.40**	...	
9. Negative Urgency	2.85	0.71	.32*	.30*	.31*	0.04	0.04	-0.01	.51**	-0.03	...

<sup>1</sup>Scores from Baseline

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



Table 6. Means and Standard Deviations on Study Measures for Suicide Ideators and Non-Ideators at Follow-Up

		Group			
		Current Suicide Ideators ( <i>n</i> = 13)	Non-Ideators ( <i>n</i> = 37)		
Measures		<i>M (SD)</i>		<i>p</i>	<i>d</i>
ETI					
	ETI Total	11.31 (4.53)	10.78 (4.85)	0.74	0.11
RRS					
	Brooding*	14.92 (3.95)	12.16 (3.80)	< .05	0.71
	Reflection*	14.08 (3.35)	11.59 (3.53)	< .05	0.72
UPPS-P SF					
Impulsivity Scale					
	Lack of Premeditation*	2.33 (0.52)	1.69 (0.58)	< .05	1.16
	Negative Urgency*	3.21 (0.58)	2.72 (0.72)	< .05	0.75
	Sensation Seeking	2.89 (0.88)	2.57 (0.86)	0.27	0.37
	Lack of Perseverance	2.13 (0.64)	1.93 (0.62)	0.31	0.32
Autobiographical Memory Test (Percentage of Memories Recalled)					
	Total OGM	26.60 (21.15)	34.84 (24.80)	0.31	0.36
	Positive OGM	31.94 (30.10)	29.00 (32.94)	0.79	0.09
	Negative OGM	20.28 (23.41)	38.19 (30.49)	0.07	0.66

\*Univariate Analysis of Variance

\*\**p* < .01, \**p* < .05

OGM = Overgeneral autobiographical memory

Table 7. Logistic Regression Predicting Suicidal Ideation at Follow-Up from Baseline Ideation, Early Life Stress, Negative Urgency and Brooding

Predictor	<i>p</i>	$e^B$ (odds ratio)	95 % CI
Baseline Ideation*	< .05	13.8	1.87 – 101.60
Early Life Stress	0.65	0.96	0.80 – 1.15
Negative Urgency**	< .01	16.2	2.34 – 112.19
Brooding	0.09	0.77	0.57 – 1.04

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

Figure 1. Means and Standard Deviations of the RRS for the Early Life Stress Groups

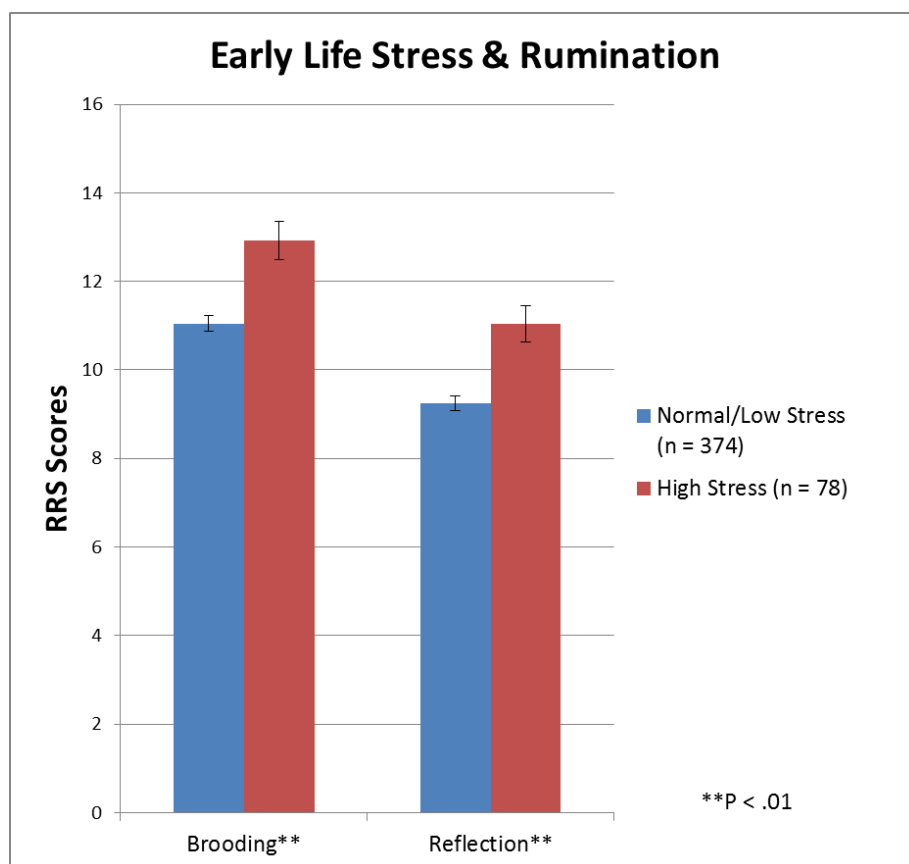


Figure 2. Means and Standard Deviations of the UPPS-SF for the Early Life Stress Groups

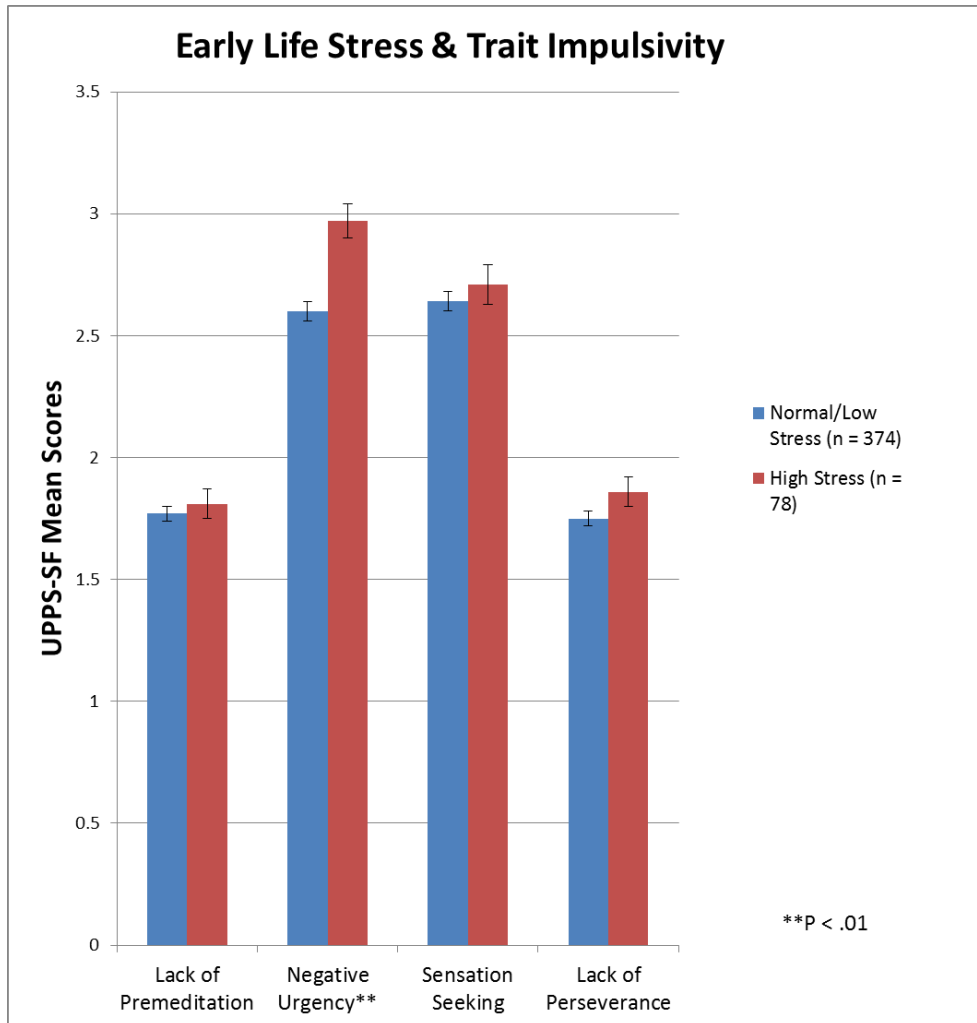
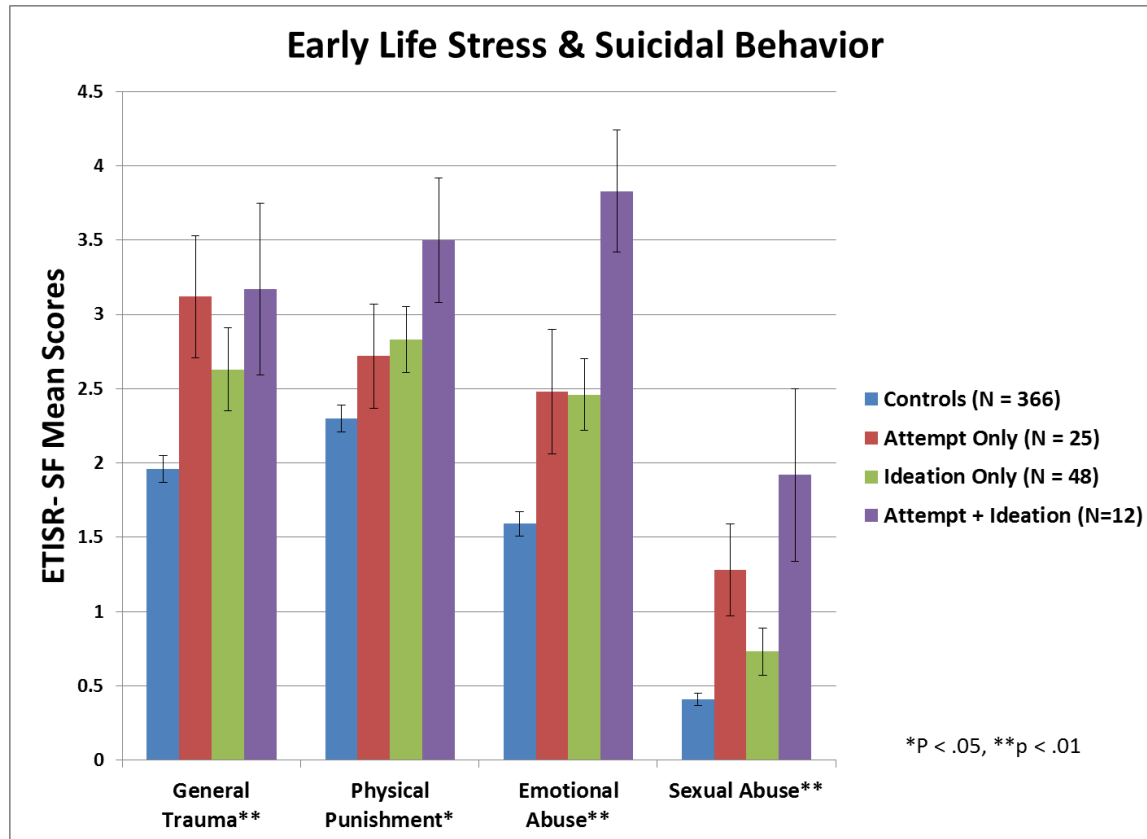


Figure 3. Means and Standard Deviations of the ETIS-R-SF for the Attempt/Ideation Groups



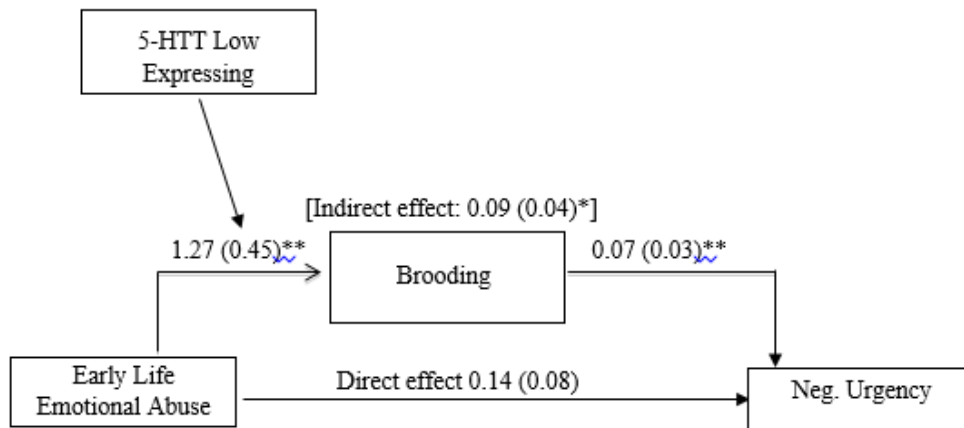


Figure 4. Early life emotional abuse does not predict negative urgency. Early life emotional abuse significantly predicts brooding. There was an indirect effect of early life emotional abuse on negative urgency through brooding for individuals possessing 5-HTT low expressing genotypes. There was no indirect effect of early life emotional abuse on negative urgency through brooding for individuals possessing 5-HTT high expressing genotypes (not shown; indirect effect: .02 (.02)). Values shown are unstandardized coefficients, with standard errors in parentheses. \* $p < 0.05$ ; \*\* $p < 0.01$ .

## **General Discussion**

The present studies sought to better understand the relationship between stress and suicidal behavior via an integrative psychological and biological approach. Specifically, these studies examined the relationship between stress and suicidal behavior via altered neurobiological functioning, maladaptive cognitions, and deficits in executive functioning. The first study revealed a positive relationship between the brooding subtype of rumination and trait impulsivity in the forms of negative urgency, lack of premeditation, and lack of perseverance. Further, brooding was associated with risk for suicidal behavior, and this relationship was mediated by lack of premeditation and lack of perseverance. The second study revealed a positive association between suicide attempt history and negative urgency, lack of premeditation and lack of perseverance, but failed to find a relationship between suicide attempt history and an overly active physiological stress response, deficits in behavioral measures of problem solving and impulsivity, and interference from suicide-related stimuli. Finally, the third study did not find a relationship between overgeneral autobiographical memory, brooding, and negative urgency. However, the study revealed that the relationship between early life stress and negative urgency – through brooding – may depend on serotonergic functioning.

The present results complement contemporary psychological theories of suicide. The interpersonal theory of suicide posits that individuals may be at risk for suicidal behavior if they have experienced repeated painful and provocative life events (Joiner, 2005). Such events have been found to mediate the relationship between negative urgency and the acquired capability for suicide among young adults (Bender et al., 2011). Indeed, suicide ideators and previous suicide attempters reported more early life stress than did controls in our third study. Moreover, each of

the present studies found a positive relationship between negative urgency and suicidal behavior in the forms of recent or present suicidal ideation and/or previous suicide attempt history. How a person is impacted by early life stress, which may be painful or provocative, is likely a result of an interaction between biological elements (e.g., serotonergic and HPA Axis functioning) and the type of stress encountered (e.g., emotional abuse).

Wenzel and Beck's (2008) cognitive model of suicidal behavior suggests that stress mediates the relationship between dispositional vulnerability factors (e.g., brooding, impulsivity) and cognitive factors (e.g., hopelessness). Maladaptive cognitions can be activated by stress and may lead to biased information processing, which, in turn, may trigger suicidal behavior. Biased attention to negative stimuli, but not positive stimuli, has been found among people with depressive symptoms (Gotlib et al., 2004). Such attentional bias is thought to be a result of schemas related to psychiatric disturbance. An individual that has experienced early life stress, such as early life emotional abuse, may have been told by their parents or caretakers that they are to blame for the occurrence of negative events within their own familial environment. Such experiences may lead individuals to develop maladaptive cognitive schemas that give rise to a negative attribution style in which a person believes that he or she is the cause of a negative life event regardless of situational circumstances that might prove otherwise, i.e., attentional bias (Antypa & Van der Does, 2010). Dispositional cognitive vulnerability factors, such as brooding, may result from a negative attributional style developed as a result of emotional abuse. Further, whether or not early life emotional abuse results in a negative attributional style may be partly dependent on serotonergic functioning. Such negative schemas may trigger impulsive acts in an effort to reduce the emotional pain caused by a negative life event. Future research should

examine the association between 5-HTT genotypes, early life emotional abuse, negative attribution styles, and impulsivity.

Recent research has revealed a variety of regions in the prefrontal cortex and limbic system that correspond to brooding and negative urgency (Boy et al., 2011; Karyadi et al., 2012; Cyders et al., 2014, Vanderhasselt et al., 2013; Piguet et al., 2014). Of note, activity in the dorsolateral prefrontal cortex (DLPFC) has been found to relate to both brooding and negative urgency (Vanderhasselt et al., 2011; Boy et al., 2011). Importantly, the DLPFC is functionally important for the engagement or disengagement to or from positive and negative stimuli. Disner et al. (2011) propose that lower activity in the DLPFC prevents individuals from attending to positive information and contributes to biased information processing toward negative stimuli. Future research should examine whether or not early life stress, emotional abuse or otherwise, relates to reduced activity in the DLPFC.

Negative urgency has been previously associated with risky behaviors, such as bulimia, substance abuse, and secondary psychopathy, as characterized by destructive behaviors (Anestis et al., 2009; Kaiser et al., 2012; Anestis et al. 2009a). While negative urgency has previously been associated with suicidal behavior and was also present in each of the present studies, whether or not it plays a direct role in the development of suicidal behavior has been questioned (Anestis et al., 2012). A clinical study of 358 patients found that dysregulated behaviors such as NSSI, alcohol consumption, binge eating, etc., fully accounted for the relationship between negative urgency and number of previous suicide attempts (Anestis et al., 2012). However, the study did not disentangle the relationship between negative urgency and dysregulated behaviors — whether or not negative urgency predicted dysregulated behaviors. Given the association



between negative urgency and dangerous risky behaviors, it might be prudent to develop non-self-report measures that assess negative urgency. Previous research has found positive associations between negative urgency and errors in the Go-Stop task (Cyders & Coskunpinar, 2011; Bagge et al., 2013). However, we found no such association in Study 1 or Study 2. Developing a computer-based task that reliably associates with or even predicts negative urgency may be an important innovation in an effort to better understand and even limit its potential to cause unsafe behaviors.

Taken together, the present results partly supported the hypotheses posed. Study 1 and Study 3 provided further evidence that brooding is a more maladaptive ruminative response style than reflection. Further, our early life stress measure in Study 3 differentiated individuals with a suicide attempt history and controls more so than the measures of life stress in Study 2. Importantly, our stressor in Study 2 did not elicit a cortisol response, thus limiting our ability to associate stress response and executive functioning. However, 5-HTTLPR analysis proved to be an important indicator of how early life stress predicts negative urgency via its association with brooding. As discussed above, 5-HTT low expressing genotypes have been associated with abnormal and decreased serotonergic functioning (Karg et al., 2011). A potential treatment for individuals with decreased serotonin activity is the class of antidepressant medications known as selective serotonin reuptake inhibitors (SSRI's). SSRI's block the action of 5-HTT, thereby allowing a greater amount of serotonin to bind onto receptors of the postsynaptic neuron. The greater availability of serotonin is believed to influence mood regulation (Schatzberg et al., 1987). However, given the complexity of neural transmission, the exact mechanism(s) whereby SSRI's relieve depression is still unclear (Kroeze et al., 2012; Walker, 2013). Indeed, the efficacy of SSRI's has been disputed and may increase risk for attempted or completed suicide

among children and adolescents (Barbui et al., 2009). Thus, treatment with SSRIs based on individuals' 5-HTT genotype requires further study.

A recent meta-analysis revealed a significant positive relationship between 5-HTT low expressing genotypes and HPA axis hyperactivity (Miller et al., 2013). Therefore, it is possible that individuals possessing 5-HTT low expressing genotypes in Study 3 also exhibit HPA axis hyperactivity. However, future research should examine the relationship between altered serotonergic functioning and early life stress and its impact on HPA Axis activity and whether HPA axis dysregulation relates to brooding, negative urgency, deficits in executive functioning and subsequent vulnerability to suicidal behavior. Findings from such research might lead to innovative targeted approaches that take into account gene x environment interactions when attempting to improve an individual's emotion regulation strategies and ultimately limit the likelihood of suicidal behavior. Lastly, the present research has further established the importance of studying stress and suicidal behavior from a multidisciplinary perspective. The interplay of risk factors for suicide is complex. However, the means to develop improved clinical interventions will be dependent on our continued understanding of how cognition, behavior, and biology interact.

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