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Exploring attentional biases, dispositional mindfulness, And the suicide Stroop

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EXPLORING ATTENTIONAL BIASES, DISPOSITIONAL MINDFULNESS, AND THE SUICIDE STROOP

A Thesis

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Masters of Arts

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The Department of Psychology

by

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Abstract

Extant research has found that attentional biases to suicide-related stimuli are relevant to suicidal thoughts and behaviors (STBs). As such, attentional biases are a core feature of both the Fluid Vulnerability Theory of Suicide and the cognitive model of suicide. Individuals with an STB history have demonstrated attentional biases to suicide-related stimuli on a suicide Stroop task, and this attentional bias has been found to aid in prediction of suicide attempts at six-month follow-up. Better understanding this attentional bias may be useful for informing mindfulness-based interventions which target attentional biases, as dispositional mindfulness has been found to be related to less interference on both the classic Stroop and emotional Stroop. The purpose of this study was to determine the feasibility of administering the suicide Stroop over the internet, determine if participants with past week suicidal ideation (SI) demonstrate a greater attentional bias to suicide-related stimuli than individuals who deny past week SI, and to determine if dispositional mindfulness moderates the relation between attentional biases on the suicide Stroop and past week SI severity. Participants were recruited based on their SI history using an online survey platform. Results indicated that (1) the suicide Stroop demonstrated unacceptable internal consistency reliability, construct validity, and criterion validity, (2) individuals who endorsed past week SI did not significantly differ from those who denied past week SI on mean RTs to suicide related stimuli, and (3) dispositional mindfulness was negatively related to past week SI severity. Limitations and future directions are discussed.
Brief Overview of Current Study

Worldwide, it is estimated that 800,000 people die by suicide each year (World Health Organization, 2017), and in the United States alone, approximately 47,000 people die by suicide annually (CDC, 2018). In addition, in the United States, 1.4 million individuals attempt suicide each year and another 9.8 million individuals report experiencing thoughts of suicide each year (Substance Abuse and Mental Health Services Administration, 2017). These numbers are alarming, and in the United States, these rates are increasing (Curtin et al., 2016). Developing tools which can aid in understanding suicidal thoughts and behaviors (STBs) has long been a goal of researchers and clinicians alike, but unfortunately the past 50 years of suicide research has done little to increase understanding of who is likely to die by suicide, and when (Franklin et al., 2017).

A significant portion of suicide research has focused on identifying risk factors of suicide. Some of the most common risk factors involve an individual’s STB history, depression symptoms, suicide specific cognitions (e.g., thwarted belongingness, psychache), substance use, sleep difficulties, and social isolation (Brown et al., 2000; Beautrais, 2000; Hawton et al., 2013). Although these factors are important in conceptualizing suicide risk, most people who endorse experiencing these risk factors will not go on to attempt or die by suicide, indicating poor specificity. In addition, the majority of suicide risk assessments rely on self-report measures. This is an easy and generally inexpensive method of gaining information related to STBs from an individual; however, reliance on self-report measures has revealed a host of problems.

For one, individuals with a history of suicidal behaviors demonstrate deficits in decision-making, reduced attention, reduced problem-solving abilities, reduced verbal fluency, over-generalized autobiographical memory, and impaired working and long-term memory, to name a
few (Barnes-Holmes et al., 2006; Jollant et al., 2011). In addition, Cha and colleagues pointed out that an individual may be motivated to conceal their suicidal thoughts (Cha et al., 2010) in part because of social stigma associated with suicide (Sudak et al., 2008) as well as other barriers to disclosure such as fear of hospitalization (Gilchrist & Sullivan, 2006) and the belief that they do not need help for their suicidal thoughts (Czyz et al., 2013). More recent research using Ecological Momentary Assessment has found that it is common for the severity of one’s suicidal thinking to deviate by an entire standard deviation in just a few hours (Kleiman et al., 2017). Taken together, these trends could help to explain findings which suggest that the majority of individuals who die by suicide denied suicidal ideation (SI) in their last medical encounter (e.g., Busch et al., 2003).

Because of these points, many researchers have called for the identification and investigation of “objective” behavioral measures of suicide risk which do not rely on self-report data (Glenn et al., 2017; Glenn & Nock, 2014). One such avenue of research has involved behavioral tasks which measure response latencies. One of the most famous is the Implicit Association Test (IAT; Greenwald et al., 1998). The classic IAT measures implicit bias and prejudice (e.g., implicit racism). The IAT has also been modified and used in suicide literature to measure implicit associations to death related words such as “suicide,” “death,” and “funeral.” One experiment using a suicide IAT found that increased response latencies to suicide related semantic stimuli concurrently predicted suicide attempt history and prospectively predicted suicide attempts at a six-month follow-up (Nock et al., 2010). Further, the suicide IAT exceeded the predictive ability of past suicide attempt history, psychiatric illness, patient prediction, and clinician prediction.
Similarly, the Stroop task has been used to determine if individuals with a history of STBs demonstrate an attentional bias opposed to an implicit bias, as measured by the IAT, to suicide-related stimuli. The classic Stroop task (Stroop, 1935) records response latencies of how quickly and accurately participants identify the color of words presented on a computer screen when the word spells out a color different than the color of the text (e.g., “GREEN” printed in the color blue). Larger response latencies indicate greater interference due to the inconsistency of the semantic/color combination of the stimuli. In one study, Cha and colleagues (2010) used a modified emotional Stroop task which included a suicide valence (i.e., suicide, death, funeral) as well as the general valences found in emotional Stroop tasks (e.g., negative valence, neutral valence). The task is similar to the classic Stroop, but instead of interference from semantic/color inconsistency, interference is interpreted as being due to the semantic (emotional) content of the word. The results of the study indicated that individuals with a suicide attempt history displayed an attentional bias to suicide-related stimuli. This attentional bias demonstrated good concurrent predictive validity and prospective predictive validity of suicide attempts in an inpatient psychiatric sample (Cha et al., 2010). This task will be referred to as the suicide Stroop.

Although the suicide Stroop measures interference due to the emotional nature of semantic or pictorial stimuli, the Stroop task broadly is a measure of selective attention—and attentional biases. The Stroop task has thus been commonly used for research of various psychopathologies, as attentional biases are a core feature of many theories of psychopathology and the target of many interventions (Tobon et al., 2011). Extant literature shows that attentional biases are characteristic of many mental ailments such as anxiety, depression, attention-deficit/hyperactivity disorder, schizophrenia, substance use, post-traumatic stress disorder, and eating disorders (Becker et al., 2001; Ben-Tovim & Walker, 1991a; Henik & Salo, 2004;
Williams et al., 1996). Some research suggests that attentional biases are directly related to specific features of one’s mental illness (Ben-Tovim & Walker, 1991b), but other research links attentional biases to negative words more generally and may serve as a transdiagnostic factor (Williams et al., 1996).

Many interventions have been developed which target attentional biases through different strategies. For example, a component of mindfulness-based interventions is to increase executive attention and decrease attentional biases to stimuli related to an individual’s psychopathology. Mindfulness can be defined as the intentional and nonjudgmental focus on the present moment. Mindfulness-based interventions have been largely successful (e.g., Goldin & Gross, 2010; Baer, 2006). For example, a randomized controlled trial of an eight-week mindfulness-based intervention led to reductions in attentional biases to physical pain in chronic pain patients (Garland & Howard, 2013). Another study found that a brief mindfulness intervention completely eliminated spontaneous approach reactions to images of food, and that this effect was maintained over a subsequent distraction period (Papies et al., 2012).

As past research has found individuals with STBs to have deficits in executive attention and increased attentional biases to suicide-related stimuli (e.g., Keilp, et al., 2013; Cha, et al., 2010), increasing mindfulness skills—focused, non-judgmental attention to the present moment—may be efficacious in treating individuals at risk for suicide. Research which has analyzed this question has had promising results thus far (e.g., Buitron et al., 2017). For example, Buitron and colleagues (2017) found correlational evidence that self-report mindfulness was protective against perceived burdensomeness and SI. In addition, Chesin and colleagues (2015) found that a nine-session mindfulness-based intervention was efficacious in lowering SI and depression symptoms in high-risk psychiatric outpatients.
The Stroop task has been found to be a good measure of mindfulness skills more broadly (e.g., Galla et al., 2011). Some research has found that dispositional mindfulness and mindfulness-related skills (e.g., non-rumination, mindful attention) act as protective factors against SI even in marginalized groups theorized to be at higher risk for engaging in suicidal behaviors (e.g., Wang et al., 2018; Tucker et al., 2014).

The current study aims to further research conducted on attentional biases to suicide using a suicide Stroop task (Cha et al., 2010). All past research using a computer-administered suicide Stroop has required participants to complete the suicide Stroop in person, making data collection difficult and often expensive. The current study aims to determine if it is feasible to have participants complete the suicide Stroop on their personal computer using an internet software designed to conduct reaction time tasks.

In the current task, participants with varying STB histories will complete a suicide Stroop as well as other self-report measures to determine if individuals who report past week SI demonstrate an attentional bias to suicide-related stimuli on the suicide Stroop compared to individuals who deny past week SI. In addition, participants will respond to self-report measures of mindfulness to determine if mindfulness interacts with attentional biases to suicide-related stimuli on the suicide Stroop to concurrently predict past week SI severity.

It is hypothesized that individuals who endorse past week SI will demonstrate an attentional bias to suicide-related semantic stimuli on the suicide Stroop. This means that participants who endorse past week SI will demonstrate mean reaction times (RTs) to trials that include suicide-related stimuli that are significantly larger than individuals who deny past week SI. It was hypothesized that past week and non-past week ideators will not differ in mean RTs to other stimuli, including negative but not suicide-related stimuli (e.g., Cha et al., 2010; Williams
& Broadbent, 1986). In addition, it was hypothesized that self-report mindfulness will buffer the relation between mean RTs to suicide-related stimuli and past week SI severity (e.g., Moore et al., 2012; Semple, 2010), such that at high levels of mindfulness, mean RTs to suicide-related stimuli suicide Stroop will not significantly related to past week.
Cognitive Models of Suicide

Dozens of models exist which aim to describe and predict who will die by suicide. One of the most studied is the Interpersonal Theory of Suicide (ITPS: Joiner, 2007) which posits that perceived burdensomeness and thwarted belonginess interact with suicide capability to confer suicide risk. Similar theories have since been developed as advancements and extensions of the IPTS. Among them are the Three Step Theory (3ST: Klonsky & May, 2015) which posits pain hopelessness, lack of connection, and capability are important to SI and the Integrated Motivational-Volitional model (IMV; O’Connor, 2011) which posits that defeat and entrapment confer risk for SI. Although all of these theories are different, they emphasize the thoughts and feelings an individual experiences as well as one’s capability for suicide (e.g., pain tolerance, access to means). In addition, they attempt to explain the escalation from experiencing SI to engaging in suicidal behaviors, and capability is often cited as the bridge between suicidal thoughts and suicidal behaviors. The theories have thus been coined “ideation-to-action” theories (Klonsky et al., 2017).

Generally, all these theories are concerned with what an individual is thinking as important for SI. Cognitive models of suicide, on the other hand, can be described broadly as also being interested in how the individual is thinking. The cognitive model of suicide (Wenzel & Beck, 2008) proposes three main constructs underlying suicidal behavior: dispositional vulnerability factors, cognitive process associated with psychiatric disturbance, and cognitive processes associated with suicidal behaviors. Dispositional vulnerability factors refer to dispositional-like psychological characteristics an individual has that increases their risk for engaging in suicidal behaviors. These can include characteristics like impulsivity, deficits in problem solving and memory, and personality traits like neuroticism and psychoticism.
Cognitive processes associated with psychiatric disturbance refers to erroneous “processing of external events or internal stimuli … therefore systematically distort[ing] the individual’s construction of his or her experiences” (Beck, 2005, p. 953-954).

As Beck (2005) points out, cognitive distortions are characteristics of many psychiatric disturbances like anxiety disorders, depressive disorders, substance abuse disorders, and schizophrenia. These cognitive distortions can include memory biases like overgeneralized memory and attentional biases like fixation and rumination. Important to note, these cognitive processes differ from dispositional vulnerability factors, as they are hypothesized to wax and wane with psychopathology symptom severity. Cognitive processes associated with suicidal behaviors, according to the cognitive model, are comprised of two suicide schemas: dispositional hopelessness and pain unbearability and are activated by dispositional vulnerability factors and or/ cognition associated with psychiatric disturbance. Wenzel and Beck (2008) hypothesized that when one or both of these suicide schemas interact with attentional fixation to suicide, the individual will experience suicidal ideation, and a suicide attempt occurs when the threshold of tolerance is surpassed.

Overlapping with “ideation-to-action” frameworks like the IPTS and 3ST as well as Wenzel & Beck’s (2008) cognitive model of suicide is the Fluid Vulnerability Theory of suicide (FVT: Rudd, 2006). The FVT is similar to theories like the IPTS and 3ST in that it weights the importance of suicide specific cognitions (e.g., thwarted belongingness, psychache, hopelessness); however, it includes a much larger scope of suicide related thoughts and does not weight the specific contents of suicide related thoughts as more relevant to suicide risk than others. Similar to the cognitive model of suicide, the FVT hypothesizes that maladaptive cognitive processes such as cognitive inflexibility and deficits in emotion regulation are
important to suicide. Unlike previous theories however, the FVT specifically emphasizes the temporal dynamics of suicide risk and highlights that suicidal crises can be relatively short in duration.

This is supported by research which has shown that severity of suicidal thinking can vary by at least one standard deviations in just a few hours (Kleiman et al., 2017). The FVT is thus nonlinear in nature, unlike ideation-to-action theories more broadly. It proposes that each person has some baseline risk for suicide which is comprised of historical factors (e.g., suicide attempt history, psychiatric status) and dispositional factors which include suicide specific cognitions classic to ideation-to-action theories as well as cognitive processes like attentional biases named in the cognitive model of suicide. Like the cognitive model of suicide, both what a person is thinking and how they are thinking are emphasized in the FVT as being important to suicide risk.

The FVT also describes the process of “activation,” which is when an individual experiences a stressor which escalates their risk past baseline and to acute. Because all people have differing levels of baseline risk, a stressor can “activate” a person to an acutely suicidal state which would not activate another person who has a lower baseline risk. The FVT, especially it’s nonlinear emphasis, has received support in several studies since it’s development. One study found that the wish to die varied in congruence with occurrences of suicidal behavior in individuals receiving a brief cognitive intervention (Bryan et al., 2016). Another study found that the content of social media postings (e.g., stressful events, cognitions, behaviors) did not only increase predictive validity of who died by suicide but also was helpful in determining proximity to suicide death in a sample of Veterans (Bryan et al., 2018).

One particular area of interest for much extant literature in cognition and suicide has focused on cognitive flexibility. Cognitive flexibility can be understood to involve “cognitive
processing strategies to face new and unexpected conditions” (Moore & Malinowski, 2009, p. 177). Deficits in cognitive flexibility can include dichotomous thinking, attentional biases, and overall deficits in problem solving. For example, individuals who score highly in rumination perform more poorly on measures of cognitive flexibility than individual who score lower on measure of rumination (Davis & Nolen-Hoeksema, 2000). These deficits in problem solving and attentional control could help account for the fact that hopelessness is considered by many theories to be integral to the development of suicidal thoughts (Klonsky & May, 2015; Rudd et al., 2010; Wenzel & Beck, 2008). Generally cognitive models of suicide such as Wenzel & Beck’s (2008) cognitive model and the Fluid Vulnerability Theory of suicide (Rudd, 2006) weigh historical factors, what people are thinking, how they are thinking, and external stressors as important to suicide risk.
Problems with Self-Report Assessment Measures of Suicide Risk

All models, in some way or another, rely on self-report. Dozens of self-report and clinician administered assessment measures are used in both clinical and research settings. A systematic review found that approximately 20 psychometrically sound assessment measures of suicide risk are used in research and practice (Brown, 2001). Among them are the 21-item Scale for Suicidal Ideation (SSI; Beck et al., 1979), the 19-item worst point adaptation of the SSI (SSI-W: Beck et al., 1999), and a single item of the Beck’s Depression Inventory (Beck et al., 1961). These measures have demonstrated good concurrent and predictive validity. For example, an individual who scores in the highest risk category on the SSI-W is 14 times more likely to die by suicide than an individual scoring in the lowest category (Beck et al., 1999b; Beck et al., 1979; Brown et al., 2000). There are also clinical interviews which directly assess desire to die such as the Self-Injurious Thoughts and Behaviors Inventory (SITBI; Nock et al., 2007) and the Parasuicide History Interview (PHI; Linehan et al., 1983), among others.

Although these assessment tools can be very helpful to clinicians and researchers alike, their use over the past decades has revealed a host of problems which do not necessarily reflect the psychometric properties of the measures themselves but reflect barriers to assessing suicide risk more broadly. The biggest obstacle associated with the use of measures such as these is the fact that they rely on self-report. Self-report is an easy and inexpensive manner in which a clinician or researcher can gain information regarding STBs from an individual. Extant literature suggests that individuals at risk for suicide are poor reporters of their own SI and are often inclined to conceal their suicidality for various reasons (Friedlander et al., 2012). Individuals experiencing STBs may also have more practical reasons of denying their own risk (e.g., Burton et al., 2012). In most states, an individual can be involuntary hospitalized for STBs, and this
could lead to a person choosing not to vocalize their intent or the severity of their suicidal thoughts. In a study of 854 high schoolers, participants were asked if they would seek help if they were experiencing thoughts of suicide. Approximately half of the sample responded “no” and indicated that “[they] would be afraid of being hospitalized” (Cigularov et al., 2008).

Suicide is a taboo topic, and the stigma associated with experiencing STBs could be the reason some individuals do not seek help from healthcare providers. In terms of stigma more broadly, research has found that the fear of being labelled as one’s mental illness can act as a barrier to help-seeking (Angermeyer & Matschinger, 2003). In 1966, researchers administered a social distancing scale which asked participants whether they would “go on a date with” various categories of people. The categories included suicide attempters, as well as Nazis, alcoholics, and various ethnic and religious groups. The researchers found that participants were less likely to report that they would go on a date with suicide attempters than all ethnic and religious groups provided. Of note, suicide attempters were ranked just six places below Nazis. These results were successfully replicated 25 years later (Lester, 1993). Even today, individuals with a history of STBs perceive stigma and shame regarding suicide which can act as a barrier to help seeking (Reynders et al., 2015).

Stigma received from the public (“Suicide attempters are weak”) can lead to internalization (“I am weak”). To demonstrate, qualitative research found that individuals who previously attempted suicide viewed themselves to be a burden to others, unreliable, and less admirable than those who had not attempted suicide (Rimkeviciene et al., 2015). Stigma has also been found to be related to worsened outcomes in some populations. For example, stigmatization has been found to be positively related to various mental health ailments (e.g., depression, anxiety; Logie et al., 2012) and negatively related to overall wellbeing in minority groups.
(Kelleher, 2009). Unfortunately, this stigmatization does not exist solely in the general population: medical students have also been found to report stigmatizing views of suicidal patients (Emul et al., 2011). Because of these factors, stigmatization of suicide could potentially inhibit an individual from vocalizing their own suicidal intent.

Individuals experiencing STBs may also have more difficulty vocalizing their risk due to deficits in cognitive functioning. Research has found that individuals who have previously attempted suicide demonstrate decreased verbal and design fluency (Bartfai et al., 1990), diminished executive functioning (Marzuk et al., 2005), and deficits in problem solving (Schotte & Clum, 1987; Jollant et al., 2011). In one study, individuals with a history of suicidal behavior performed less accurately on measures of working memory and attention, including a classic Stroop task, than both healthy controls and individuals with depression (Keilp et al., 2013). In terms of self-report measures, these deficits in cognitive functioning could cause an individual to have trouble identifying and vocalizing thoughts related to suicide. These findings have helped to inform cognitive models of suicide which place an emphasis on cognitive flexibility, executive function, and emotion regulation (Rudd, 2006; Wenzel & Beck, 2008).

More recently, researchers have questioned if reduced vocalization of suicidal intent could be related to temporal dynamics of suicide risk, as proposed by the FVT (Rudd, 2006). In a study using Ecological Momentary Assessment (EMA), adolescent participants recently discharged from the hospital for STBs reported the frequency and severity of their suicidal thoughts to deviate by at least 1 standard deviation each day and by several standard deviations over a 28-day period (Czyz et al., 2018). In another similar study using EMA, a quarter of all suicide-related ratings varied by a standard deviation above or below their previous response (Kleiman et al., 2017). Kleiman et al. (2017) also noted that in the second sample, 100% of
participants experienced a change in suicidal thinking which was one standard deviation above or below their previous rating of suicidal thoughts (Kleiman, et al., 2017). Husky et al. (2017) conducted a similar EMA study with adults recently discharged from the hospital following a suicide attempt. Their results found that the occurrence of suicidal thoughts varied day to day, and that certain factors (e.g., negative family events) increased the probability of the occurrence of suicidal thoughts.

Although it has previously been thought that denial of suicidal thoughts in individuals who later go on to die by suicide is due to factors such as stigma alone, it could also reflect genuine changes in the experience, frequency, duration, and severity of suicidal thoughts. Because of this, a self-report measure of STBs administered by a provider may not be sensitive to the temporal dynamics of suicide risk. In other words, they might not be having suicidal thoughts at the moment, or any time recently, to taking the self-report measure. A denial of suicidal thoughts may not mean that the individual is at a lower risk for suicide, but it could mean that they are at risk for not getting suicide-related care when it is needed.
Behavioral Measures of Suicide

Due to the aforementioned issues regarding self-report measures and clinician rated suicide risk, it is important to determine if suicide risk can be assessed using objective, behavioral measures. The Research Domain Criteria (RDoC: Insel et al., 2010) has been identified as a valuable framework in which to study suicide (Glenn et al., 2017). The RDoC matrix includes various domains of research (positive/negative valence, cognitive systems, social processes, arousal and regulatory systems, sensorimotor systems) all with their own subdomains which can be measured using different units of analysis (genes, molecules, cells, circuits, physiology, behavior, and self-report). The five transdiagnostic domains and seven units of analysis were determined based on evidence of underlying neural circuits (Cuthbert & Kozak, 2013). The goal of RDoC is to fill in the entire matrix so as to develop of transdiagnostic framework of all levels of functioning from typical to atypical and to discover potential endophenotypes for various psychopathologies by identifying “dimensions of observable behavior and neurobiological measures” (NIMH, 2008).

Behavioral measures of suicide have been of interest to many suicidologists as they do not rely on self-report, can be researched in connection to other units of analysis (e.g., eye-blink rate as a proximal measure of dopamine functioning), and can inform theories of suicide which include various domains of functioning (Glenn et al., 2017; Rudd, 2006; Wenzel & Beck, 2008). The negative valence system of RDoC is perhaps the domain for which most suicide research has been conducted, as it contains sustained threat (e.g., trauma, bullying, hopelessness), potential threat (e.g., anxiety disorders), loss (e.g., death of a family member, loss of employment, loneliness), frustrated non-reward (e.g., aggression, irritability, anger, substance abuse), and acute threat (e.g., panic attacks; Glenn et al., 2017).
The social processes domain has been a focus of suicide research as it contains affiliation and attachment (e.g., perceived burdensomeness, attachment style, religiosity), perceptions of self (e.g., implicit self-identification with death), perceptions of others, and social communication (Glenn et al., 2017). The Implicit Association Task (IAT) for suicide falls under this domain and is the most studied behavioral task related to suicidal behaviors. The classic IAT measures how strongly participants associate certain stimuli (e.g., people of color) with certain evaluations (e.g., good, intelligent). The IAT has been found to have very strong psychometric properties, as it has demonstrated strong reliability (Banse et al., 2001; Cunningham et al., 2001) and construct validity (Banse et al., 2001; Lane et al., 2007). In addition, the IAT is resistant to participant attempts to demonstrate themselves as being less biased toward stimuli being measured (e.g., Banse et al., 2001).

This is particularly important when for measuring suicide risk, as individuals experiencing thoughts of suicide may be motivated to conceal their SI (e.g., Cha et al., 2010; Sudak et al., 2008). The longer it takes participants to match a stimulus with an evaluation is interpreted as more interference due to unconscious bias toward stimulus/evaluation match. In an IAT modified to measure implicit attitudes toward self-injury, researchers found that the IAT was able to predict suicide related outcomes both concurrently and prospectively (Nock & Banaji, 2007; Nock et al., 2010). A study with over 7,000 participants found that self-harm and suicide IATs were able to differentiate individuals with and without a history of non-suicidal self-injury and suicide attempts (Glenn et al., 2017).

Similar to the IAT is the Implicit Relational Assessment Procedure (IRAP: Barnes-Holmes et al., 2006) which was developed to measure implicit relations people have toward specific stimuli. Instead of measuring whether or not a stimulus is “good” or “bad”, as one might
in an IAT, the IRAP allows participants to rate how similar or different combinations of stimuli are while being instructed to complete the task as if a certain kind of stimuli is good or bad. The IRAP has demonstrated good reliability, predictive validity, and construct validity (Barnes-Holmes, & Stewart, 2010; Barnes-Holmes et al., 2009). It has also demonstrated resistance to “faking” attitudes (McKenna et al., 2007). A single study has analyzed relational biases using the IRAP in individuals reporting suicidal thoughts and found that the stimuli “my death” but not “death” correctly classified 75% of individuals by group (STBs or control; Hussey et al., 2016). The IRAP for suicide, like the IAT, falls under social processes (perceptions of self) of RDoC, but can also be connected to the language subgroup of the cognitive systems domain (see Relational Frame Theory; Barnes-Holmes & Roche, 2001) as well as sustained and acute threat from the negative valence system (e.g., fearlessness of death).

The cognitive systems domain has also been particularly relevant to many theoretical models of suicide. The cognitive systems domain contains aspects of memory (declarative and working) as well as cognitive control (e.g., executive attention, problem solving, inhibition and activation, attentional control), perception (e.g., hallucinations, pain), and language (e.g., speech patterns, anhedonic speech; Glenn et al., 2017). Research analyzing attentional biases in individuals who have attempted suicide using the suicide Stroop falls under the cognitive systems domain and can include cognitive control and attention.
The Suicide Stroop

The suicide Stroop is a behavioral measure which presents various words which fall into specific valences. The first computerized version of the suicide Stroop was created by Cha and colleagues (2010) and includes the following valences: suicide-related (i.e., suicide, funeral, death), negative (i.e., rejected, stupid, alone), positive (i.e., happy, success, pleasure), and neutral (i.e., museum, paper, engine). Stimuli were chosen based off extant literature assessing suicide-related constructs with behavioral measures (e.g., suicide IAT) (Nock et al., 2010) as well as their clinical relevance. In addition, Cha and colleagues (2010) found that the stimuli chosen did not significantly differ in length, emotionality, or general frequency of use within the English language. Each word is presented in one of two colors, and participants much match the word to the correct color as quickly as possible.

A task similar to the suicide Stroop was first used by Williams & Broadbent (1986) who found that individuals with a history of suicidal behaviors took longer to identify the color of suicide-related stimuli than depressed controls. These results were successfully replicated more than a decade later (Becker et al. 1999). Cha et al. (2010) successfully replicated these results again, this time using a computerized suicide Stroop. In addition, the results of the study found that the time it took participants with suicidal histories to identify the color of suicide-related stimuli was negatively related to time passed since last suicide attempt—indicating attentional biases might wax and wane with severity of STBs and supporting temporal models of suicide (Rudd, 2006). The suicide Stroop was also able to improve prediction of who from the sample would attempt suicide at 6-month follow up above and beyond the usual clinical predictors (Cha et al., 2010). However, Chung and Jeglic (2016) only partially replicated the result in a study of 820 college students, finding no difference in reaction time for suicide valanced words compared
to other valences but only for the single word “suicide.” This effect was no longer significant when controlling for depressive symptoms; however, this failure to replicate was found in a far less severe sample (i.e., college students vs. discharged inpatients).

The suicide Stroop has thus garnered mixed results, and more recently, an investigation of the suicide Stroop psychometric properties has introduced doubt regarding attentional biases and suicide (Wilson et al., 2019). In this meta-analysis, the suicide Stroop was found to have unacceptably low internal consistency when using interference scores and did not demonstrate concurrent validity (i.e., prediction of suicide attempt history). However, they found that use of mean RTs demonstrated acceptable internal consistency for both psychiatric and general adult populations. Although the results of the meta-analysis did not indicate that attentional biases to suicide were able to concurrently predict suicide attempt history, the researchers noted that they did not sample for a specific control group, such as nonsuicidal depressed adults, or control for depression which could have confounded the results of their study. In addition, they used a categorical outcome variable (suicide attempt history vs no suicide attempt history) and thus were not able to capture severity or recency of attempt history or any information related to the presence of SI and/or the severity of SI. Importantly, concurrent predictive validity was the only measure of validity included in the meta-analysis, and the authors note that, although one study of inpatient individuals did not find evidence of concurrent prediction, it did predict suicide attempts at 6 month follow-up above and beyond the usual measures of suicide risk (Cha, et al., 2010; Wilson, et al., 2019), supporting the validity of the construct being measured. Furthermore, Richard-Devantoy and colleagues (2016) meta analyzed the results of four suicide Stroop studies and found that suicide attempters demonstrated a bias to suicide-related words, but not negatively valenced words, providing evidence of construct validity. Also of note, the
data cleaning procedure removes incorrect responses and correct responses two standard deviations above or below a participants’ mean RT, but as Wilson et al., (2019) point out, an incorrect trial or a very lengthy RT could be indicative of an attentional bias.

Although there is some evidence that the suicide Stroop lacks concurrent predictive validity, it has demonstrated predictive validity above and beyond the commonly assessed risk factors for suicide and has demonstrated good internal consistency when using mean RTs. In addition, the suicide Stroop has demonstrated construct validity in several previous studies (e.g., Richard-Devantoy, et al., 2016; Cha, et al., 2010). Of note, convergence and divergence regarding mean RTs to suicide-related stimuli and other suicide Stroop valence categories has yet to be analyzed. Specifically, no study has analyzed if mean RTs to suicide-related stimuli are related to other known suicide-risk factors (e.g., psychache, hopelessness, suicide cognitions) in addition to their relation with SI severity.

In addition, it remains unstudied is if the suicide Stroop demonstrates acceptable internal consistency reliability and validity when administered on participant’s personal computers. This is an important area of research, as exploring the nature of attentional biases to suicide is essential for investigating theories of suicide where maladaptive cognitive processing styles are said to be at play (e.g., the cognitive model of suicide, the FVT); however, suicide is a low base rate phenomenon. Having to rely on in-person data collection is time consuming and expensive. Determining the feasibility of administering the suicide Stroop over the internet is thus important for the swift progression of suicidology as well as for future researchers to address remaining limitations of the current suicide Stroop. Research of attentional biases using the suicide Stroop is also important for determining if attentional biases are a useful treatment target for individuals
with a history of STBs, as interventions like cognitive behavioral therapy and mindfulness-based therapies both seek to reduce maladaptive attentional processes like rumination and fixation.
Dispositional Mindfulness, the Stroop Task, and Suicide

Mindfulness can be characterized as “the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment to moment” (Kabat-Zinn, 2003, p. 145). Mindfulness originated from Buddhist philosophy (see Satipatthana Sutta) and has been adapted as a common therapeutic practice in the “West,” often in the form of stress reduction and relaxation (e.g., Kabat-Zinn, 1982, 1990). Mindfulness-based interventions are often targeted at cognitive flexibility and reactivity. One study found that a single, brief mindfulness intervention was negatively related to mind-wandering during an attentional task, and that this relation was not seen in passive relaxation or control groups (Mrazek & Smallwood, 2012). Because of this, mindfulness is often prescribed as a treatment for psychopathologies where cognitive inflexibility is said to be at play, such as with depression, anxiety, and obsessive-compulsive disorder.

Such change in cognitive flexibility through mindfulness practice has been demonstrated through behavioral tasks such as the Stroop task. In one study, mindfulness meditators demonstrated less interference—they performed more quickly and accurately—on the classic Stroop task, than non-meditators and scored higher on every measure of self-report attention than did non-meditators (Moore & Malinowski, 2009). This finding is comparable to research which has found that mindfulness meditators can interrupt habitual responding on behavioral tasks (Wenk-Sormaz, 2005) and are less susceptible to distraction than non-meditators on behavioral tasks (Fan et al., 2002). In a randomized control trial, the mindfulness meditation group showed greater discriminability of a signal detection task and demonstrated increases in sustained attention not explained by relaxation or practice effects (Semple, 2010). In this signal detection task, participants were asked to identify the letter “X” as it appeared on a computer screen from
eleven possible letters, but only if it preceded the letter “A”. A randomized mindfulness intervention led to decreased cognitive rigidity in an Einstellung water jar task (Greemberg et al., 2012). This water jar task is said to measure the “Einstellung effect,” which is where rigid problem-solving patterns formed through experience preclude consideration of simpler problem-solving approaches (Greemberg et al., 2012). Behavioral findings such as these are corroborated by neurobiological research which has found that daily brief, mindfulness meditation practice improves the efficiency of cognitive resources, as measured by electrophysiological markers of attention control, causing improved self-regulation and attention (Moore et al., 2012). Although mindfulness is an aspect of various interventions, it has also been cited as a dispositional characteristic (Tucker, et al., 2014).

Dispositional mindfulness refers to individual differences in mindfulness skills, such as the ability to have moment to moment awareness and the practice of non-judgment. There is evidence to suggest that, without mindfulness training or interventions, dispositional mindfulness remains consistent over time (Baer et al., 2004; Brown & Ryan, 2004). Self-report measures of dispositional mindfulness correlate in the expected directions with other self-report measures. For example, dispositional mindfulness is positively related to emotion regulation abilities (Goodall et al., 2012), wellbeing, self-control (Bowling & Baer, 2012), authenticity (Lakey et al., 2008), positive reappraisal (Hanley & Garland, 2014), and executive functioning (Riggs et al., 2015), and negatively related to impulsivity (Peters et al., 2011), rumination (Raes & Williams, 2010), defensiveness (Lakey et al., 2008), and neuroticism (Hanley, 2016).

There is also neurobiological evidence of individual differences in mindfulness. For example, individuals who report high levels of mindfulness demonstrate greater prefrontal cortical activation and reduced bilateral amygdala activity during a task where they must label
the affect of faces (Creswell et al., 2007). Self-report dispositional mindfulness has also been found to be negatively related to resting activity in self-referential processing areas of the brain and negatively related to resting activity in the amygdala (Way et al., 2010).

Mindfulness, particularly dispositional mindfulness, has been found to be protective in individuals experiencing STBs (e.g., Lamis & Dvorak, 2013). In an inpatient sample, dispositional mindfulness was negatively related to SI (Cheng, et al., 2017). In another study, dispositional mindfulness was found to be negatively related to SI and acted as a moderator in the relation between neuroticism/extraversion and SI (Tucker, et al., 2014). Mohammadkhani et al. (2015) suggested that dispositional mindfulness may be a better target for suicide prevention than identifying reasons for living, as dispositional mindfulness (and not reasons for living) mediated the relation between symptom severity and suicide-related outcomes. Overall, dispositional mindfulness has been found to be positively related to cognitive flexibility and attention through Stroop task performance and negatively related to STBs. These studies suggest that mindfulness may alter the effect cognitive inflexibility has on STBs. However, this hypothesis has gone unstudied.
Aims and Hypotheses

The current study had three aims: (1) to determine if the psychometric properties (i.e., internal consistency reliability, construct validity, criterion validity) of the suicide Stroop were acceptable when the suicide Stroop was administered online on participants’ personal computers, (2) to determine if participants who endorsed past week SI demonstrated a greater attentional bias to suicide-related stimuli than those who denied past week SI, and finally (3) to determine if self-report dispositional mindfulness moderated the relation between mean RTs to suicide-related stimuli on the suicide Stroop and past week SI severity.

It was hypothesized that the suicide Stroop, when administered on participants’ personal computers would (1) demonstrate acceptable psychometric properties (i.e., good internal consistency reliability, construct validity, and criterion validity). Regarding construct validity, it was expected the mean RTs to suicide-related stimuli would be positively related to past week SI severity as well as prominent correlates of SI (i.e., psychache, hopelessness, suicide cognitions) and would demonstrate non-redundant associations with mean RTs to other valence categories (e.g., negative). Regarding criterion validity, it was expected that mean RTs to suicide-related stimuli would predict past week SI severity above and correlates of SI, including depression symptom severity, hopelessness, and psychache. It was hypothesized that (2) individuals who endorsed past week SI would demonstrate significantly larger mean RTs to suicide-related stimuli than individuals who denied past week SI. Finally, it was hypothesized that (3), self-report dispositional mindfulness would moderate the relation between mean RTs to suicide-related stimuli and self-report SI severity—specifically higher levels of self-report mindfulness would attenuate the positive relation between attentional biases to suicide-related stimuli and past week SI severity.
Methodology

Procedure

Participants were recruited through Qualtrics Panels, a survey recruitment platform. Participants were invited to participate based off of a non-zero score on a single item from the Suicidal Behaviors Questionnaire (Osman et al., 2001) which assesses past year SI. This recruitment methodology has been used elsewhere to increase representation of STBs in suicide prevention research (Cramer et al., 2019). All study questionnaires and tasks were completed by participants online from their personal computers.

Participants responded to demographic questions, self-report measures of SI and suicide-related constructs, and the suicide Stroop (Cha et al., 2010). All participants completed the suicide Stroop prior to completing self-report questionnaires. At the completion of the study, participants were presented with a debriefing sheet which included national resources for mental health support and one-click options to contact the National Suicide Prevention Lifeline if in crisis. Participants were compensated by Qualtrics Panels for their completion of the survey.

A power analysis using G*Power (Faul et al., 2009) was conducted to determine the required sample size for study analyses. Aim three of the study required a linear hierarchical regression with two covariates (age, gender), two main effects (mean RTs for suicide related stimuli, mindfulness total score), and one interaction term (suicide-related Stroop scoresXmindfulness) resulting in five total predictors and one dependent variable (past week SI severity). For a small to moderate effect size ($F^2=0.08$), standard alpha ($\alpha=0.05$) and power (0.80), a minimum of 141 participants were required. This was hypothesized given previous research showing small to moderate moderating effects of mindfulness on the relations between suicide risk factors and SI (Tucker et al., 2014).
Participants

Approximately 2,529 individuals recruited by Qualtrics interacted with the study. Of those, 1,934 terminated at some point prior to completion (e.g., immediately after consent form; did not return to Qualtrics after completing suicide Stroop). Of the remaining, \( n=40 \) participants were removed for missing more than two attention checks, and \( n=8 \) were removed for failing to complete the Stroop task. Thus, the final sample was comprised of \( N=547 \) participants.

Participants excluded from the analyses did not significantly differ in past week SI severity \( t(379)=-0.22, p=.83 \); however, they did significantly differ in age \( t(583)=2.25, p<.05 \). Individuals excluded from the analyses (\( M=29.11, SD=8.27 \)) tended to be younger than those included in the analyses (\( M=35.31, SD=16.87 \)).

The majority of participants identified as Women (\( n=335, 61.2\% \)) and ranged in age from 18 to 72 (\( M=34.91, SD=16.87 \)). Participants described themselves as White (\( n=377, 68.9\% \)), African American/Black (\( n=49, 9\% \)), Latino(a)/Latinx (\( n=35, 6.4\% \)), Asian American/Asian (\( n=54, 9.9\% \)), American Indian or First Nation (\( n=2, 0.4\% \)), Biracial (\( n=28, 5.1\% \)), and not listed (\( n=2, 0.4\% \)). See Table 1 for participant demographic characteristics.

Past week SI was reported by almost two thirds of the sample (\( n=351, 64\%, M=14.78, SD=6.84 \)). Using the recommended PHQ-9 cutoff of 10 (Moriarty et al., 2015), the majority of participants screened positive for DSM-IV criteria for Major Depressive Disorder (\( n=393, 71.8\% \)). Participants demonstrated RTs to suicide-related stimuli (\( M=491.31, SD=157.70 \)), positive stimuli (\( M=488.29, SD=161.61 \)), negative stimuli (\( M=491.00, SD=156.52 \)), and neutral stimuli (\( M=489.76, SD=152.43 \)).
Table 1. Demographic characteristics of participants with past week SI and past year SI

*Note. SI=suicidal ideation*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Past week SI (N=351)</th>
<th>Past year SI (N=196)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Man</td>
<td>141 (40.2)</td>
<td>66 (33.7)</td>
</tr>
<tr>
<td>Woman</td>
<td>190 (54.1)</td>
<td>125 (63.8)</td>
</tr>
<tr>
<td>Transgender</td>
<td>6 (1.7)</td>
<td>1 (.5)</td>
</tr>
<tr>
<td>Gender Non-conforming</td>
<td>13 (3.7)</td>
<td>3 (1.5)</td>
</tr>
<tr>
<td>Not listed</td>
<td>1 (.3%)</td>
<td>1 (.5)</td>
</tr>
<tr>
<td><strong>Race/ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>234 (66.7)</td>
<td>143 (73)</td>
</tr>
<tr>
<td>Black or African American</td>
<td>34 (9.7)</td>
<td>15 (7.7)</td>
</tr>
<tr>
<td>Asian/Asian-American</td>
<td>37 (10.5)</td>
<td>17 (8.7)</td>
</tr>
<tr>
<td>Native American or American Indian</td>
<td>2 (0.6)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Latino(a)/Latinx</td>
<td>25 (7.1)</td>
<td>10 (5.1)</td>
</tr>
<tr>
<td>Biracial</td>
<td>18 (5.1)</td>
<td>10 (5.1)</td>
</tr>
<tr>
<td>Not listed</td>
<td>1 (0.3)</td>
<td>1 (.5)</td>
</tr>
<tr>
<td><strong>Sexual Orientation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straight</td>
<td>249 (70.9)</td>
<td>161 (82.1)</td>
</tr>
<tr>
<td>Gay</td>
<td>10 (2.8)</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Lesbian</td>
<td>9 (2.6)</td>
<td>4 (2)</td>
</tr>
<tr>
<td>Bisexual</td>
<td>65 (18.5)</td>
<td>18 (9.2)</td>
</tr>
<tr>
<td>Not sure</td>
<td>7 (2.0)</td>
<td>3 (1.5)</td>
</tr>
<tr>
<td>Not listed</td>
<td>8 (2.3)</td>
<td>5 (2.6)</td>
</tr>
<tr>
<td><strong>Highest Level of Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some grade school</td>
<td>3 (0.9)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Grade school</td>
<td>1 (0.3)</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Some High School</td>
<td>13 (3.7)</td>
<td>5 (2.6)</td>
</tr>
<tr>
<td>High School</td>
<td>72 (20.5)</td>
<td>36 (18.4)</td>
</tr>
<tr>
<td>Some College</td>
<td>93 (26.5)</td>
<td>64 (32.7)</td>
</tr>
<tr>
<td>College</td>
<td>108 (30.8)</td>
<td>66 (33.7)</td>
</tr>
<tr>
<td>Some professional school</td>
<td>11 (3.1)</td>
<td>4 (2)</td>
</tr>
<tr>
<td>Professional school</td>
<td>48 (13.7)</td>
<td>19 (9.7)</td>
</tr>
<tr>
<td><strong>Past year household income</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$0 - $10,000</td>
<td>67 (19.1)</td>
<td>35 (17.9)</td>
</tr>
<tr>
<td>$10,000 - $20,999</td>
<td>47 (13.4)</td>
<td>26 (13.3)</td>
</tr>
<tr>
<td>$20,000 - $30,000</td>
<td>56 (16)</td>
<td>21 (10.7)</td>
</tr>
<tr>
<td>$30,000 - $40,000</td>
<td>29 (8.3)</td>
<td>19 (9.7)</td>
</tr>
<tr>
<td>$40,000 - $50,000</td>
<td>25 (7.1)</td>
<td>15 (7.7)</td>
</tr>
<tr>
<td>$50,000 - $60,000</td>
<td>25 (7.1)</td>
<td>22 (11.2)</td>
</tr>
<tr>
<td>$60,000 - $70,000</td>
<td>23 (6.6)</td>
<td>7 (3.6)</td>
</tr>
<tr>
<td>$70,000 - $80,000</td>
<td>21 (6)</td>
<td>12 (6.1)</td>
</tr>
<tr>
<td>$80,000 - $90,000</td>
<td>10 (2.9)</td>
<td>10 (5.1)</td>
</tr>
<tr>
<td>$90,000 - $100,000</td>
<td>19 (5.4)</td>
<td>4 (2)</td>
</tr>
<tr>
<td>Above $100,000</td>
<td>29 (8.3)</td>
<td>24 (12.2)</td>
</tr>
</tbody>
</table>

**Measures**
**Demographics**

Participants responded to general questions that assessed sex, age, gender, sexual orientation, race and ethnicity, education level, and income level.

**Attention checks**

Participants responded to three questions which assessed whether or not they were paying attention to the questions being posed. Attention checks included “select ‘true’ if you are paying attention” and “select ‘strongly agree’ if you are paying attention” (Alvarez et al., 2019). These questions were embedded in the self-report measures throughout the study. Participants who missed two or more attention check questions were removed from study analyses.

**Suicide Stroop**

The suicide Stroop (Cha et al., 2010) measures attentional bias toward suicide-related stimuli. This behavioral task measures response times of how quickly participants identify the color of varying words presented on a computer screen. Larger response times were interpreted as representing greater attentional biases due to the nature of the semantic stimuli (e.g., suicide-related, negative valence, positive valence, neutral).

The task begins by briefly explaining the task and asking participants to complete it in a quiet and distraction-free environment. Next, task directions appear, instructing participants to choose the color of words (red or blue) on the screen by clicking a corresponding key as quickly and accurately as possible. Each trial begins with a blank four second white screen followed by a one second centered “+” followed by another one second white screen. Next, a word printed in either red or blue appears on the screen and remain there until the participant chooses a response (i.e., clicks one of the two possible keys). Per recommendations by Wilson et al., (2019) 12—opposed to eight—practice trials were administered to improve accuracy of performance and
preservation of instructions. The practice trials use number words such as “one” and “seven.” Following the practice trials, participants completed the critical trials in a single block design presented in random order. Each valence has three words presented over 12 trials for each of the four valences, equating to 48 critical trials. The critical trials included the following words for each valence type: suicide (suicide, dead, funeral), positive (happy, success, pleasure), negative (alone, rejected, stupid), and neutral (museum, paper, engine). Stimuli were presented and response times recorded using Inquisit (2015) software. Regarding the current study, psychometric results are presented in the results.

**Beck’s Scale for Suicidal Ideation (BSSI)**

The BSSI (Beck et al., 1979) is a 21-item rating scale which measures past week suicidal thoughts, behaviors, and suicide planning. Each item has three statements for participants to choose from. Example statements from one item include “I have a moderate wish to live,” “I have a weak wish to live,” and “I have no wish to live.” The first two items of the BSSI assess an individual’s desire to live and die. A non-zero score prompts 17 more questions which include severity of SI and planning behaviors. Two questions record the incidence and frequency of past suicide attempts. The SSI has been found to have good internal reliability (Beck et al, 1979) and predictive validity (Brown et al., 2000). The BSSI-19, which omits two questions regarding lifetime history of suicide attempts, will be used to analyze the major study hypotheses given its focus on SI and not historical behaviors. The BSSI-19 has demonstrated good internal reliability and both concurrent and discriminant validity (Beck, Brown, & Steer, 1997). In the current study, the BSSI-19 demonstrated good internal consistency reliability ($\alpha=.85$).

**Patient Health Questionnaire-8 (PHQ-8)**
Depression symptoms were measured using the first eight items of the PHQ-9 (Kroenke et al., 2001), which reflects depression symptoms as defined by the Diagnostic and Statistical Manual of Mental Disorders—fourth edition (DSM-IV). The final item of the PHQ-9, which assesses SI, was omitted to avoid content contamination with study independent variables (i.e., mean RTs to suicide-related stimuli). Past research indicates a score of 10 or greater can be used to assess the presence of Major Depressive Disorder (MDD) using the PHQ-8 (Kroenke et al., 2009). Participants respond to items from zero (not at all) to three (nearly every day) with a resulting range from zero to 24. The PHQ-8 has demonstrated excellent internal consistency reliability as well as criterion validity (Kroenke et al., 2009). In the current study, the PHQ-8 demonstrated good internal consistency reliability (α=.89).

**Beck’s Hopelessness Scale-Short Form (BHS-SF)**

The BHS-SF (Hanna et al., 2011) is a four-item measure adapted from the longer 20 item scale which measures how hopeless one feels about the future. Participants respond to each statement with True or False. Higher scores indicate more hopelessness about the future. Example statements include “My future seems dark to me” and “I have great faith in the future”. The BHS-SF has demonstrated good internal consistency reliability (e.g., Hanna et al., 2011). In the current study, the BHS-SF demonstrated adequate internal consistency reliability (α=.76) which is to be expected of briefer measures. The BHS-SF was used as an indicator of convergent validity with the suicide Stroop.

**Scale of Psychache**

The Scale of Psychache (Holden et al., 2001) is a 13-item measure which asks participants to think about their psychological pain. Participants respond to statements using a five-point Likert scale which ranges from one (strongly disagree) to five (strongly agree).
Example questions include “My pain makes me want to scream,” and “Because of my pain, my situation is impossible.” The Scale of Psychache has demonstrated excellent internal reliability (e.g., Klonskey & May, 2013) and construct validity (Holden et al., 2001). In the current study, the scale of psychache demonstrated excellent internal consistency reliability (α=.94). The scale of psychache was used as an indicator of convergent validity with the suicide Stroop.

**Suicide Cognitions Scale Short Form (SCS-SF)**

The SCS-SF (Bryan et al., 2017) is a nine-item measure adapted from the longer 18-item measure designed to analyze thoughts and attitudes commonly experienced by suicidal individuals. Participants respond to statements using a five-point Likert scale which ranges from one (strongly disagree) to five (strongly agree). Questions include “The world would be better off without me,” “I am completely unworthy of love,” and “I can’t stand this pain anymore.” The SCS-SF has demonstrated good internal consistency reliability, convergent validity, and divergent validity (Bryan, et al., 2017). In the current study, the SCS-SF demonstrated excellent internal consistency reliability (α=.93). The SCS was used as an indicator of convergent validity with the suicide Stroop.

**The Five Facet Mindfulness Questionnaire (FFMQ)**

The FFMQ (Baer et al. 2006) is a 39-item measure designed to measure mindfulness and mindfulness-related skills. Participants respond to statements using a five-point Likert scale which ranges from one (never or very rarely true) to four (very often or always true). The FFMQ has five subscales which measure different aspects of mindfulness. They include observing (e.g., “I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing”), describing (e.g., “I’m good at finding words to describe my feelings”), acting with awareness (e.g., “I am easily distracted”), nonreactivity to inner experience (e.g., “When I have distressing thoughts or
images, I just notice them and let them go”), and nonjudgement of inner experience (e.g., “I disapprove of myself when I have irrational ideas”). The FFMQ total score and each subscale has demonstrated good internal validity and construct validity (Baer et al., 2006). In the current study, the full scale of the FFMQ demonstrated good internal consistency reliability ($\alpha=.85$). In addition, each subscale of the FFMQ demonstrated at least acceptable internal consistency reliability ($\alpha=.72-.89$).

**Analytical Strategy**

Prior to any statistical analysis, participants who incorrectly responded to two or more of the three attention check questions were removed from the study. Consistent with the recommendations of Cha and colleagues (2010) only correct trials on the suicide Stroop were included in the analysis, trials with RTs $\pm 2$ SD from the participants’ mean RT were removed, and participants whose mean RT is $\pm 2$ SD from the sample mean RT were removed.

**Aim One: Psychometric Properties of the Suicide Stroop**

The first aim of the study was to determine if the psychometric properties of the suicide Stroop are acceptable when administering the task on participants’ personal computers. To determine the internal consistency reliability of the suicide Stroop, split-half reliability with Spearman Brown correction were conducted by first dividing individual RTs into odd and even trials, creating two separate suicide Stroop scores. These mean RTs for the two suicide Stroops were correlated to calculate the internal consistency reliability of each valence category.

To demonstrate construct validity, Pearson correlations between self-report study variables (past week SI severity, psychache, hopelessness, suicide cognitions) and mean RTs of suicide-related stimuli were conducted to demonstrate convergent validity. It was expected that mean RTs to suicide-related stimuli would be positively related to both past week SI severity and
prominent correlates of SI (i.e., psychache, hopelessness, suicide cognitions). Next, divergent validity was assessed by correlating mean RTs of suicide-related stimuli with mean RTs of negative stimuli to determine if any significant correlation equates to redundancy. Although less central to suicide Stroop validity, correlations between the mindfulness total score, each mindfulness subscale, and mean RTs for each suicide Stroop valence were conducted to inform later analyses.

Finally, concurrent validity (one aspect of criterion validity) was established by determining if measuring attentional biases to suicide-related stimuli aid in concurrent prediction of past week SI severity. To do this, a hierarchical linear regression predicting past week SI severity was conducted. Age and gender were added as covariates, as age has been found to be positively related to RTs on reaction time tasks (Der & Deary, 2006) and frequency and severity of SI has been found to differ between men and women (e.g., Allison et al., 2001). Along with age and gender, hopelessness, psychache, suicide cognitions, and mean RTs to negative stimuli were entered into step one. Mean RTs to suicide-related stimuli were entered into step two of the regression to determine if attentional biases to suicide-related stimuli aid in the prediction of self-report SI above and beyond traditional measures of suicide risk. Significant results were followed-up with an additional linear hierarchical regression including depression symptom severity (PHQ-8) in step one of the regression. As previous research has indicated that the relation between mean RTs to the word “suicide” and STBs was no longer significant after controlling for depression symptoms (Chung & Jeglic, 2016), PHQ-8 total scores were added as a covariate.

**Aim Two: Group Differences in Suicide-Related Attention Bias**
The second aim of the study was to determine if participants who endorse past week SI demonstrate a greater attentional bias to suicide-related stimuli than individuals with past year history of SI but deny past week SI. In this analysis, mean RTs to suicide-related stimuli was used as the outcome variable to determine if mean RTs to suicide-related stimuli were significantly different in those endorsing past week SI and those denying past week SI, even if said difference was not useful in predicting past week SI severity. To determine this, an independent samples t-test was conducted to determine if those who endorse past week SI demonstrate significantly larger mean RTs to suicide-related stimuli compared to those with a history of SI but deny past week SI. Three additional independent samples t-tests were conducted to determine if those who endorse past week SI demonstrate significantly different mean RTs to positive, negative, or neutral stimuli compared to those with a history of SI but deny past week SI.

**Aim Three: Moderating Effect of Dispositional Mindfulness**

The third aim of the study was to determine if self-report dispositional mindfulness moderates the relation between mean RTs to suicide-related stimuli and past week SI severity. Following the demonstration of acceptable psychometric properties of the suicide Stroop as well as associations of mean RTs to suicide-related stimuli and past week SI severity, moderation analyses were conducted using the moderation model (model=4) with 5,000 bootstrapped samples via the PROCESS macro (Hayes, 2013) to determine if dispositional mindfulness moderates the relation between mean RTs to suicide-related stimuli and past week SI severity. Although minimal past research has investigated the relations between the facets of dispositional mindfulness and SI, there is some evidence which suggests that acting with awareness and nonjudgement of inner experience subscales of common mindfulness measures are negatively
related to SI and thus drive the relation between the broader mindfulness construct and SI (Cheng et al., 2017; Tucker et al., 2014). Therefore, three separate moderation analyses were to be conducted to determine if the dispositional mindfulness total score as well as the acting with awareness and nonjudgment of inner experience subscales moderate the relation between mean RTs to suicide-related stimuli and past week SI severity.
Results

Data Cleaning

Incorrect trials (2,416) and trials with RTs ± two standard deviations from that participants mean RT (1,795) were removed. No participants demonstrated mean RTs ± two standard deviations from the group mean RT. Self-report measures of past week SI severity, psychache, suicide cognitions, hopelessness, and dispositional mindfulness were all normally distributed. RTs for each valence category demonstrated elevated skew and kurtosis, which is typical of RT data and is typically not transformed (Whelan, 2008). See Table 2 for descriptive statistics of RT data.

Table 2. Descriptive Statistics of Valence RTs

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Skew</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suicide-related RTs</td>
<td>491.31</td>
<td>157.70</td>
<td>1.58</td>
<td>5.04</td>
</tr>
<tr>
<td>Negative RTs</td>
<td>491.00</td>
<td>156.52</td>
<td>1.35</td>
<td>4.08</td>
</tr>
<tr>
<td>Positive RTs</td>
<td>488.29</td>
<td>161.61</td>
<td>2.15</td>
<td>9.80</td>
</tr>
<tr>
<td>Neutral RTs</td>
<td>489.76</td>
<td>152.43</td>
<td>1.37</td>
<td>3.53</td>
</tr>
</tbody>
</table>

Note: RTs=reaction times, SD=standard deviation

The number of errors in each valence category were as follows: suicide-related (568), positive (565), negative (641) and neutral (632). Using chi-square analyses, results indicated that participants were more likely to incorrectly identify the color of neutral stimuli versus suicide-related stimuli $X^2(9828, N=585)=4.24, p<.05$, neutral stimuli versus positive stimuli $X^2(9828, N=585)=3.99, p<.05$, negative stimuli versus suicide-related stimuli $X^2(9828, N=585)=5.38, p<.05$, negative stimuli versus positive stimuli $X^2(9828, N=585)=5.10, p<.05$, but not positive stimuli versus suicide-related stimuli $X^2(9828, N=585)=.00, p=.96$ or negative stimuli versus neutral stimuli $X^2(9828, N=585)=.07, p=.82$. 
Aim One: Psychometric Properties of the Suicide Stroop

Regarding reliability, mean RTs for positive and neutral stimuli demonstrated unacceptable internal consistency reliability \((\alpha=.32, .04\) respectively). Negative and suicide-related stimuli demonstrated good to excellent reliability \((\alpha=.75, .91\) respectively). See Table 3 for correlations of study variables. Regarding convergent validity, mean RTs to suicide-related stimuli were not significantly related to past week SI \(r(349)=.02, p=.66\), suicide cognitions \(r(544)=.06, p=.12\), psychache \(r(544)=.01, p=.75\) or hopelessness \(r(544)=.07, p=.08\) when analyzed in the full sample (i.e., including those who denied past week SI). This same pattern was seen when just analyzing these relations in those who endorsed past week SI severity: mean

<table>
<thead>
<tr>
<th>Measure</th>
<th>M</th>
<th>SD</th>
<th>Skew</th>
<th>Kurtosis</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. BSSI</td>
<td>14.78</td>
<td>6.84</td>
<td>.63</td>
<td>.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. BHS-SF</td>
<td>2.17</td>
<td>1.52</td>
<td>-.56</td>
<td>-.99</td>
<td>.27</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Psychache</td>
<td>44.54</td>
<td>11.77</td>
<td>-.53</td>
<td>.34</td>
<td>.42</td>
<td>.51</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4. SCS</td>
<td>24.37</td>
<td>9.39</td>
<td>-.14</td>
<td>-.39</td>
<td>.58</td>
<td>.50</td>
<td>.74</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. FFMQ-Total</td>
<td>111.36</td>
<td>18.27</td>
<td>-.68</td>
<td>.45</td>
<td>-.12</td>
<td>-.38</td>
<td>-.42</td>
<td>-.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Describe</td>
<td>23.08</td>
<td>6.80</td>
<td>-.05</td>
<td>.19</td>
<td>-.08</td>
<td>-.30</td>
<td>-.35</td>
<td>-.33</td>
<td>.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Act with</td>
<td>22.71</td>
<td>5.32</td>
<td>.19</td>
<td>-.24</td>
<td>-.21</td>
<td>-.27</td>
<td>-.46</td>
<td>-.44</td>
<td>.57</td>
<td>.37</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Non-judgement</td>
<td>20.97</td>
<td>7.16</td>
<td>.22</td>
<td>-.19</td>
<td>-.17</td>
<td>-.23</td>
<td>-.51</td>
<td>-.43</td>
<td>.55</td>
<td>.29</td>
<td>.57</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Nonreaction</td>
<td>19.34</td>
<td>5.64</td>
<td>.06</td>
<td>-.45</td>
<td>.01</td>
<td>-.20</td>
<td>-.15</td>
<td>-.04</td>
<td>.61</td>
<td>.41</td>
<td>-.02</td>
<td>-.01</td>
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</tr>
<tr>
<td>10. Observing</td>
<td>25.25</td>
<td>6.40</td>
<td>-.11</td>
<td>.02</td>
<td>.07</td>
<td>-.11</td>
<td>.11</td>
<td>.10</td>
<td>.38</td>
<td>.23</td>
<td>-.23</td>
<td>-.33</td>
<td>.45</td>
<td></td>
</tr>
</tbody>
</table>

Note. BSSI-19= Beck’s Scale for Suicidal Ideation-19 item; BHS-SF= Beck’s Hopelessness Scale- Short Form; SCS= Suicide Cognitions Scale; FFMQ= Five Facet Mindfulness Scale; Bolded correlations indicate significance \(p<.01\) to \(p<.05\).
RTs to suicide-related stimuli were not related to past week SI, \( r(349)=.03, p=.60 \), suicide cognitions \( r(349)=.01, p=.99 \), psychache \( r(349)=-.04, p=.47 \), and hopelessness \( r(349)=.05, p=.31 \). Regarding divergent validity, mean RTs to suicide-related stimuli demonstrated redundant correlations with negative stimuli \( r(544)=.90, p<.01 \), neutral stimuli \( r(544)=.86, p<.01 \), and positive stimuli \( r(544)=.94, p<.01 \). In addition, mean RTs to suicide-related stimuli demonstrated non-significant relations with the FFMQ total score \( r(544)=.004, p=.94 \), the observing subscale \( r(544)=-.01, p=.76 \), the describing subscale \( r(544)=.004, p=.93 \), the acting with awareness subscale \( r(544)=.02, p=.61 \), the nonjudgement of experience subscale \( r(544)=-.01, p=.86 \), and the nonreactivity subscale \( r(544)=.05, p=.22 \). Similarly, there were no significant correlations between mean RTs to negative, positive, or neutral stimuli with the FFMQ total score or any of its subscales.

Regarding concurrent validity, a stepwise multiple regression indicated that (step one) age, gender, suicide cognitions, hopelessness, and psychache were significantly related to past week SI, \( F(6,345)=29.78, p<.01, R^2=.34, R^2_{\text{Adjusted}}=.34 \); however, the addition of mean RTs to suicide-related stimuli (step two) did not significantly improve model fit \( F(1, 344)=25.99, p=.14, \Delta R^2=.004 \). As a result, an additional regression adding past two-week depression symptoms as measured by the PHQ-8 as a covariate was not conducted. See Table 4 for results of this analysis.
Because the Stroop task failed all measures of validity, post-hoc validity analyses were computed using only mean RTs to the word “suicide” and omitting other stimuli from the suicide category (i.e., funeral, death). This decision was based on of extant literature which has found that, although participants did not demonstrate an attentional bias to suicide-related stimuli, significantly greater mean RTs were seen for just the word “suicide” (Chung & Jeglic, 2016, 2017). Similar to the previous findings in the current study, latency scores for the word “suicide” were not significantly related to past week SI severity $r(350)=-.003, p=.95$, suicide cognitions $r(544)=.06, p=.19$, hopelessness $r(544)=.08, p=.06$, or psychache $r(543)=-.01, p=.91$ and demonstrated redundant associations with suicide-related stimuli $r(544)=.94, p<.01$, positive stimuli $r(544)=.89, p<.01$, negative stimuli $r(544)=.87, p<.01$, and neutral stimuli $r(544)=.86, p<.01$). Because the validity of the word “suicide” was not superior to composite of suicide-related stimuli, the composite of suicide-related stimuli was used in the remainder of analyses.

### Aim Two: Differences in Suicide-Related Attention Bias

<table>
<thead>
<tr>
<th>Step</th>
<th>Predictor</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>$R^2$ change</th>
<th>$F$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>.16</td>
<td>.93</td>
<td>.34</td>
<td>30.10</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>Sex</td>
<td>.48</td>
<td>.04</td>
<td>.34</td>
<td>.43</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age</td>
<td>-.01</td>
<td>-.03</td>
<td>.34</td>
<td>.56</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hopelessness</td>
<td>.29</td>
<td>.06</td>
<td>.34</td>
<td>.22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suicide Cognitions</td>
<td>.42</td>
<td>.51</td>
<td>.34</td>
<td>.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Psychache</td>
<td>.05</td>
<td>.07</td>
<td>.34</td>
<td>.26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Neg Mean RTs</td>
<td>.00</td>
<td>.00</td>
<td>.34</td>
<td>.97</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Mean RTs Suicide stimuli</td>
<td>.006</td>
<td>.164</td>
<td>.348</td>
<td>26.26</td>
<td>.12</td>
</tr>
</tbody>
</table>

*Note.* SI=Suicidal ideation; RTs= reaction times

Table 4. Regression results predicting past week SI severity
Regarding RTs to suicide-related stimuli, there was no significant effect of past week SI severity, $t(544)=-1.35, p=.18$, despite those endorsing past week SI ($M=497.96, SD=179.27$) demonstrating greater mean RTs to suicide-related stimuli than those denying past week SI ($M=478.61, SD=117.81$). A similar pattern emerged regarding mean RTs and past week SI severity: there was no significant effect of past week SI severity and positive stimuli $t(544)=-1.09, p=.27$, negative stimuli $t(581)=-.86, p=.39$, and neutral stimuli $t(581)=-.57, p=.55$.

**Aim Three: Moderating Effect of Dispositional Mindfulness**

Bivariate correlations between past week SI and mindfulness/its sub-facets were as hypothesized. The FFMQ total score and the acting with awareness and nonjudgement of experiences subscales were significantly, negatively associated with past week SI severity $r(544)=-.12, -.21, -.17$ respectively, $p$s<.05. The observing, describing, and nonreaction to experiences subscales demonstrated no significant relations with past week SI severity. Although the suicide Stroop as a whole was demonstrated to be unreliable and invalid, the moderation analyzing if dispositional mindfulness moderates the relation between mean RTs to suicide-related stimuli and past week SI severity was conducted as mean RTs to suicide-related stimuli demonstrated excellent internal consistency reliability.

The first moderation model tested if the dispositional mindfulness total score moderated the relation between mean RTs to suicide-related stimuli and past week SI severity. The full model of mean RTs to suicide-related stimuli, dispositional mindfulness, and their interaction did not significantly predict past week SI severity ($R^2=.02, F(3, 347)=2.2, p=.09$).

The second moderation model tested if the acting with awareness subscale moderated the relation between mean RTs to suicide-related stimuli and past week SI severity. The full model of mean RTs to suicide-related stimuli and acting with awareness significantly predicted past
week SI severity ($R^2=.21, F(3, 348)=5.46, p<.01$). RTs to suicide-related stimuli did not predict past week SI severity ($b=.00, p=.77$) but the main effect for acting with awareness was significant ($b=-.23, p<.01$). The addition of the acting with awareness interaction term was not significant ($R^2 change=.00, F(1, 348)=.11, p=.74$).

The final moderation model tested if the nonjudgement of inner experiences subscale moderated the relation between mean RTs to suicide-related stimuli and past week SI severity. The full model of mean RTs to suicide-related stimuli and nonjudgement of inner experiences significantly predicted past week SI severity ($R^2=.17, F(3, 348)=3.48, p<.05$). RTs to suicide-related stimuli did not predict past week SI severity ($b=.00, p=.72$) but the main effect for nonjudgement of inner experiences was significant ($b=-.18, p<.01$). The addition of the nonjudgement of inner experiences interaction term was not significant ($R^2 change=.00, F(1, 348)=.09, p=.77$).
Discussion

Both the cognitive model of suicide (Wenzel & Beck, 2008) and the FVT (Rudd, 2006) posit that certain maladaptive cognitive processes confer one’s risk for experiencing suicidal desire through systematic distortions of one’s experiences. Research has indeed found that a number of maladaptive cognitive processes are related to SI, such as cognitive inflexibility (e.g., Miranda et al., 2012), memory biases (e.g., Arie et al., 2008), executive functioning impairments (e.g., Marzuk et al., 2005), implicit associations (e.g., Nock et al., 2010), and attentional biases (e.g., Cha et al., 2010). Consistent with these theories, prior research suggests that individuals with a history of STBs demonstrate an attentional bias to suicide-related stimuli on the suicide Stroop (e.g., Chung & Jeglic, 2016) which subsequently predicts suicide attempts at six-month follow-up (Cha et al., 2010). However, a recent meta-analysis of suicide Stroop research has introduced some doubt regarding the psychometrics of the suicide Stroop (Wilson et al., 2019).

To add to the literature regarding attentional biases to suicide-related stimuli, the current study had the following aims: (1) to determine if the suicide Stroop has acceptable psychometric properties when administered online, (2) to determine if those who deny past week SI demonstrate greater mean RTs to suicide-related stimuli than individuals who endorse past year SI but deny past week SI, and (3) to determine if dispositional mindfulness moderates said attentional-biases to suicide-related stimuli. It was hypothesized that the suicide Stroop would demonstrate acceptable internal consistency reliability as well as convergent and divergent validity and that individuals experiencing past week SI would demonstrate significantly larger mean RTs to suicide-related stimuli than individuals who denied past week SI. Finally, it was hypothesized that dispositional mindfulness would attenuate the anticipated positive relation regarding mean RTs to suicide-related stimuli and past week SI severity.
To this end, the suicide Stroop was administered to a large sample of United States adults who endorsed past year SI. Participants completed the suicide Stroop as well as other self-report measures related to suicide (e.g., hopelessness, psychache) on their personal computers. Contrary to expectations, the suicide Stroop was unreliable and failed all aspects of validity tested.

Specifically, although mean RTs to suicide-related and negative stimuli demonstrated acceptable reliability; mean RTs to positive and neutral stimuli demonstrate unacceptable, near-zero reliability. Mean RTs to suicide-related stimuli failed to demonstrate convergent, divergent, or concurrent validity as mean RTs to suicide-related stimuli were not significantly related to known SI risk factors (e.g., hopelessness, psychache) and did not aid in the prediction of past week SI severity above other SI risk factors. Further, individuals who endorsed past week SI did not have significantly different mean RTs to suicide-related stimuli compared to individuals who denied past week SI, and no mean RT difference was seen between these groups for any other valence category. Post-hoc analyses using latency scores for just the word “suicide” similarly failed to demonstrate relations with past week SI and SI risk factors and failed to significantly differentiate between those experiencing past week SI and those denying past week SI. The findings of the current study add to a growing body of research indicating that the suicide Stroop may not be a reliable or useful tool for understanding risk factors related to SI or is at least in need of significant refinement.

The hypothesis that dispositional mindfulness would moderate the relation between mean RTs to suicide-related stimuli and past week SI severity was not supported: the FFMQ total score and the acting with awareness and nonjudgement of inner experiences subscale failed to demonstrate a significant interaction with mean RTs to suicide-related stimuli. On the one hand, these null results could be due to the poor psychometric properties of the suicide Stroop;
however, it could also indicate that dispositional mindfulness skills do not attenuate the impact that attentional biases to suicide-related stimuli have on the severity of SI. Future research should aim to replicate these results, ideally using a version of the suicide Stroop (discussed later) that demonstrates acceptable psychometric properties. Despite the moderation results, the dispositional mindfulness total score was negatively related to past week SI severity as well as all SI risk factors measured (e.g., Lamis & Dvorak, 2013). Regarding past week SI severity, the acting with awareness and non-judgement of experience subscales demonstrated a negative relation to past week SI severity with small effect sizes while the observing, describing, and nonreaction to inner experience subscales lacked any significant relation, which is consistent with past research (Cheng et al., 2017).

There are several potential explanations for the overall finding of this study. Regarding internal consistency reliability, Wilson and colleagues’ (2019) meta-analysis was the first study to report internal consistency reliability of the suicide Stroop, as this was not reported in initial investigations (e.g., Cha et al., 2010; Chung & Jeglic, 2016, 2017). The meta-analysis collected data from seven suicide Stroop studies resulting in $N=875$ participants and found excellent internal consistency reliability across valences ($\alpha \geq .93$). Within the current study, internal consistency estimates for suicide-related stimuli were high and consistent with past research (Wilson et al., 2019) and internal consistency estimates for negative stimuli were lower than those found in past research (Wilson et al., 2019), but still acceptable. Neutral and positive stimuli, however, were unacceptably low, which is discrepant from the findings of the Wilson and colleagues’ (2019) meta-analysis. This indicates that the poor reliability in the current study may be due to problems with online administration (e.g., distraction, multitasking); however, extant literature in other RT-based tasks in suicide and suicide-related fields has demonstrated
similar problems regarding internal consistency. For example, the Affect Misattribution Procedure is a RT-based task which measures implicit associations with images related to suicide. Using this task, Tucker and colleagues (2018) found that although suicide-related and negative images demonstrated good internal consistency (α≥.83), positive images demonstrated only adequate reliability (α=.75) and neutral images demonstrated unacceptably low reliability (α=.57).

Although these discrepant results could be due to problems related to online administration, the acceptable reliability for suicide-related and negative stimuli and unacceptable reliability for positive and neutral stimuli could be due to a set-switching bias. Set-switching is a type of response bias which occurs when longer RTs are related to one trial being of a different valence category of the preceding trial (i.e., “switching”), rather than the result of interference due to the emotional nature of the word itself (Cheng et al., 2015). For example, research has indicated that individuals suffering from anxiety have difficulty switching from negative to neutral stimuli on the dot-probe task (Johnson, 2009), and a modest set-switching effect has been demonstrated in individuals with MDD when switching from positive to negative stimuli on the emotional Stroop task (Cheng et al., 2015). Importantly, these individuals with MDD did not differ from healthy controls in mean RTs to positive and negative stimuli, indicating that the interference was only detectable when analyzing set-switching (Cheng et al., 2015). This hypothesis is further supported by the finding that participants were more likely to have incorrect trials on neutral and negative trials compared to trials with suicide-related stimuli.

In the current study, it could be that positive stimuli following suicide-related stimuli yield greater RTs than positive stimuli following another positive stimuli. Such discrepancy could lower reliability, and future research may consider investigating the potential impact of
set-switching through secondary analyses of previous suicide Stroop research. However, this may prove difficult due to the design of the suicide Stroop where words are presented at random, meaning theoretically a person could see several trials of the same valence category in succession. Therefore, an adaptation of the suicide Stroop (discussed later) may aid in investigating this hypothesis.

Regarding validity, our findings that mean RTs to suicide-related stimuli were not useful for predicting severity of past week SI are in concordance with Wilson and colleagues’ (2019) meta-analysis that has found that attentional biases to suicide-related stimuli were not predictive of suicide attempt history or useful for distinguishing those currently experiencing SI from controls. Our findings that the mean RTs to suicide-related stimuli were not related to SI risk factors (e.g., hopelessness) should be replicated in future research, as no previous study has investigated this question. On the one hand, the suicide Stroop’s failure to demonstrate any type of validity may indicate that the suicide Stroop is unable to detect attentional biases in relation to the severity and recency of SI. On the other hand, it simply could be that individuals thinking about suicide (who have not attempted suicide) do not demonstrate an attentional bias to suicide-related stimuli. This would be surprising if true, as the cognitive model of suicide (Wenzel & Beck, 2008) posits that attentional biases to suicide-related stimuli precede, not follow, the engagement in suicidal behaviors, and the FVT (Rudd, 2006) posits that these attentional-biases wax and wane with the severity of suicide desire. Further, research indicates that attentional biases to suicide-related experiences when measured through self-report are related to the recency and severity of SI (Moscardini et al., 2020) as well as past suicide attempts (Adler et al., 2015). Although several measures were taken to remove participants who performed carelessly on the task (e.g., removing participants with very large or very small mean RTs, missing
attention checks in self-report surveys), it could be that some participants who paid poor attention to the task remained undetected by these measures. The failure to identify and remove said participants could have led to an underestimation of internal consistency reliability. When the suicide Stroop is administered in person, there may be greater pressure to act in a socially desirable manner, resulting in greater attention to the task, a pressure which may be absent when the test is administered on individual’s personal computers. The lack of validity in the current study may also be the result of methodological limitations, discussed later.

These findings regarding dispositional mindfulness were in concordance with past research which has indicated that the acting with awareness and non-judgement of experience subscales are the primary drivers behind the mitigating role of dispositional mindfulness and SI severity. Extant literature indicates that lower levels of dispositional mindfulness exacerbate the effect that symptom severity (e.g., Posttraumatic Stress Disorder, Borderline Personality Disorder) has on SI even after accounting for factors like historical suicide attempts, impression management, age, and number of past traumatic events (e.g., Cheng et al., 2017; Shorey et al., 2016). Although it was unable to be determined if dispositional mindfulness demonstrates this protective affect through its impact on attentional biases, it appears that dispositional mindfulness, regardless of the mechanism of action, is inversely related to SI. In addition, the correlation between dispositional mindfulness and past week SI severity demonstrated small effect sizes but moderate to large effect sizes regarding SI risk factors (i.e., SCS, psychahce). This pattern could indicate that the protective role dispositional mindfulness may have with SI severity is the result of its impact on related experiences (e.g., hopelessness), which is a question that future research should seek to answer.
Mindfulness may serve to prevent individuals from acting impulsively (e.g., substance abuse) or self-destructively (e.g., suicide attempt) and promote one’s ability to cope with unpleasant internal experiences (e.g., hopelessness, SI) (Wupperman et al., 2008; Shorey et al., 2016). Findings of the current study concur with past research which suggests that mindfulness as a dispositional characteristic may serve to protect against the escalating severity of SI (e.g., Wupperman et al., 2008). Although the correlation between dispositional mindfulness and past week SI severity demonstrated a small effect size, potentially limiting its clinical utility, it could be that mindfulness-based interventions lead to clinically useful changes in other important predictors of SI (e.g., depression symptoms) which could have a clinically important indirect effect on SI severity. Fortunately, mindfulness is indeed a learnable skill, and mindfulness interventions have been shown to decrease SI severity and depression symptom severity in individuals deemed high risk for suicide (Chesin et al., 2015). More so, some researchers have hypothesized that mindfulness-based interventions may be superior to cognitively based interventions when working with patients experiencing STBs due to the hypothesis that cognitive reactivity (i.e., decreased tolerance to mild unpleasant stimuli following suicidal episodes) is central to the suicidal mind and best mitigated through mindfulness and acceptance practices (see Williams et al., 2006). However, so few studies have analyzed the efficacy of mindfulness-based interventions for suicide risk that this hypothesis is difficult to speak to.

**Limitations**

Although the current study has a number of strengths, it should be interpreted in light of its limitations. Because of limitations regarding survey administration, the suicide Stroop was not counterbalanced (i.e., all participants completed the suicide Stroop prior to completing the remainder of the survey), potentially leading to bias. For example, it is possible that completing
the suicide Stroop resulted in greater endorsement of SI in later self-report measures. Future research which aims to replicate these findings should address this by counterbalancing their design.

Regarding the grouping of participants as endorsing past week SI and no past week SI, it is possible that individuals who denied past week SI had previously attempted suicide and thus increased the mean RTs of the no past week SI group. There has been no consensus in terms of past research regarding how participants with past and current STBs should be grouped. Some have combined individuals with past/current STBs (Chung & Jeglic, 2016) and some have compared individuals who have attempted suicide with healthy controls without consideration of SI history or depression symptom severity of controls (e.g., Wilson et al., 2019). As Wilson and colleagues (2019) note, this is a major limitation of suicide Stroop research as it hinders comparison across studies and should be addressed in future work. Participants removed from the survey tended to be younger in age ($M=29.11$) than individuals included in study analyses ($M=35.31$), indicating that these results may only be applicable to some age groups. Age-related differences have been seen in previous research, but generally it is older participants excluded (Wilson et al., 2019). Participants were also mostly White, meaning the results of the current study may not be generalizable to other populations. Finally, the cross-sectional design of the current study prevented investigations of test-retest reliability as well as longitudinal changes in attentional biases.

**Future Directions**

The current problems with the suicide Stroop do not necessarily signify that individuals experiencing STBs do not demonstrate a measurable attentional bias to suicide-related stimuli. Rather, modifications made to the suicide Stroop may improve its ability to detect attentional
biases if they indeed are present. An in-depth description of potential improvements has been described elsewhere (see Wilson et al., 2019). To summarize their recommendations, the suicide Stroop benefit by adding additional blocks, increasing the number of stimuli for each category, and increasing the number of trials administered. These changes would help counteract habituation effects associated with high stimuli repetition and potentially increase reliability (Ben-Haim et al., 2016). Related to the aforementioned discussion regarding set-switching, it is also recommended that future iterations of the suicide Stroop present stimuli in a non-random order which will facilitate analysis of various response biases. In addition, future researchers may consider how the removal of incorrect responses and very large mean RTs affect suicide Stroop interpretation, as these trials could be the result of an attentional bias to suicide-related stimuli and not task taking carelessness.

If a modified suicide Stroop proves itself psychometrically sound, longitudinal study designs may be very helpful for better characterizing fluctuations in attentional biases and suicide desire. The use of ecological momentary assessment methodologies (EMA) are particularly relevant to suicide research due to the highly variable nature of SI (Kleiman et al., 2017). As other versions of the Stroop have been adapted for moment to moment mobile use (e.g., Spanakis et al., 2019), it is reasonable to think that the suicide Stroop too could be adapted to an EMA format. Such research endeavors would be better equipped to testing the tenants of cognitive models of suicide than cross-sectional research such as the current study.

However, in the absence of improved modifications to the current suicide Stroop, other behavioral tasks may be preferable for use in suicidology. For example, associations of self-injury with oneself as measured by a modified version of the IAT were able to predict past and future SI and suicide attempts in a sample of adolescents with a history of STBs (Nock & Banaji,
Similarly, a modified IRAP found that associations with one’s personal death outperformed associations with death in general in predicting SI severity (Hussey et al., 2016). Although the IAT and IRAP use RTs to compare groups, the tasks themselves ask participants to evaluate associations and thus do not directly tap into attention and attentional biases as the suicide Stroop is intended to do. However, the dot probe paradigm is intended to measure selective attention and research using this task has found that individuals who have previously attempted suicide demonstrate an attentional bias to happy faces compared to angry faces (e.g., Gerlus et al., 2018). Thus, the dot probe paradigm is one example of a task which may be useful for researchers who remain invested in analyzing attentional biases in individuals experiencing STBs.

Interestingly, past research indicates that four sessions of attention bias modification training was unsuccessful in decreasing both attentional biases to suicide-related stimuli and subsequently the severity of SI (Cha et al., 2016); however, it has been demonstrated that mindfulness training decreases attentional biases in other contexts (e.g., Moore & Malinowsky, 2009; Moore et al., 2012). As a result, future research interested in studying the modification of attentional biases in individuals experiencing SI may benefit from the continued investigation of the impact mindfulness training may have on attentional biases to suicide-related stimuli.

Findings regarding the suicide Stroop are disappointing when considered in the larger context of suicide risk identification and prevention: researcher’s ability to anticipate who is at risk for attempting or dying by suicide has not improved despite 50 years of effort (Franklin et al., 2017). As noted by Franklin and colleagues (2017), most existing suicide prediction research has focused on risk factors which are unchangeable, such as historical suicide attempts and trauma history, and factors which rely on self-report methodologies susceptible to validity.
concerns (e.g., non-disclosure, genuine fluctuations in symptom severity). Further, said self-report methodologies generally rely on an individual’s conscious awareness of information being collected on, limiting research ability to gain insight on non-conscious processes proposed to be related to suicide desire (e.g., attention biases). The goal of the current study was to determine if hypothesized risk factors for experiencing SI (i.e., attentional biases) were useful in understanding fluctuations in SI severity, and thus contribute to theory building and suicide prevention initiatives. On the contrary, study hypotheses regarding the suicide Stroop were not confirmed.

In light of difficulties anticipating temporal changes in STBs, it is important to note that prevention of STBs is possible in the absence of useful prediction of the experience of STBs. For example, although the current study was unable to analyze how dispositional mindfulness interacts with attentional biases to confer SI severity, results did find that dispositional mindfulness was inversely related with past week SI severity. This is consistent with intervention outcomes research and theories of mindfulness and suicide which posit that mindfulness may be a powerful tool in mitigating suicide risk (e.g., Williams et al., 2006). However, there remains a considerable gap in research regarding treatment efficacy of mindfulness-based interventions for suicide risk.
Appendix. IRB Approval

ACTION ON PROTOCOL APPROVAL REQUEST

TO: Raymond Tucker
   Clinical Psychology

FROM: Dennis Landin
       Kinesiology

DATE: October 8, 2019

RE: IRB# 4277

TITLE: Interpersonal Hopelessness and the Modified Emotional Stoop Task


Review type: Full ___ Expedited X ___ Review date: 10/3/2019

Risk Factor: Minimal ___ X ___ Uncertain ______ Greater Than Minimal_____

Approved ______ X _____ Disapproved__________

Approval Date: 10/3/2019 Approval Expiration Date: 10/2/2020

Re-review frequency: (annual unless otherwise stated)

Number of subjects approved: 300

LSU Proposal Number (if applicable):

By: Dennis Landin, Chairman [Signature]

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –

Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
8. SPECIAL NOTE: When emailing more than one recipient, make sure you use bcc.

*All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/irb
References

https://doi.org/10.1007/s10608-015-9683-7

https://doi.org/10.1046/j.1440-1614.2001.00927.x

https://doi.org/10.1017/pan.2018.57

https://doi.org/10.1016/j.comppsych.2007.07.004

https://doi.org/10.1177/1073191105283504


56


https://doi.org/10.1037/a0034028

https://doi.org/10.1080/07448481.2013.820731


https://doi.org/10.1046/j.1525-1497.2001.016009606.x


Substance Abuse and Mental Health Services Administration (SAMHSA) (2017). *Key Substance Use and Mental Health Indicators in the United States: Results from the 2016 National Survey on Drug Use and Health Center for Behavioral Health Statistics and Quality*


VITA

Emma Moscardini, a native to Safety Harbor, Florida, received her bachelor’s degree at the University of Florida in 2017. During her time there, she volunteered at a suicide hotline doing emergency mobile outreach. In 2018, she decided to enter graduate school in the Department of Psychology at Louisiana State University. She will receive her master’s degree in May 2021 and plans to begin work on her doctorate upon graduation.