# Disrupted Inhibitory Control of Negative Emotion in Suicide Risk: A Neural and Behavioral Investigation

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**Abstract**

An estimated 720,000 Americans died by suicide as reported by the CDC in 2025. Despite the relentless growing nature of suicide in the United States, the cognitive and behavioral mechanisms underlying suicide remain poorly understood. The existing literature regarding cognitive and behavioral processes as they relate to impulsivity remains scarce. Currently, there is a gap in the literature regaurding how negative urgency, an individual's propensity to engage in impulsive actions as a result of negative affect, may impair appropriate inhibitory control, particularly within emotionally charged contexts. We hypothesize individuals in the suicide risk group will exhibit prolonged response times during negatively valanced trials, greater negativity bias, and higher miss rate, with these group differences to be more prominent post-negative mood induction. Additionally, we hypothesize distinct neural alterations post-negative mood induction, specifically a reduced frontocentral P300 amplitude, a unique neural marker of response inhibition. In exploratory analyses, we predict that among our clinical population, individuals with more recent accounts of suicide attempts or ideations (within the past 4 months) will display an even stronger behavioral and neural effect. To test the study hypotheses, primary analyses will focus on a series of mixed-design 2 (Group) x 2 (Mood induction type) ANOVAs to examine differences in stop-signal response times to negative stimuli based on group status (suicide risk vs. Control) mood induction type (neutral vs. Negative), as well as if the impact of the mood induction differed based on group status. Overall, we seek to understand the behavioral and neural correlates underlying negative urgency among suicidal individuals by assessing the influence of negative affect states on behavioral response inhibition.

**Distinction of Work:**

While the broader focus of both the ASPIRE lab (PI: Brown) and this project is to examine the mechanisms underlying suicidal thoughts and behaviors in order to inform novel treatments, the proposed study is an independent study that is distinct from other studies being conducted in the ASPIRE lab in terms of its conceptualization, design, and data collection.

# Introduction

## Self-directed Violence

With an estimated 720,000 people worldwide dying by suicide each year, suicide remains a widespread public health issue that impacts not only those who have lost their lives, but also the families, friends, and communities left behind (WHO, 2025). In the United States, 49,316 Americans died by suicide in 2023 alone, with men dying by suicide 3.8 more times often than women (CDC, 2025). Moreover, the number of individuals who report suicide ideation (i.e., thinking about, considering, or planning for suicide; Crosby et al., 2011), has escalated in recent years with a global lifetime prevalence rate of approximately 9.2% (Nock et al., 2008). Whereas a staggering 12.8 million American adults in 2023 reported experiencing suicidal thoughts, fewer individuals (3.7 million) made a suicide plan (i.e., a systematic formulation of a program of action that has the potential for resulting in self-injury; Silverman et al., 2007) and even fewer individuals (1.5 million) attempted suicide (i.e., engaged in a non-fatal potentially injurious behavior; CDC, 2025; Crosby et al., 2011). In terms of identifying risk factors, previous suicide attempts are the strongest predictor of death by suicide (Bostwick et al., 2016; Irigoyen et al., 2019). Together, these findings suggest that specific factors may differentiate suicidal desire from suicidal behavior, highlighting the urgent need to identify variables linked to suicide attempts that may help us better determine who is most at risk for death by suicide.

Current literature in the field focuses on developing ideation-to-action theories that aim to distinguish factors linked to suicide ideation from factors associated with suicidal behavior. The Interpersonal Theory of Suicide (IPTS; Joiner, 2005; Van Orden et al., 2010) is one of the most studied theories and has been used extensively to examine risk for suicide ideation and suicidal behaviors transdiagnostically (Anestis et al., 2016; Bryan et al., 2015; Chu et al., 2017; Ma et al.,

2016; Ribeiro & Joiner, 2009; Stellrecht et al., 2005; Zeppegno et al., 2021). This theory posits that thwarted belongingness (i.e., a lack of reciprocal caring relationships and feelings of loneliness), and perceived burdensomeness (i.e., feelings of self-hate and the belief that others would be better off if one were dead), together with a sense of hopelessness that these states will not change gives rise to active suicide ideation. Importantly, this theory states that when suicidal desire is coupled with acquired capability, indicated by fearlessness about death and elevated pain tolerance, the risk of lethal or near-lethal suicidal behavior is elevated (Van Orden et al., 2010).

In addition to the IPTS, other ideation-to action framework theories have emerged, including the three-step theory (Klonsky & May, 2015) and the integrated motivational-volitional model of suicide behavior (IMV; O'Connor, 2011). Each of these theories propose different factors linked to the development of suicide ideation. The three-step theory posits pain, hopelessness, and connectedness, whereas the IMV emphasizes feelings of defeat and entrapment. Within ideation-to-action frameworks such as the ITPS, suicide capability is conceptualized as a multi-faceted construct involving fearlessness about death (i.e., suppression of the natural instinct for survival, often acquired through habituation to pain or repeated exposure to traumatic events), increased physical pain tolerance, and access to and familiarity with lethal means**.** Some theories also suggest that impairments in executive functioning, particularly under emotional distress, may further reduce an individual's ability to inhibit suicidal behavior and act as a factor enhancing capability (Smith & Cukrowicz, 2010). Despite its central role, suicide capability remains poorly understood, especially in the context of heightened emotional states. Moreover, the literature presents contrasting findings regarding elevated suicide capability under strong affective states as one study evidenced lower levels of

acquired capability for suicide and pain tolerance among an undergraduate sample when assessing negative urgency and emotion dysregulation, a finding contrary to predictions (Anestis et al., 2011). Overall, the aim of this study is to determine how impulsivity, particularly negative urgency, may contribute to suicide capability, thereby increasing an individual's risk for suicidal behavior.

**Impulsivity and Negative Urgency**

Prior studies have found that suicidal behaviors are associated with greater levels of impulsivity (e.g., Baca-Garcia et al., 2001; Hadzic et al., 2020; Williams et al., 1980), whereas other studies suggest there are no significant associations between impulsivity and suicide risk (e.g., Anestis et al., 2014). These contradictory findings could potentially reflect the varied operationalizations researchers use as to define impulsivity and an overreliance of self-report measures. Some researchers quantify impulsivity as the tendency to engage in risky behavior (Barratt, 1993), while others define impulsivity as the tendency to focus on smaller, immediate rewards instead of longer-term rewards (Bickel & Marsch, 2001). Despite these differences, there is consensus that impulsivity is a multifaceted construct, encompassing a broad umbrella of subcomponents such as negative urgency, deficits in planning, sensation seeking, and lack of perseverance (Anestis et al., 2014; Whiteside & Lynam, 2001).

Anestis and colleagues (2014) propose that while impulsive individuals may be more likely to engage in suicidal behavior, such acts are not always impulsive in nature. Suicidal behavior may involve episodic planning, with individuals delaying action due to an inability to overcome the fear of death in the moment. Over time, habituation to physical and psychological pain may increase acquired capability, allowing planned behavior to transition into action. From this perspective, trait impulsivity more broadly may not be associated with suicidal behavior;

however, there may be facets of impulsivity that account for more rapid transitions from suicidal thoughts to behaviors. Negative urgency is a specific facet of impulsivity that is characterized by the tendency to act impulsively as a result of experiencing strong negative affect that has been linked to emotion dysregulation and disinhibition (Allen et al., 2021; Whiteside and Lynam, 2001). Thus, negative urgency may play a critical role in the moments leading up to a suicide attempt, given ideation-to-action framework theories suggest this period of time involves intense emotional distress.

Prior studies have demonstrated a clear link between elevated suicide risk and high levels of self-reported negative urgency, as individuals may be more likely to quickly develop suicidal ideation and potentially resort to self-injurious behaviors while under intense negative affective states (e.g., Anestis & Joiner, 2011; Scheve et al., 2024). In line with ideation-to-action theories, studies have demonstrated self-reported negative urgency amplifies associations between the three components of the IPTS (e.g., thwarted belongingness, perceived burdensomeness, and acquired capability) and suicide attempts (Anestis & Joiner, 2011). These findings suggest negative urgency may serve as another component of suicide capability, that acts as a critical mechanism driving individuals to engage with suicidal thoughts and behaviors during periods of intense emotional distress. Additionally, there extensive literature linking negative urgency to mental illnesses with elevated suicide rates such as borderline personality disorder, dysregulated eating, substance use disorders, and antisocial personality disorder (Anestis et al., 2009; Anestis et al., 2008; Verdejo-Garcia et al., 2007; Whiteside et al., 2005).

Despite growing literature linking negative urgency to elevated suicide risk, most studies rely on self-report measures and cross-sectional approaches, which may explain the inconsistent findings in the literature (Anestis & Joiner, 2011, Anestis et al., 2012, Maxfield & Pepper, 2017,

Picou et al., 2024). By relying solely on self-report measures to assess negative urgency, the construct may be inaccurately represented. Participants may find it difficult to accurately report on their impulsive tendencies under distress, and self-report tools often fail to capture the state-dependent nature of negative urgency, which are driven by affective responses in the moment rather than stable trait characteristics (Cyders & Coskunpinar, 2011; Hedge, Powell, Bompas, Sumner, 2020). Given the inconsistencies of self-reported negative urgency, this study aims to experimentally test the influence of negative affective states using a behavioral inhibition paradigm.

**Behavioral Indices: Emotional Response Inhibition**

As studies suggest, greater levels of impulsivity often reflect deficient inhibitory processes as an individual is unable to delay impulses without considering the implications of their actions (Bari & Robbins, 2013; Chen et al., 2021; Jauregi, Kessler, Hassel, 2018). Response inhibition, defined as the ability to suppress context-inappropriate actions that interfere with goal-directed behavior, is a key construct assessed through an array of cognitive tasks (Mostofsky & Simmonds, 2008). Further, in line with this study's focus on the interaction between emotion and behavior, emotional response inhibition (ERI) represents a particularly relevant extension of this construct as it captures how emotional stimuli modulates inhibitory action. This is especially important within the context of suicide risk, as ideation-to-action framework theories suggest the transition from thought to behavior may rely on one's ability to inhibit maladaptive urges in moments of intense affect (Brudern et al., 2022; Joiner, 2005; Klonsky & May, 2015; O'Connor, 2011).

Response inhibition can be divided into distinct phases: an early stage involving the suppression of impulses before engaging in a motor response, and a later stage, typically referred

to as action termination, that reflects the ability to cancel an already-initiated behavioral response as indexed by a stop-signal task design (Allen et al., 2021). Across healthy and transdiagnostic clinical samples, studies have shown that emotion plays a critical role in either enhancing or impairing cognitive performance depending on the emotional potency of the stimuli in stop-signal paradigms (Hartikainen, Ogawa, Knight, 2000; Pessoa et al., 2012; Phelps, Ling, Carrasco, 2006). Some studies suggest that, regardless of emotional valence, stimuli with a high degree of arousal can lead to prolonged response times and delayed stopping latencies (Verbruggen & De Houwer, 2007; You et al., 2020). Furthermore, theories suggest that delays in response times may result from the disproportionate allocation of attentional resources to the emotional valence of the stimuli, thereby reducing attention to task-relevant demands (Hartikainen et al., 2000). Overall, there is a clear connection between the recruitment of attentional resources and the ability to effectively inhibit responses to emotionally valanced stimuli, such that intense negative affective states may impair one's ability to inhibit responses.

A few studies have found that later-stage ERI impairment may underpin emotion dysregulation across transdiagnostic samples (Allen et al., 2021; Rogante et al., 2024; Hoptman et al., 2024). These findings suggest that an individual's potential difficulties in managing complex, negative emotions may be linked to increased risk for suicidal behaviors; however, there is limited research in this domain with only one study drawing a clear connection (McPherson et al., 2022). One study assessed inhibition difficulties among adolescents with acute suicide risk and found similar response time and accuracy as compared to healthy controls (Porteous et al., 2021). A study in a sample of individuals engaging in non-suicidal self-injury (NSSI) found individuals with NSSI had worse negative emotion action termination compared to healthy controls, such that they were unable to accurately withhold a prepotent responses to

negative affective images (Allen & Hooley, 2019; Allen et al., 2021). These limited and somewhat contrasting findings highlight the need for additional research that behaviorally assesses emotion-specific inhibitory control among suicide-risk populations.

For the purposes of this study, emotional response inhibition will serve as a behavioral proxy for negative urgency. Given the benefits of a controlled laboratory environment, a task-based approach in assessing the behavioral correlates of response inhibition was deemed appropriate for the current study. Therefore, to address the lack of understanding regarding behavioral indices of negative urgency and its role in suicide risk, this study aims to examine whether suicidal individuals evidence deficits in inhibitory control in response to negative information, using the emotion stop-signal task (ESST) as a validated behavioral task (Allen et al., 2021).

**Neural Markers of Response Inhibition**

The neural mechanisms underlying the association between negative urgency and suicide risk also remain largely unexplored. The neural markers underlying critical processes such as response inhibition offer valuable insight into how the brain regulates cognitive control and decision-making, particularly under affective conditions. Response inhibition is a core component of the broader executive control network, which encompasses a set of flexible, top-down cognitive processes that support goal-directed behavior, including working memory, attentional allocation, and cognitive flexibility (Diamond, 2013). These functions are primarily localized within the prefrontal cortex, which plays a vital role in maintaining and manipulating abstract information such as task goals (Munakata et al., 2012). While the right inferior frontal gyrus (rIFG) has been consistently implicated in enacting inhibitory control, evidence suggests that inhibition reflects a broader interaction among multiple prefrontal regions (Tabibnia et al.,

2011). Notably, studies have observed increased bilateral activation in the dorsolateral prefrontal cortex (DLPFC), ventrolateral prefrontal cortex (VLPFC), and parietal cortex (PC) during successful inhibition, supporting the notion of a distributed inhibitory network.

Event-related potentials (ERPs), time-locked voltage fluctuations in neural activity elicited by specific stimuli or events, offer a temporally precise method for examining the neural dynamics of response inhibition. Of particular interest is the fronto-central P300 (P3) component, which typically emerges 250 to 500 milliseconds after the presentation of task-relevant stimuli. The amplitude of the P3 has been linked to processes such as attention allocation, working memory, and notably, inhibitory control (Hajcak & Foti, 2020). In the context of stop-signal paradigms, numerous studies have reported larger P3 amplitudes during successful stop trials compared to failed ones in healthy individuals (Bekker et al., 2005; Dimoska et al., 2006; Greenhouse & Wessel., 2013; Waller, Hazeltine, Wessel, 2021). In other words, these findings indicate a more robust P3 response reflects a stronger ability to inhibit responses. Additionally, the onset latency of the fronto-central P3 closely correlates with stop-signal reaction time (SSRT) in healthy populations and is sensitive to the success of the inhibition attempt itself (Wessel & Aron, 2014). Put differently, if an individual is successful in inhibiting a response, they would display a shorter P3 latency with even shorter latencies on successful trials. Few studies to date have examined neural activity in response to the emotion stop-signal task in clinical populations. Studies among individuals with depression (Camfield et al., 2018) and high schizotypy (Jia et al., 2023) have found a reduced NoGo P3 component in response to both positive and negative stimuli, relative to neutral stimuli, suggesting impaired inhibitory processing across emotional contexts. Together, these findings provide evidence that the P3 is modulated by emotional contexts, and clinical samples show a smaller P3 response indicating

impaired engagement of the inhibitory network and poorer behavioral control. However, studies have yet to examine potential differences in P3 responses as they relate to emotional response inhibition among suicidal individuals. In the context of suicide risk, this pattern may reflect an inability to inhibit acting on suicidal thoughts and a greater risk for engaging in suicidal behavior, particularly in the context of intense negative emotional states linked to suicide ideation. This study aims to examine the neural correlates underlying behavioral and negative urgency and negative emotional response inhibition as it relates to suicide risk.

**Simulating Affect-Driven Impulsivity**

Mood induction procedures (MIPs) are widely used in clinical research to experimentally alter participants' affective states in a controlled environment (e.g., Ferrer et al., 2015; Hewig et al., 2005; Rottenberg et al., 2007; Westermann et al., 1996). These techniques, often involving emotionally evocative stimuli such as film clips, music, or guided imagery (Gross & Levenson, 1995; Khalfa et al., 2008; Mayer et al., 1995), allow researchers to simulate real-world emotional experiences and investigate their impact on behavior and neural activity.

In the context of suicide research, MIPs offer a valuable opportunity to examine how transient mood states, particularly negative affect can influence mechanisms associated with elevated suicide risk, such as emotion regulation, decision-making, and inhibitory control (Bibb et al., 2025; Colmenero-Navarrete et al., 2022). For example, prior studies have demonstrated that individuals with a history of suicidal thoughts or behaviors often exhibit heightened emotional reactivity and impaired cognitive control under distress, factors not easily captured through self-report or tasks conducted in affectively neutral contexts (Bredemeier & Miller, 2015; Dougherty et al., 2004).

While the Emotion Stop-Signal Task (ESST) incorporates emotionally valanced images to disrupt inhibition, it does not manipulate or sustain broader mood states. In other words, it captures transient emotional interference in response to momentarily appearing stimuli, rather than longer lasting mood states under which real-world impulsive or suicidal behaviors are likely to occur. Consequently, the ESST alone may not fully reflect the role of negative urgency because it lacks the mood-driven context in which these impulsive actions typically emerge.

By incorporating MIPs into the ESST paradigm, this study introduces a state-based perspective on emotion response inhibition, capturing the influence of sustained negative affect on cognitive control. This combination provides a more ecologically valid and clinically meaningful approach for understanding how negative urgency and mood interact to impair inhibition and potentially elevate suicide capability. In doing so, the study moves beyond isolated stimulus-response associations and toward a broader understanding of suicide-relevant mechanisms relevant under real affective conditions.

**Study Aims**

Despite extensive research, important gaps remain in our understanding of the role that negative urgency plays in elevated risk for suicide behaviors. Moreover, no studies to date have examined how affective states may influence behavioral inhibition and its neural correlates among suicidal individuals. Thus, the present study aims to address these gaps by examining responses to an emotion-based behavioral inhibition task following a negative mood induction procedure while assessing neural fluctuations. Study aims are as follows:

**Aim 1.** We aim to examine 1a) whether individuals with a history of suicide attempt and/or ideation evidence deficits in response inhibition relative to healthy controls and 1b) if this

deficit is pronounced in the context of negative mood states. To this end, the study utilizes the emotion stop-signal task (ESST) to examine key performance metrics, including stop-signal reaction time (SSRT), negativity bias, and miss rate. Particular emphasis is placed on the nSSRT, as it reflects the efficiency of response inhibition, a core facet of top-down control, for negatively valanced stimuli. Assessing these behavioral outputs is critical for understanding how affective states may alter cognitive control processes potentially leading to delayed inhibitory responses and biased classification of stimuli, regardless of their emotional valence. Therefore, we expect individuals in the suicide risk group to exhibit prolonged SSRTs in negatively valanced trials, an increased negativity bias, and higher miss rate, defined as the percentage of go trials in which response is omitted.

**Aim 2.** We aim to examine the neural correlates associated with suicide behavior and negative emotional response inhibition. Given the extensive literature identifying the P3 event-related potential (ERP) as a neural marker of response inhibition in general (Hajcak & Foti, 2020; Wessel & Aron, 2016) and findings that show reduced P3 amplitudes in transdiagnostic clinical populations (Camfield et al., 2018; Jia et al., 2023), this study seeks to investigate how P3 activity is modulated under negative mood states in an elevated suicide risk population compared to healthy controls. Specifically, we hypothesize that compared to healthy controls, individuals in the suicide risk group will exhibit a blunted P3 amplitude during stop trials, particularly trials involving negatively valanced stimuli further reflecting impairments in inhibitory control under emotional distress. Additionally, we hypothesize that these differences will be pronounced in the context of negative mood states. Secondary analyses will explore P3 responses (amplitude and latency) across Go and NoGo trials for all emotional conditions

(positive, negative, and neutral), to further characterize affect-specific modulation of cognitive control.

## Method

### Participants

#### *Recruitment*

A total of 48 young adults will be recruited and assigned to one of two groups: a suicide risk group ($n$ = 24) and a control group ($n$ = 24). Participants will be recruited through FSU's psychology subject research pool (SONA) and the Tallahassee community via flyers.

#### *Inclusion and Exclusion Criteria*

General inclusion in the study requires participants to be between ages 18 and 35, able to give informed consent, speak English, and be right-handed as to maintain standardization across the sample and eliminate lateralization differences (Lajtos et al., 2023; Provins & Cunliffe, 1972). Exclusion criteria include currently taking medications affecting neurophysiological arousal (stimulants, benzodiazepines), neurological disorders, active mania or primary psychosis, active substance use, a history of brain surgery or traumatic brain injury, and potential imminent risk (e.g., resolved plans and intent; Depressive Symptom Index - Suicidality Subscale (DSI-SS; Joiner et al., 2002) score of ≥ 11 with intent rating greater than 8).

#### *Group Eligibility Criteria*

Participants will be grouped into two groups: a suicide risk group and a control group. Participants in the suicide risk group must have a lifetime history of a suicide attempt or active suicide ideation assessed via the Columbia-Suicide Severity Rating Scale (C-SSRS; Posner et al., 2011) screener. For the control group, participants cannot have a history of any self-reported psychiatric diagnoses or a lifetime history of a suicide attempt or active/passive suicide ideation.

## Behavioral Tasks

### *Emotion Stop Signal Task (ESST; Allen et al., 2021).*

Participants indicate their response on go/no-signal trials by quickly and accurately categorizing valanced images as either positive (i.e., 'pleasant') or negative (i.e., 'unpleasant') by keypress, based on their automatic, reflexive, or 'gut' reaction to the affective content of each image. However, on random trials, an auditory stop signal will be presented, instructing participants to inhibit both their emotional response and accompanying motor action. Throughout the task, positive, neutral, and negative images will be presented pseudo randomly with only positive or negative images being presented on stop signal trials. The task encompasses four blocks of 120 trials each *(N* = 480 total trials), with 75% containing no stop-signal trials (*n* = 360; 90 per block) and the remaining 25% being stop-signal trials requiring emotional response inhibition (*n* = 120; 30 per block). Images have been procured from the International Affective Picture System (IAPS: Bradley et al. 2017). Multiple behavioral indices can be derived from this task, including response time, accuracy, negativity bias, miss rate, and false alarm errors. The primary analysis will use the negative stop-signal reaction time (nSSRT), calculated by subtracting the median stop-signal delay (SSD) on stop-signal trials with negative images from the mean reaction time on go trials featuring negative images. Secondary analyses will include positive and neutral stimuli SSRT; response accuracy, defined as the proportion of go trials without a stop signal in which negative and positive stimuli are correctly identified; negativity bias, calculated based on the misclassification of stimulus valence; miss rate, defined as the proportion of unanswered go trials; and false alarm errors, calculated as the proportion of stop-signal trials in which participants fail to inhibit their response. The total duration of the task is approximately 15-20 minutes. The task will be run on an acquisition PC using Python and PsychoPy.

**Negative MIP.** Participants will view a 2 minute 51 second clip from the ending scene of *The Champ* (1979). This short clip depicts a young boy mourning his father's death following a brutal wrestling match. In a sample of 52 adults, the clip produced a 94.2% hit rate, defined as the percentage of participants who reported experiencing the target emotion at least one point more intensely than each of six nontarget emotions. Further, a 5.71 mean rating on a scale of 0 to 8 for target emotion was reported (Gross & Levenson, 1995; Gross et al., 1998). Afterwards, they will be provided with a visual analog scale to rate their mood on a scale of 1-10.

**Neutral MIP.** Participants will be instructed to enter a neutral mood and watch an edited 4-minute clip about magnets from the documentary program *Modern Marvels* (Dora et al., 2023). Afterwards, they will be provided with a visual analog scale to rate their mood on a scale of 1-10.

**Positive MIP.** Participants will be instructed to get into a happy mood then view an uplifting 4-minute video clip entitled "Hakuna Matata" from the animated 1994 *The Lion King* (Dora et al., 2023). Afterwards, they will be provided with a visual analog scale to rate their mood on a scale of 1-10.

**Interviews and Self-report Assessments**

***The Columbia-Suicide Severity Rating Scale (C-SSRS).***

The C-SSRS (Posner et al., 2011) is a comprehensive, evidence-based clinical measure designed to assess suicidal ideation and behavior across both the past four months and lifetime. It includes five binary (yes/no) items that capture the type of suicidal ideation an individual is experiencing, ordered by increasing severity (i.e., passive ideation, non-specific active ideation,

active ideation with methods without intent, active ideation with intent, and active ideation with a specific plan and intent). The C-SSRS also includes five items rated on a 5-point ordinal scale that assess frequency, duration, controllability, deterrents, and reasons for ideation, specifically with respect to the most intense period of ideation during both the lifetime and past four months. These intensity items are scored from 0 to 25, with higher scores indicating more severe worst-point ideation. Four additional items capture lifetime and past four-month history of suicidal behaviors, including preparatory acts, aborted, interrupted, or actual suicide attempts. Given the semi-structured nature of the interview, follow-up questions can be asked to clarify responses. Data from this interview will allow for exploratory analyses such as comparing behavioral and neural data based on recency of suicidal ideation or behaviors.

### *Self-Report Measures*

This study encompasses a comprehensive battery of self-report assessments aimed at assessing mood states, impulsivity, common comorbidities, and suicidal ideation or behaviors. These measures will be used in tandem with behavioral and neural data in drawing connections between mood, emotion response inhibition, and suicide.

**Demographics.** A short demographics assessment created for the purposes of the study will be administered to gather basic background information such as age, race, ethnicity, marital status, education status, history of self-reported psychiatric diagnosis, and psychiatric hospitalization.

**Patient Health Questionnaire (PHQ-9).** The PHQ-9 (Kroenke et al., 2001) is a 9-item self-report assessment indexing the severity of depressive symptoms. Participants rate items on a 5-point ordinal response metric ranging from 0 (Not at all) to 4 (Nearly every day). Total scores range from 0 to 27 with higher scores indicating greater severity of depressive symptoms. The

PHQ-9 has evidenced high internal consistency among clinical samples (α = .86-.89; Kroenke et al., 2001) and convergent reliability (i.e., positively correlated with anxiety [General Anxiety Disorder-7; Spitzer et al., 2006] and depression [Patient Health Questionnaire Anxiety and Depression Scale; Kroenke et al., 2016] among international university students (Rahman et al., 2022). Additionally, there is evidence of a high degree of test-retest reliability with an estimate of 0.82 (Kroenke et al., 2001).

**Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM-5) Level 1 Cross- Cutting Symptom Measure.** The CCSM (APA, 2013) is a 23-item self-report assessment developed to screen a broad range of psychiatric symptoms relevant to common mental disorders. There are 13 total symptoms domains assessed: depression, anger, mania, anxiety, somatic symptoms, suicidal ideation, psychosis, sleep problems, memory, repetitive thoughts and behaviors, dissociation, personality functioning, and substance use. Participants rate items on a 5-point ordinal response metric ranging from 1 (None/ Not at all) to 5 (Severely/ Nearly every day). Total scores range from 0 to 92, with higher scores indexing greater severity of symptoms within each domain. The CCSM domains showed excellent internal consistency (α = 0.96 for all items) and strong convergent validity with corresponding symptom measures: depression with PHQ-9 ($r$ = 0.73; Kroenke et al., 2001), anxiety with PSWQ ($r$ = 0.60; Meyer et al., 1990), substance use with AUDIT ($r$ = 0.45; Saunders et al., 1993) and DAST-10 ($r$ = 0.44; Skinner, 1982), and personality functioning with LPFS-SR ($r$ = 0.70; Morey, 2017). Other CCSM domains were also significantly associated with mental health measures. However, discriminant validity was poor for the anxiety and personality functioning domains (Doss & Lowmaster, 2022). This data will be used to characterize the suicide risk sample.

**Barratt Impulsiveness Scale Version 11 (BIS-11).** The BIS-11 (Patton et al., 1995) is a 30-item self-report assessment assessing various subdomains such as attention, cognitive instability, motor impulsiveness, cognitive complexity, perseverance, and self-control. Participants rate items on a 4-point ordinal response metric ranging from 1 (Rarely/ Never) to 4 (Almost always). Total scores range from 0 to 55 with higher scores indicating greater impulsivity across the subdomains. The BIS-11 has demonstrated good internal consistency (α = .71- .83), test-retest reliability over a four-week period (*r* = .83), and convergent validity with behavioral tasks and related self-report measures of sensation seeking and impulsivity in clinical and non-clinical samples (Stanford et al., 2009).

**Difficulties in Emotion Regulation Scale Short Form (DERS-SF).** The DERS-SF (Kaufman et al., 2015) is a 36-item self-report assessment examining difficulties in emotion regulation and includes 6 subscales: nonacceptance of emotional response, difficulties engaging in goal-directed behavior, impulse control difficulties, lack of emotional awareness, limited access to emotion regulation strategies, and lack of emotional clarity. Participants rate items on a 5-point ordinal response metric ranging from 1 (Almost never) to 5 (Almost always). Total scores range from 36-180, with higher scores indicating greater difficulties with emotion regulation. The DERS total and subscale scores have demonstrated excellent internal consistency (α = .93 - .95) and strong construct validity, including positive associations with measures of emotional avoidance and negative mood (Fowler et al., 2014). Test-retest reliability over 4–8 weeks is good (*r* = .88; Gratz & Roemer, 2004). Most relevant to the current study, the impulse control subscale (6 items) assesses how well an individual can control impulsive behaviors when experiencing negative emotions and has shown good internal consistency (α = .88; Hallion et al., 2018).

**Short UPPS-P Impulsive Behavior Scale.** The SUPPS-P (Cyders et al., 2014) is a 20-item self-report assessment capturing multiple facets of impulsivity via 5 distinct subscales: Negative urgency, lack of perseverance, lack of premeditation, sensation seeking, and positive urgency. Participants rate items on a 4-point ordinal response metric ranging from 1 (Agree strongly) to 4 (Disagree strongly). Total scores range from 20 to 80 points with higher scores indicating greater impulsivity. The negative urgency subscale (4 items) assesses impulsive decision making under negative affective states. The SUPPS-P has shown good internal consistency (α = .74–.88 across subscales) and convergent validity with the original full-length UPPS-P, behavioral disinhibition, and self-report measures of risk-taking and emotional dysregulation (Cyders et al., 2014). Test-retest reliability has been demonstrated over periods of up to 3 months (*r* = .81; Cyders et al., 2014).

**Positive and Negative Mood Affect Scale (PANAS).** The PANAS scale (Watson et al., 1988) is a 20-item self-report assessment of current positive and negative affect. Participants rate items on a 5-point ordinal response metric ranging from 1 (Very slightly or not at all) to 5 (Extremely). The scale is comprised of two subscales: positive (10 items) and negative (10 items). Subscale scores range from 10 to 50 points with higher scores indicating stronger affect. The PANAS evidenced strong internal consistency for both subscales (α = .86–.90 for Positive Affect; α = .84–.87 for Negative Affect) and good test-retest reliability over 8 weeks (*r* = .68–.71; Watson et al., 1988). It has been shown to have adequate convergent validity with mood and anxiety measures (BDI-II: Beck et al., 1996; PHQ-9: Kroenke et al., 2001; BAI: Beck et al., 1988) and has been validated across clinical and non-clinical populations (Diaz-Garcia et al., 2020).

**Depressive Symptom Index - Suicidality Subscale (DSI-SS).** The DSI-SS (Joiner et al., 2002) assesses key aspects of suicidal thoughts including their frequency, intensity, controllability, and the presence of suicide-related impulses over the past two weeks. Participants rate items on a 4-point ordinal response metric ranging from 0 (I am not having thoughts of killing myself) to 3 (I am having thoughts about suicide and have formulated a definite plan) for example. Total scores range from 0 to 12 with higher scores indicating greater severity of suicidal ideation. The DSI-SS has evidenced good internal consistency ($\alpha$ = .89-.91) and has shown convergent validity ($r$ = .52-.74) with other suicide-related measures (e.g., Beck Scale for Suicide Ideation [Beck et al., 1996]; Stanley et al, 2021). It is also sensitive to clinical populations and predictive of suicide attempts in high-risk samples (Stanley et al, 2021).

**Acquired Capability with Rehearsal for Suicide Scale (ACWRSS).** The ACWRSS (George et al., 2016) is a 7-item self -report assessment of aspects of acquired capability including pain tolerance, fearlessness about death, and preparations for suicide. Participants rate items on a 9-point ordinal response metric ranging from 0 (Not at all) to 8 (Very strongly) with higher scores indicating greater suicide risk. The ACWRSS has evidenced excellent internal reliability ($\alpha$ = .91; George et al., 2016) and strong convergent validity as scores were positively correlated with suicide risk factors (e.g., thwarted belongingness, perceived burdensomeness, suicide ideation, intent, readiness, and attempts) and negatively correlated with meaning in life.

**Visual Analogue Scale (VAS).** The VAS (Hayes & Patterson, 1921) is a 1-item self-report assessment indexing current mood rating and will be administered as part of the ESST task. Participants utilize a sliding scale response metric to represent their current mood ranging from 0 (Extremely negative) to 100 (Extremely positive). With total scores ranging from 0 to 100, higher scores indicate greater positive affect. While this presentation of the VAS is unique

to the task, a revised version of the Visual Analog Mood Scales (VAMS-R; Kontou et al., 2021) has evidenced high internal consistency in healthy and clinical populations ($\alpha = .74$, $\alpha = .80$, respectively).

**Procedures**

Prior to the session, participants will complete a brief phone screening to determine eligibility and provide an overview of the study. If the participant is deemed eligible and is interested in participating, they will be scheduled for the in-person study visit. Additionally, participants will be provided information on how to prepare for their in-person visit, including expectations regarding eating, drinking, and medications the day of their scheduled visit.

Prior to completing the study procedures, the study will be explained by the research staff and informed consent will be obtained. Next, participants will complete a physical data form to assess for day-of eligibility. Participants who were unable to adhere to day-of eligibility will be rescheduled. Once deemed eligible for the assessment session, participants will complete the brief self-report battery while they are being fitted with the high-density EEG cap. Continuous EEG will be recorded utilizing the EGI geodesic 64-channel saline-based system using standard 10/20 formatting. (Magstim EGI, Minneapolis, United States). Afterwards, the ESST task will be explained thoroughly, and the participant will have the opportunity to practice under supervision of the researcher. Next, participants will undergo either the neutral mood induction or the negative mood induction, which will be counterbalanced across participants within each group to control for ordering effects. Participants will provide subjective mood ratings (VAS) pre- and post- each mood induction procedure. Participants will complete the ESST following each of the two mood induction procedures, with continuous EEG data recorded during each task session.

Once the mood and ESST tasks are complete, the EEG cap will be removed, and the participant will be guided to an interview room to complete the C-SSRS interview with a trained researcher. Prior to the interview, participants will be reminded of the limits to confidentiality and risk procedures. Lastly, participants will complete the positive mood induction procedure. Prior to leaving, necessary suicide risk assessment (SRA) procedures will be completed, and all participants will be provided a study resource packet that includes a list of local and national crisis services. The SRA protocol will be developed and overseen by the study's clinical psychologist, Dr. Sarah Brown, and administered by Dr. Brown and the study lead, Morgan Brown.

**Preliminary Data Analytic Plan**

Prior to analyses data will be pre-processed, and behavioral and neural indices will be calculated based on group (suicide risk vs. control) and condition (neutral vs. negative mood). For the neural data, EEG recordings will be preprocessed and filtered using the EEGLAB toolbox in MATLAB (2023b). Following preprocessing, mean ERP amplitude and latency will be extracted for each ESST trial type (neutral, positive, and negative stimuli). Primary analyses will focus on a series of mixed-design 2 (Group) x 2 (Mood induction type) ANOVAs to examine differences in nSSRT based on group status (suicide risk vs. Control; Aim 1a and 2a) mood induction type (neutral vs. Negative), as well as if the impact of the mood induction differed based on group status (Aim 1b and Aim 2b). Stated differently, these analyses will test the main effects and interaction between group and mood induction on nSSRT and P3 amplitudes. Where appropriate, post-hoc t-tests and pairwise comparisons will be conducted to explore significant interactions. Additional exploratory analyses will be conducted to examine the associations between suicide risk factors (e.g., suicide capability, attempt status) and

measures of emotional response inhibition, as well as their corresponding neural correlates. For example, logistic regression analyses will be conducted to predict suicide attempt and/or ideation severity using a combination of self-reported negative urgency (SUPPS-P Negative Urgency subscale score), deficits in emotion dysregulation (DERS total score), performance on the emotion stop-signal task including nSSRT, emotional response accuracy, and miss rate, and P3 ERP metrics.

## Anticipated Difficulties

With any research study, there are anticipated challenges that may hinder data collection and impact study procedures and data analysis. The primary anticipated challenges include 1) difficulty recruiting the clinical sample of individuals with a history of suicide ideation or behaviors, 2) the resulting heterogeneity within the suicide risk group, 3) navigating the challenges of using experimental approaches with at-risk clinical groups to study suicide related processes. Inherently with research studies, recruiting eligible participants is a common challenge, particularly when targeting a population with a history of suicide ideation or suicide attempts. This issue arises for several reasons. Suicide ideation and suicidal behavior are relatively low-base rate behaviors; therefore, the potential pool of participants with these experiences is inherently lower. Additionally, individuals may choose not to disclose sensitive information in valuable screening assessments, or participants may be reluctant to enroll in studies assessing suicide risk. Furthermore, individuals in the suicide risk group may present with common comorbidities associated with suicide, such as anhedonia or social anxiety disorder (Nock et al., 2009; Gallagher et al., 2014). These conditions may hinder participation as they can contribute to avoidance of new environments, and discomfort performing a task in front of research personnel or disclosing sensitive information. To mitigate these potential challenges, we

plan to open recruitment to not only Florida State University students but the greater Tallahassee area via recruitment posters. To increase study feasibility, we are recruiting a broader sample of individuals with a history of either suicide ideation or suicidal behaviors, as opposed to focusing on a sample with more current suicide risk or a sample comprised only of individuals with a history of suicide attempts. Additionally, we will ensure that participants understand protections and limitations of confidentiality in the context of research and all procedures related to suicide risk management.

Although we purposely chose to recruit a broader suicide risk sample, this introduces potentially important ambiguity that could impact study findings. A broader suicide risk sample increases variability in the severity of symptoms, recency of suicidal ideation or attempts, comorbidities, cognitive function, and treatment history. Our approach may obscure associations between suicide risk and negative urgency as the group-level effects may be reduced due to greater individual differences. Despite these limitations, the proposed study will be a substantial contribution to the literature given no studies to date have implemented mood induction procedures to study behaviorally assessed negative urgency in a suicide risk sample.

Another challenge of this study is managing participant safety and addressing any potential psychological distress related to the negative mood induction and exposure to images that depict gore and violence. Although these procedures have been used in at-risk populations (Allen et al., 2018, You et al, 2020) and are not expected to cause significant distress, participant well-being and safety is of utmost importance. Therefore, we have incorporated a positive mood induction to mitigate potential short-term increases in distress and we have evidence-based risk assessment and management procedures in place to manage suicide risk. All participants will receive self-report measures and a gold-standard interview on suicide risk, which will directly

inform suicide risk management approaches based on level of risk (e.g., providing local and national resources, safety planning) and the need for further risk assessment by Dr. Sarah Brown.

## Anticipated Benefits

The overall goal of this research is to assess how negative urgency may play a vital role in the progression of suicidal thoughts to behaviors. Additionally, we seek to understand the behavioral and neural correlates underlying deficits in behavioral inhibition via negative urgency among suicidal individuals by assessing the influence of negative affect states that may better characterize suicide ideation states. Prior research on negative urgency and suicide has been limited, especially examining behaviorally assessed emotional response inhibition and the neural underpinnings of negative urgency as it relates to suicide risk. Additionally, this study will inform future research on the behavioral and neural markers associated with suicidal behaviors that could impact suicide risk assessment and intervention approaches. For example, if a distinct ERP marker can reliably indicate elevated suicide risk, it could serve as a valuable clinical tool, potentially saving lives given its non-invasive nature and ease of implementation.

Beyond identifying behavioral and neural markers of suicidality, this study adds to the understanding of theoretical models of suicide. While there several current theories of suicide that propose suicide capability mechanisms, theory alone does not fully represent the behavioral mechanisms underlying negative urgency and suicide risk. Therefore, the methods in which we currently rely on are not a sufficient representation of the behavioral aspects related to negative urgency. This study aims to address that critical gap by examining how individuals respond to emotionally charged stimuli in behavioral inhibition paradigms during negative mood states. Furthermore, this study provides insight into whether intense negative affect and compromised

cognitive control may contribute to the transition from suicidal thinking to engaging in suicidal behaviors.

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