



# Three Tests of the Benefits and Barriers Model of Nonsuicidal Self-Injury

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Three Tests of The Benefits and Barriers Model of Nonsuicidal Self-Injury

A dissertation presented

by

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to

The Harvard University Department of Psychology Clinical Science Faculty

in partial fulfillment of the requirements

for the degree of

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in the subject of

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## Three Tests of The Benefits and Barriers Model of Nonsuicidal Self-Injury

### Abstract

Nonsuicidal self-injury (NSSI; e.g., self-cutting) includes harmful behaviors that are self-inflicted in the absence of suicidal intent. Even though NSSI typically involves painful and stigmatized behaviors, NSSI is alarmingly common *and* most people who engage in these behaviors report that doing so helps them to feel better. Building upon a recently proposed theory, the Benefits and Barriers Model, the present dissertation sought to provide insights into who is at risk for engaging in NSSI and into why NSSI serves as an emotion regulation strategy. The Benefits and Barriers Model proposes that NSSI can produce several positive consequences, but that critical barriers keep most people from engaging in these behaviors. Shedding light on who is at risk for engaging in NSSI, results of this dissertation suggested that erosion of two proposed barriers, self-worth and aversion toward self-harming stimuli, may be risk factors for continued NSSI engagement (Study 1). Providing insight into why self-criticism may be a NSSI risk factor, results indicated that self-criticism affects aspects of pain processing among people who do (Study 2) and do not (Study 3) engage in NSSI. Results imply that self-criticism may lower a key NSSI barrier, pain, and that self-criticism may alter the mood benefits of NSSI. Taken together, findings support key aspects of the Benefits and Barriers Model of NSSI.

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## **Introduction**

Nonsuicidal self-injurious behaviors (NSSI) include self-harming behaviors that are enacted purposely and without the intent to die (Nock, 2010). Although definitions of this term vary, more stringent definitions clarify that NSSI does not include severe forms of self-injury (e.g., bone breaking), mild forms of self-injury (e.g., hair pulling, lip biting, picking at wounds), nor does it include “indirect” forms of self-injury, in which self-harm is an unintended consequence or side effect of a behavior (e.g., drinking alcohol, drug use; Nock, 2010). Instead, NSSI includes moderately self-harming behaviors that result in some tissue damage, such as cutting, burning, and hitting.

Although less prevalent than many indirectly or mildly self-harming behaviors, NSSI is moderately common. Prevalence rates of these behaviors range widely across studies; however, a meta-analysis on the lifetime prevalence of NSSI suggests that approximately 17% of adolescents and 5.5% of adults in the general population report engaging in these behaviors at some point in their lifetimes (Swannell, Martin, Page, Hasking, & St John, 2014). Higher lifetime prevalence rates among adolescents compared to adults suggests that these behaviors may be becoming more common. However, according to the same meta-analysis, the majority of data indicating increases in NSSI over time can be explained by methodological factors (e.g., measurement type). Instead, Swannell and colleagues propose that higher prevalence rates among adolescents are likely explained by factors such as recall bias, which may disproportionately affect stigmatized behaviors.

Regardless, the prevalence of NSSI is concerning for several reasons. First, NSSI inherently causes tissue damage and physical harm, sometimes even requiring emergency room visits for especially severe episodes requiring stitches or other forms of intensive medical care

(e.g., Cloutier, Martin, Kennedy, Nixon, & Muehlenkamp, 2010). Second, NSSI is associated with numerous negative outcomes including internalizing symptoms (e.g., Gollust, Eisenberg, & Golberstein, 2008; Nock, Joiner, Gordon, Lloyd-Richardson, & Prinstein, 2006; Selby, Bender, Gordon, Nock, & Joiner, 2012), drug and alcohol use (e.g., Klonsky, 2011; Zetterqvist, Lundh, Dahlström, & Svedin, 2013), and self-reported difficulties with emotion regulation (e.g., Glenn, Blumenthal, Klonsky, & Hajcak, 2012; Nock, Wedig, Holmberg, & Hooley, 2008). Moreover, engaging in NSSI increases risk for later interpersonal stressors and depressive symptoms among female adolescents (Burke, Hamilton, Abramson, & Alloy, 2015) as well as later feelings of anger, guilt, and shame for males and females (Klonsky, 2009). Third and perhaps most alarmingly, NSSI is associated with suicidal behaviors both concurrently (for reviews, see Andover, Morris, Wren, & Bruzzese, 2012; Hamza, Stewart, & Willoughby, 2012) and prospectively (Asarnow et al., 2011; Bryan, Bryan, Ray-Sannerud, Etienne, & Morrow, 2014; Cox et al., 2012; Goldstein et al., 2012; Guan, Fox, & Prinstein, 2012; Whitlock et al., 2013; Wilkinson, Kelvin, Roberts, Dubicka, & Goodyer, 2011). In fact, a recent meta-analysis suggests that NSSI is one of the strongest studied predictors of future suicide attempts, above and beyond other theoretically important factors, such as prior suicide attempts (Ribeiro et al., 2016).

Together, this research highlights that NSSI is both highly prevalent and a cause for clinical concern. Unfortunately, very few treatments have been shown to reduce these behaviors compared to active control treatments (see Brausch & Girresch, 2012; Glenn, Franklin, & Nock, 2015; Gonzales & Bergstrom, 2013; Nock, 2010; Washburn et al., 2012). Although there are exceptions (e.g., Franklin et al., 2016), even these newer and more effective treatments do not fully eliminate NSSI engagement nor do they significantly decrease NSSI engagement beyond the active treatment period. Lack of effective treatments indicates that the majority of existing

treatments for NSSI do not target core processes that lead to NSSI. To create better treatments, it is necessary to understand why people engage in NSSI, which will in turn highlight factors increasing risk for these behaviors as well as potential treatment and prevention targets.

### **Why do people engage in NSSI?**

Pain and stigma make it difficult to understand why people choose to engage in NSSI. People have likely evolved to avoid and escape pain to help increase likelihood of survival (e.g., Eccleston & Crombez, 1999). Yet, people engaging in NSSI are choosing to self-inflict pain and endure physical injury rather than avoid or escape it, sometimes doing so hundreds of times a year. Helping to make sense of this counterintuitive behavior, the majority of people who engage in NSSI report that they do so to regulate their mood or current mental state in some way, such as to feel better, to feel pain, to interrupt unpleasant memories or emotions (e.g., Klonsky, 2009; Nock, Prinstein, & Sterba, 2010; Selby, Nock, & Kranzler, 2014). Indeed, a recent meta-analysis suggests that 66-81% of people engaging in NSSI endorse these types of intrapersonal functions (Taylor et al., 2018). Corroborating retrospective self-reported motivations, using ecological momentary assessment (EMA), researchers have found both minor increases in positive mood (Muehlenkamp et al., 2009) and a mix of increases in positive mood and decreases in negative mood (Claes, Klonsky, Muehlenkamp, Kuppens, & Vandereycken, 2010) after engaging in NSSI. Together, this research suggests that NSSI is often used as a way to regulate mood. However, this body of research does not explain how or why NSSI serves this function.

Seeking to understand why NSSI improves mood, a growing body of basic experimental research has examined mood changes from before to after pain. This basic research has demonstrated that the removal of pain, termed “pain offset relief,” improves mood. Among people with a history of NSSI, this research shows that pain offset relief improves mood across

self-reported and psychophysiological measures (Bresin & Gordon, 2013; Franklin et al., 2013; Franklin et al., 2010; Schoenleber, Berenbaum, & Motl, 2014). Importantly however, this effect is not exclusive to people engaging in NSSI: this mood improvement occurs universally. That is, pain offset relief has been observed in research involving community samples of humans (Andreatta, Mühlberger, Yarali, Gerber, & Pauli, 2010; Bresin & Gordon, 2013; Bresin, Gordon, Bender, Gordon, & Joiner, 2010; Franklin et al., 2013) and across other species (e.g., rats, fruit flies; Tanimoto, Heisenberg, & Gerber, 2004). Thus, this research suggests that pain offset relief likely represents one mechanism through which mood improves after NSSI engagement.

Although helpful in understanding why people engage in NSSI, improved mood upon the removal of pain is inevitably an insufficient explanation for these behaviors. If all people feel better after the removal of pain, ostensibly this coping strategy should be used far more often and by far more people as it is a relatively easily accessible and reliable strategy. Accordingly, as proposed by Hooley and Franklin (in press), there are several barriers that prevent most people from engaging in NSSI despite these and other potential benefits. Two such barriers with the most empirical support include aversion toward NSSI-relevant stimuli (e.g., pain, razors, blood, knives) and positive self-worth. Unlike the benefits of NSSI, these barriers tend to vary across people and may represent key factors that predict engagement in NSSI and that may represent possible treatment or prevention targets for these behaviors.

### **Diminished aversion toward NSSI**

The majority of people find self-injury stimuli (e.g. knives, blood, razors, cuts) highly unpleasant and rate them as even more negative than other unpleasant stimuli (e.g., Bradley et al., 2001; Schupp et al., 2004). As a result, even in the face of knowledge that NSSI could improve mood, many people would likely remain unwilling to engage in NSSI simply because of

a desire to avoid these stimuli. However, research suggests that at least among people who engage in NSSI, this barrier is reduced. In fact, people who engage in NSSI tend to find these stimuli less aversive or even positive on explicit (Glenn & Klonsky, 2010), implicit (Franklin et al., 2014a; Nock & Banaji, 2007), behavioral (Allen & Hooley, 2015), and psychophysiological measures (Brain, Haines, & Williams, 1998). Moreover, diminished implicit and explicit aversion to NSSI stimuli significantly predicts future NSSI engagement (Franklin et al., 2014b).

It is not yet clear why this decreased aversion exists, however several reasonable possibilities exist. The explanation with the most empirical support is pain offset relief conditioning (Hooley & Franklin, in Press). Just as research has shown that pairing stimuli with pain offset relief can result in conditioning effects (e.g., this conditioning leads fruit flies to approach those conditioned stimuli at above-chance rates; Yarali et al., 2008), conditioning during NSSI could lead to similar effects. That is, repeatedly pairing blood, razors, and knives (i.e., NSSI stimuli) with the removal of pain during NSSI episodes could lead people to develop more positive associations with those stimuli. Consistent with this possibility, more recent and frequent engagement in NSSI is associated with more positive associations with NSSI stimuli, even compared to those with greater lifetime (but no past year) NSSI engagement (Franklin et al., 2014).

Importantly, we lack research examining whether some diminished aversion is present before the onset of any NSSI behavior. Such research could highlight whether this is a risk factor for the onset of NSSI. Additionally, only one study has examined the longitudinal association between diminished aversion to NSSI and continued engagement in NSSI in the future. Franklin and colleagues (Franklin et al., 2014b) found that diminished aversion to NSSI (but not unpleasant stimuli more generally) was a risk factor for future NSSI engagement. However, the

sample included a relatively long follow-up period (i.e., 6 months) and only a small number of participants reported any NSSI over this follow-up period (i.e., 24/49). Accordingly, it is unclear whether aversion to NSSI would remain a significant risk factor among a more severe sample. This distinction could help ascertain whether there is a threshold of decreased aversion that increases risk or whether different levels of aversion to NSSI predict variations in NSSI frequency over time.

### **Lowered self-worth and self-criticism**

A large body of social psychology research highlights that, for a variety of reasons, people are motivated to maintain, and do maintain, relatively high levels of self-esteem (see Pyszczynski, Greenberg, Solomon, Arndt, & Schimel, 2004 for review), though this effect may be larger across North American cultures (Heine et al., 1999). However, people who engage in NSSI do not tend to report this normative effect. In fact, people who engage in NSSI demonstrate lowered levels of self-worth across several domains, including body image (e.g., Muehlenkamp & Brausch, 2012), self-dissatisfaction (Victor & Klonsky, 2014), and self-criticism (e.g., Glassman, Weierich, Hooley, Deliberto, & Nock, 2007; Hooley, Ho, Slater, & Lockshin, 2010).

The self-punishment hypothesis is a helpful tool to understand why lowered self-worth and self-criticism are related to NSSI. A common reason cited for engaging in NSSI is self-anger (Muehlenkamp et al., 2013) and a desire to self-punish (Swannell et al., 2008; Nock & Prinstein, 2004; Klonsky, 2009). Indeed, between 41-62% of people engaging in NSSI report self-punishment motivations (Taylor et al., 2018). Accordingly, for highly self-critical individuals, pain elicited from NSSI could be perceived as deserved, and NSSI may therefore gratify a desire for self-punishment (Hooley et al., 2010; Hooley & St. Germain, 2014; St. Germain & Hooley, 2012). Consistent with this hypothesis, self-criticism (Hooley & St. Germain, 2014; Hooley et

al., 2010) and negative self-worth more generally (Bastian, Jetten, & Fasoli, 2011) predict one's willingness to endure pain. Moreover, endorsing self-punishment as motivation for engaging in NSSI is associated with increased pain tolerance and less aversive pain ratings even compared to other individuals with a history of these behaviors (Hamza, Willoughby, & Armiento, 2014). Together, this evidence suggests that NSSI may be egosyntonic for highly self-critical individuals.

This research thus suggests two intriguing possibilities. One, for highly self-critical individuals, the experience of pain could actually improve mood above and beyond the role of pain-offset relief. That is, if pain is perceived as deserved, it could provide a form of mood improvement in and of itself. Second, if self-criticism provides a pathway to engaging in NSSI via self-punishment, it is possible that self-criticism is an important risk factor for future NSSI engagement. Neither of these hypotheses has yet been tested.

### **Three Tests of The Benefits and Barriers Model of Nonsuicidal Self-Injury: Overview of Studies**

As summarized above, there are both benefits of and barriers to engaging in NSSI (Hooley & Franklin, in Press). Following this theory, NSSI mood benefits appear to be universal, whereas barriers to NSSI tend to vary across people and provide insights into the circumstances under which people choose to engage in these behaviors. Although preliminary research supports this theory, it requires additional empirical studies. Specifically, it remains unclear whether erosion of these barriers predicts future engagement in NSSI among people with histories of NSSI. Moreover, it is important to test whether erosion of these barriers impacts *how* NSSI improves mood.

The present dissertation seeks to address these gaps in knowledge. In particular, I present three studies addressing the following questions:

**Question 1:** Do implicit and explicit measures of self-criticism and decreased aversion toward NSSI stimuli predict NSSI frequency four weeks later, above and beyond important covariates?

**Paper 1.** Fox, K. R., Ribeiro, J. D., Kleiman, E. M., Hooley, J. M., Nock, M. K., & Franklin, J. C. (2018). Affect toward the self and self-injury stimuli as potential risk factors for nonsuicidal self-injury. *Psychiatry research*, 260, 279-285.

**Question 2:** Does self-criticism impact mood improving mechanisms of pain and the removal of pain among people with past year NSSI histories? What role do distraction and time play in this process?

**Paper 2.** Fox, K. R., Toole, K. E., Franklin, J. C., & Hooley, J. M. (2017). Why Does Nonsuicidal Self-Injury Improve Mood? A Preliminary Test of Three Hypotheses. *Clinical Psychological Science*, 5(1), 111-121.

**Question 3:** Do mood improving properties of pain differ among individuals with and without NSSI histories? If so, does self-criticism explain these differences?

**Paper 3.** Fox, K. R., O'Sullivan, I. M., Wang, S. B., & Hooley, J. M. (submitted). Self-Criticism Impacts Emotional Responses to Pain

**Paper 1: Affect toward the self and self-injury stimuli as potential risk factors for  
nonsuicidal self-injury**

Fox, K. R., Ribeiro, J. D., Kleiman, E. M., Hooley, J. M., Nock, M. K., & Franklin, J. C. (2018).  
*Psychiatry research*, 260, 279-285.

**Abstract**

Few risk factors for nonsuicidal self-injury (NSSI) have been identified. This study investigated diminished aversion toward self-injury (i.e., NSSI, suicide/death-related stimuli) and self-criticism as unique NSSI risk factors. After terminating a treatment study, 154 adults with a recent and frequent NSSI history completed self-report and computer-based measures of psychopathology, implicit and explicit self-criticism, and implicit aversion to NSSI and death related stimuli. Participants were then contacted 4 weeks later to test factors predicting NSSI frequency over this follow-up period. Diminished aversion toward NSSI stimuli and self-criticism significantly predicted NSSI 4 weeks later. These effects were unique from other theoretically important predictors, such as past week NSSI frequency and number of NSSI methods employed. Findings provide support that erosion of barriers to NSSI (e.g., aversion to self-injurious stimuli, decreased self-worth) may facilitate continued engagement in these dangerous behaviors. Results shed light on potential treatment targets for NSSI.

*Keywords:* NSSI; self-injury; risk factor; self-criticism; longitudinal; prediction

## 1. Introduction

Nonsuicidal self-injury (NSSI) is defined as direct and deliberate self-injury enacted without suicidal intent (most often self-cutting; Nock, 2010). These behaviors are surprisingly prevalent; approximately 5.5% of adults and 13.4% of young adults report engaging in these behaviors at some point in their lives (Swannell et al., 2014). Among clinical samples these rates are even higher, with around 50% reporting lifetime NSSI engagement (DiClemente et al., 1991; Penn et al., 2003). NSSI is associated with numerous health risk behaviors, most alarmingly future suicidal behaviors (Asarnow et al., 2011; Bryan et al., 2014; Cox et al., 2012; Goldstein et al., 2012; Guan et al., 2012; Whitlock et al., 2013; Wilkinson et al., 2011). Despite a few promising single-group studies, very few treatments have consistently reduced NSSI compared to active control treatments (Brausch and Girresch, 2012; Glenn et al., 2015; Gonzales and Bergstrom, 2013; Nock, 2010; Washburn et al., 2012; see Franklin et al., 2016 for an exception).

An important step toward creating effective NSSI treatments is identifying strong risk factors for these behaviors. Unlike correlates, risk factors precede NSSI and divide individuals into high- and low-risk groups (Kraemer et al., 1997). Risk factors are especially useful tools for forming and refining theory, targeting groups for prevention, and determining effective treatment targets. Few strong and consistent NSSI risk factors have been identified (Fox et al., 2015; Nock, 2010) largely due to methodological factors including few longitudinal NSSI studies; use of community samples with low rates of NSSI; long follow-up lengths (~12 month average); examination of highly nonspecific risk factors (e.g., depressive symptoms); inclusion of mild or common (vs. moderate) self-harming behaviors like lip biting or wound picking; and dichotomous assessment of NSSI. To identify clinically meaningful NSSI risk factors, longitudinal studies using rigorous empirical designs, narrower definitions of NSSI, continuous

NSSI assessment, and shorter follow-up periods are necessary. Shorter follow-up periods are particularly useful for discovering risk factors that can help identify people at risk for NSSI engagement in the near future, and for identifying treatment targets that can lead to shorter-term NSSI reductions.

An emerging NSSI model based on recent experimental and longitudinal research has proposed two novel risk factors: diminished aversion to self-injury stimuli (Franklin et al., 2014b) and self-criticism (Hooley and St Germain, 2014). The Benefits and Barriers Model (Hooley & Franklin, In Press) proposes that there are benefits to engaging in NSSI, but that there are also many barriers that prevent most people from engaging in these behaviors. Benefits of NSSI, such as improved mood upon the removal of pain (i.e., pain-offset relief; Franklin et al., 2013), appear to be universal and are experienced among people with and without an NSSI history. The universality of these benefits indicates that they likely are not risk factors, as they cannot divide people into high- and low-risk groups. Barriers to NSSI include positive associations with the self and aversion to NSSI stimuli. Unlike the benefits of NSSI, barrier levels differ across individuals. If eroded barriers are risk factors, the degree to which these barriers are eroded should both differentiate people at high- and low-risk for NSSI and predict future NSSI. Of note, we conceptualize eroded aversion to NSSI as a risk factor, but aversion toward NSSI could also be conceptualized as a protective factor. For more in depth discussion of these distinctions, see a recent review of this model (Hooley & Franklin, Under Review).

There were three primary goals in this study. First, we sought to test whether self-criticism is a risk factor for prospective NSSI frequency. Second, we sought to replicate and extend previous studies testing decreased aversion to NSSI stimuli as an NSSI risk factor. Third,

we sought to examine associations among decreased aversion to NSSI stimuli, death-related stimuli, and future NSSI frequency.

*1.1.Goal 1: Investigate whether self-criticism is a risk factor for NSSI*

A large body of social psychology research highlights that, for a variety of reasons, people are motivated to maintain, and do maintain, relatively high levels of self-esteem (see Pyszczynski et al., 2004 for review), though this effect may be larger across North American cultures (Heine et al., 1999). It is hypothesized that these feelings of positive self-worth lead people to protect their bodies from pain and provide a barrier to intentional self-injury. When these positive feelings decrease, people likely become more willing to harm themselves (Hooley & Franklin, In Press). Providing support for this theory: research suggests that negative self-beliefs directly impact one's willingness to endure pain (Bastian et al., 2011; Hooley and St Germain, 2014; Hooley et al., 2010); people who engage in NSSI demonstrate lowered levels of self-worth across several domains, including body image (e.g., Muehlenkamp and Brausch, 2012), self-dissatisfaction (Victor and Klonsky, 2014), and self-criticism (e.g., Glassman et al., 2007; Hooley et al., 2010); and self-criticism mediates the relationship between childhood maltreatment and NSSI engagement (Glassman et al., 2007).

It remains unclear whether self-criticism precedes NSSI or NSSI precedes self-criticism. We hypothesized that self-criticism would predict NSSI frequency over a 4-week follow-up period. Of note, we were not able to test whether self-criticism predicted initiation of NSSI, as all participants in this study had a past month history of NSSI at baseline. To test this hypothesis, we used multiple measures of self-criticism. First, we utilized a previously used self-report measure of self-criticism (i.e., the Self-Rating Scale; Hooley et al., 2010). Second, given limitations of self-report (e.g., limited capacity for introspection; Nisbett and Wilson, 1977) and

the unique importance automatic, unconscious processes (Greenwald and Banaji, 1995), we created an implicit test of self-criticism to provide unique insights into the construct. This implicit measure of self-criticism (implicit affect toward the self) examines automatic, emotional responses to self-related words (described in more detail below).

*1.2.Goal 2: Replicate and extend previous findings that lack of aversion to NSSI is a risk factor for NSSI*

Serving as a barrier to engaging in NSSI, people typically find self-injury stimuli (e.g., knives, blood, razors, cuts) highly unpleasant and rate them as even more negative than other unpleasant images (Franklin et al., 2014a). Several factors (e.g., pain offset relief conditioning, peer, familial, or media exposure to NSSI, media exposure to blood, wounds, and gore) may reduce this barrier and increase the likelihood that someone will choose to engage in NSSI (Hooley & Franklin, In Press). Providing support for this hypothesis, people who engage in NSSI report self-injury-related stimuli to be less aversive or even positive on explicit (Glenn and Klonsky, 2010), implicit (Franklin et al., 2014a; Nock and Banaji, 2007), behavioral (Allen and Hooley, 2015), and psychophysiological measures (Brain et al., 1998). Moreover, diminished implicit and explicit aversion to NSSI stimuli significantly predicts future NSSI frequency (Franklin et al., 2014b).

Together, this literature suggests that decreased aversion to NSSI might be a risk factor for NSSI. However, only one study to date has examined the longitudinal association between diminished aversion to NSSI and future NSSI frequency. Franklin and colleagues (2014b) found that diminished aversion to NSSI (but not unpleasant stimuli more generally) was a potential NSSI risk factor, but the study suffered from a number of limitations including infrequent NSSI engagement among a small number of participants (i.e., 24/49 participants engaged in NSSI over the follow-up period) and use of a relatively long follow-up period (i.e., 6 months). Participants

also varied in terms of how recently and frequently they had engaged in NSSI at baseline. It is thus unclear whether aversion to NSSI would remain a significant risk factor among participants with a more frequent and recent history of these behaviors. This distinction will be critical in determining whether different levels of aversion to NSSI mirror variations in NSSI frequency. To test this possibility, it is necessary to examine whether diminished aversion to NSSI predicts future NSSI frequency within a sample with a more recent and frequent history of these behaviors. We hypothesized that aversion toward NSSI would predict NSSI frequency over a 4-week follow-up period within a sample with a recent and frequent NSSI history. To test this hypothesis, we used implicit affective ratings toward NSSI (i.e., self-cutting) related stimuli.

### *1.3.Goal 3: Examine whether decreased aversion to suicide/death is a risk factor for NSSI*

Engagement in NSSI, especially moderate and repetitive NSSI, is associated with suicidal thoughts and behaviors concurrently (Brunner et al., 2007; Lloyd-Richardson et al., 2007; MacLaren and Best, 2010; Tang et al., 2011) and prospectively (Ribeiro et al., 2016). One possibility for this overlap is that people who engage in NSSI develop a diminished aversion toward self-injury more generally (i.e., not just NSSI, but suicidal self-injury as well). If this is the case, people who engage in NSSI will demonstrate a similar decreased aversion to both NSSI and suicide/death. Consequently, this decreased aversion to suicide/death will predict prospective NSSI frequency. Another possibility is that people who engage in NSSI demonstrate a diminished aversion specific to NSSI stimuli. In this case, diminished aversion to suicide/death will not be an NSSI risk factor. Notably, research using the implicit association test (IAT) examining automatic associations between oneself and death supports this second hypothesis, as implicit associations with suicide/death were associated with a history of suicide attempts, not NSSI (Nock et al., 2010). However, it remains unclear whether implicit affect scores, which

measure automatic, emotional responses to suicide and NSSI-relevant stimuli, will show the same pattern. This is particularly important in light of evidence that measures of implicit identification are uncorrelated with implicit affect, likely because they represent unique constructs (Franklin et al., 2014b; Payne et al., 2008). Research has not yet investigated whether the observed diminished aversion to self-cutting images generalizes to death and suicide relevant stimuli. This could have important implications for our understanding of comorbidity between NSSI and suicidal thoughts and behaviors.

Addressing many limitations of previous NSSI risk factor studies, we tested whether self-criticism and decreased aversion to self-injury (i.e., NSSI specific and suicide/death) acted as risk factors for NSSI frequency. Specifically, we examined whether implicit affect toward the self, self-cutting stimuli (e.g., knives, blood, cuts on skin, blades), and suicide/death (e.g., skulls, nooses) acted as unique predictors of NSSI frequency over a short-term (i.e., 4-week) follow-up period among people with a recent and frequent history of NSSI. We used an online format for this study. Recent research suggests that online and in-person recruitment procedures produce highly similar results across a wide range of tasks and populations (Bauermeister et al., 2012; Crump et al., 2013; Hauser and Schwartz, 2016; Weinberg et al., 2014). In addition, online studies facilitate participant anonymity and privacy. This may increase participant comfort in disclosing stigmatized thoughts, behaviors, and symptoms, including self-injury (Swannell et al., 2014).

## **2. Methods**

### *2.1 Procedures*

Participants were recruited from online forums related to self-injury and severe psychopathology to participate in a larger, online treatment study in which they were randomized to a treatment or a control group for the first four weeks of the study (detailed description of

recruitment and treatment study are described elsewhere; Franklin et al., 2016). Briefly, based on research described above, the treatment employed sought to increase self-harm aversion and decrease self-criticism using an application-like game. The present study combined participants recruited for both Study 1 and Study 2, but not Study 3, as both Studies 1 and 2 included participants recruited based on their recent NSSI histories and included the same set of measures.

We sought to predict NSSI frequency over the final month of the study (i.e., 4 weeks after treatment termination). Specifically, on the final day of the online treatment, participants completed a battery of questionnaires, including past week and month NSSI frequency, self-criticism, and emotion reactivity. After completing these questionnaires, participants completed a computerized assessment of implicit affect toward the self, NSSI, and suicide/death using the affect misattribution procedure (AMP) described in more detail below. They were then contacted for a follow-up assessment four weeks later. Of note, we utilized the one month follow-up period because treatment effects did not persist over this period (Franklin et al. 2016). Therefore, we anticipated that there would be little to no effect of treatment group on NSSI frequency at this final time point. Indeed, results are nearly identical when controlling for treatment group and these results are available upon request.

## *2.2 Subjects*

Participants were adults ages 18 and older, who were fluent in English, who had a recent history of NSSI (i.e., 2+ episodes of self-cutting in the past month), and who completed the final assessment in the treatment study described above. Of the 243 participants in the larger study, 154 (63.37%) completed both the end of treatment assessment and the final follow-up assessment four weeks later. We conducted Little's (Little, 1988) Missing Completely at

Random (MCAR) test to determine the representativeness of non-missing data. Results were non-significant, suggesting that data were missing at random.

Participants were primarily young adults ( $M = 22.68$  years old,  $SD = 5.52$ ) reporting female sex at birth (79.87%) and female gender (76.62%). The majority of participants identified as European American (78.6%), with remaining participants identifying as Asian (7.8%), Black/African American (1.3%), Hispanic/Latino (3.2%), and Other (9.0%; e.g., Native American, mixed race).

## 2.3 Measures

### 2.3.1 Demographics

We assessed basic demographic information (i.e., sex, gender, age, race).

### 2.3.2. *Self-Injurious Thoughts and Behaviors Interview (SITBI; Nock et al., 2007)*

The SITBI assesses the presence, frequency, and characteristics of suicidal and non-suicidal self-injurious thoughts and behaviors. This measure has demonstrated strong test-retest reliability (average kappa = 0.70) and interrater reliability (average kappa = 0.99). We used an online version of the SITBI in the present study; the online and in-person versions of the SITBI produce very similar estimates of NSSI status and frequency (Franklin et al., 2014a).

At baseline, the SITBI was used to assess self-injurious thoughts and behaviors over participants' lifetime, past year, past month, and past week. At the final assessment, past week and past month self-injurious thoughts and behaviors, including NSSI, were assessed. Of note, NSSI frequency variables were calculated as a composite of the reported number of episodes of self-cutting, burning, hitting, scraping skin to the point of drawing blood, and inserting objects under the skin during a given period. This ensured that mild behaviors (e.g., picking at wounds) were not included.

### 2.3.3. *The Self-Rating Scale (SRS; Hooley et al., 2010)*

The SRS is an eight-item measure assessing self-critical thoughts. Sample items include: “Sometimes I feel completely worthless” and “Others are justified in criticizing me.” Responses are provided on a 1 (strongly disagree) to 7 (strongly agree) scale. The reliability of the SRS ranges from 0.73–0.88 (Glassman et al., 2007; Hooley et al., 2010). At baseline, Cronbach’s alpha was 0.95.

### 2.3.4. *Emotion Reactivity Scale (ERS; Nock et al., 2008)*

The ERS is a 21-item self-report questionnaire of emotion reactivity, a component of emotion regulation involving emotional sensitivity, intensity, and persistence. Responses are provided on a 0 (not at all like me) to 4 (completely like me) scale. The ERS demonstrates strong internal consistency, convergent and divergent construct validity, and criterion-related validity (Nock et al., 2008). At baseline, Cronbach’s alpha was 0.87.

### 2.3.6. *The Self-Injury and Self-Criticism Affect Misattribution Procedure (AMP, Payne et al., 2005)*

The AMP is a brief computerized task that measures implicit affect. On each trial of the AMP, participants see an emotionally evocative stimulus (i.e., images, words) for 75 milliseconds, a blank screen for 125 milliseconds, an ambiguous Chinese symbol for 100 milliseconds, and, last, a gray screen. On each trial, participants were instructed to ignore the picture or word that they saw prior to the Chinese symbol, and to judge whether the Chinese symbol was more or less pleasant than average. Despite instruction to ignore the emotional stimuli, several studies have demonstrated that Chinese symbol ratings are influenced by the emotional stimulus preceding this symbol; more pleasant stimuli generate more pleasant ratings of subsequent symbols (Payne et al., 2005). This likely occurs because individuals misattribute the emotional response evoked by the earlier stimulus as being evoked by the later ambiguous

Chinese symbol. Through this misattribution, the AMP indexes implicit affective reactions to the emotional stimuli that are flashed at the beginning of each trial.

The current AMP contained neutral (e.g., towel, plates;  $n = 6$ ), suicide/death (e.g., skulls, gun pointed at head, skeletons, graveyard;  $n = 6$ ; termed implicit affect toward suicide/death), and self-cutting images ( $n = 12$ ; termed implicit affect toward NSSI) that have been validated in prior studies (Franklin et al., 2014a; Franklin et al., 2014b). In addition, the present AMP included images of 5 self-related words (i.e., I, mine, my, me, myself; termed implicit affect toward the self) and 5 images of other-related words (i.e., other, them, their, theirs, they). AMP scores are calculated as the number of trials on which participants select a positive association compared to the total number of trials within a given category. Higher scores on the AMP indicate a more positive association toward the category.

Of note, at the start of the treatment study, implicit affect toward the self, but not other related words (e.g., “they,” “them”), was significantly associated in the expected directions with SRS scores (Spearman rho = -0.20,  $p < 0.05$ ), suggesting that these measures are likely assessing aspects of the same construct, or a related construct.

#### *2.4 Data Analytic Plan*

First, we examined characteristics, including means, standard deviations, and spearman correlations, among variables of interest at baseline (i.e., at the end of the treatment study). Second, we examined which independent variables (i.e., self-criticism, implicit affect toward the self, implicit affect toward NSSI and suicide/death stimuli, past week and month NSSI history, baseline psychopathology, emotion reactivity, number of methods used for NSSI engagement) significantly predicted NSSI frequency over the follow-up period. Third, after examining each of these variables’ unadjusted, univariate association with NSSI over the 4-week follow-up period,

we tested a multivariate model to examine which of these variables uniquely contributed to prospective NSSI frequency when controlling for variance due to relevant covariates (i.e., prior NSSI, number of NSSI methods employed). Due to high levels of multicollinearity and to increase the power of our multivariate model, we only included measures with significant univariate associations with follow-up NSSI frequency. In cases where multiple measures of the same construct (i.e., past week and past month NSSI) showed significant univariate associations with NSSI frequency at follow-up, we only included the measure with the stronger univariate association.

NSSI frequency outcome variables typically violate the assumptions of statistical tests based on normal distributions as they represent count data including a large number of small values and a small number of very large values. Moreover, NSSI frequency outcomes are often zero-inflated, positively skewed count variables. These violations were also true in the present study. To model these types of data, zero-inflated Poisson (ZIP) and zero-inflated negative binomial (ZINB) regression are appropriate. ZINB is utilized when data are overdispersed, above and beyond of the context of the excess zeros inherent in these data. Given that the overdispersion parameter calculated by ZINB was not significant across the majority of analyses, we utilized ZIP to model these data. Of note, we used listwise deletion to handle missing data.

### **3. Results**

Means, standard deviations, and Spearman correlations among variables of interest are listed in Table 1.1. Past week and past month NSSI frequency at baseline were correlated with the self-rating scale (i.e., explicit self-criticism), but not implicit affect toward the self or implicit affect toward NSSI stimuli, at this time point. Interestingly, although implicit affect toward the self and self-rating scale scores were correlated at baseline of the treatment study, they were no

longer correlated by the end of treatment and the start of this assessment. Implicit affect toward NSSI and implicit affect toward suicide/death were moderately correlated.

In addition to reporting two or more episodes of self-cutting in the past month at the start of the treatment study (as required by inclusion criteria), participants continued to self-reported extensive NSSI histories at the end of the treatment, which served as the baseline for these analyses. At time one, participants reported that their NSSI episodes included self-cutting (42.21%), self-hitting (23.38%), scraping to the point of drawing blood (20.78%), burning (12.99%), and inserting objects under the skin (12.99%). “Other” methods were not included in analyses to decrease the likelihood that minor, more normative self-harming behaviors (e.g., picking at wounds) would be included in analyses. Additionally, at time one, most participants reported suicide ideation (76.62%) in the past month, and almost half reported suicide plans (42.86%) in the past month. Over the 4-week follow-up period, 66.89% of participants reported continued NSSI engagement. The majority of participants reported that these episodes involved self-cutting (56.49%), though participants also reported self-hitting (29.22%), scraping to the point of drawing blood (22.73%), burning (14.29%), and inserting objects under the skin (9.09%).

Univariate ZIP models assessing each covariate revealed that each of the following significantly predicted NSSI frequency over the 4-week follow-up period: past week NSSI episodes, past month NSSI episodes, total number of NSSI methods used, implicit affect toward the self (negatively), implicit affect toward NSSI images, and self-criticism scores (i.e., SRS). Implicit affect toward suicide/death stimuli and ERS were not significant predictors (see Table 1.2).

Given stronger associations with the outcomes of interest, we included past week instead of past month NSSI frequency in the multivariate model. Together, the multivariate ZIP model included past week NSSI episodes, total number of NSSI methods ever used, SRS, implicit affect toward NSSI-stimuli, and implicit affect toward the self. Results demonstrated that each of these variables significantly and uniquely predicted NSSI frequency over the 4-week follow-up period (See Table 1.3).

#### **4. Discussion**

This study examined self-criticism and diminished aversion to NSSI and suicide/death as risk factors for prospective NSSI frequency. These associations were examined within a large, Internet-based sample with a recent and frequent history of NSSI across a 4-week follow-up period. Results demonstrated that self-criticism, measured implicitly and explicitly, and an implicit measure of diminished aversion to NSSI, were each associated with NSSI frequency over the follow-up period.

##### *4.1. Goal 1: Investigate whether self-criticism is a risk factor for NSSI*

Across implicit and explicit measurement, results demonstrated that both measures of self-criticism significantly predicted NSSI frequency. Both self-criticism, as measured by the self-rating scale and as measured by implicit affect toward the self, remained significant even when controlling for numerous theoretically important factors, including frequency of past week NSSI, number of NSSI methods ever employed, and implicit aversion to NSSI stimuli. Results suggest that self-criticism is an independent predictor of future NSSI.

##### *4.2. Goal 2: Replicate and extend previous findings that aversion to NSSI is a risk factor for NSSI*

Findings replicated and extended previous research suggesting that diminished aversion to NSSI is an important NSSI risk factor. Specifically, results showed that even within a sample

engaging in recent and frequent NSSI, diminished aversion to NSSI predicted future NSSI. Findings suggest that different levels of NSSI aversion predict variations in NSSI frequency. Within the multivariate model, even when controlling for other theoretically important factors, decreased aversion toward NSSI predicted follow-up NSSI frequency.

#### *4.3. Goal 3: Examine whether decreased aversion to suicide/death is a risk factor for NSSI*

Previous research demonstrated that diminished aversion toward NSSI, but not negative stimuli more generally, is associated with prospective NSSI frequency (Franklin et al., 2014a). However, prior to the present study, it remained unclear whether this effect was specific to NSSI stimuli or whether it generalized to suicide/death stimuli. Results showed that aversion toward NSSI and aversion toward suicide/death were moderately correlated, but that aversion toward NSSI and not death related stimuli predicted follow-up NSSI frequency. Accordingly, results suggest that decreased aversion toward NSSI-relevant stimuli, but not suicide/death more generally, increase risk for NSSI frequency. However, additional studies replicating this effect in larger samples, using both implicit and explicit measures of this aversion, are needed.

#### *4.4. Limitations*

These findings should be interpreted in light of several limitations. First, aversion to NSSI was assessed using pictures relevant to self-cutting (e.g., knives, blood, cuts). Self-cutting is not specific to NSSI and is also involved in some suicide attempts. Although our images depict moderately self-harming behavior (e.g., surface level cuts, blood, scars not requiring medical care) that likely appear less severe than would wounds arising from a self-cutting suicide attempt, it is possible that these stimuli are not unique to NSSI and instead also prime affective responses to suicide as well. Future studies should consider including images related to other forms of NSSI (e.g., bruises, burns, fists) to test whether these findings generalize to other types

of NSSI. Second, measures were administered in the same order across participants, with AMP measures occurring last. Although this is consistent with prior work utilizing similar measures (e.g., Franklin et al., 2014a, Franklin et al., 2014b), ordering effects may have biased responses on implicit (i.e., AMP) ratings. For example, participants who reported more extensive SITB histories during the survey may have been primed to rate these stimuli as more positively than those with less extensive histories, thus biasing results. Future research should consider investigating whether the order in which these measures are administered influences results.

Third, participants were recruited from online forums related to self-injury and all participants reported recent (i.e., past month) histories of NSSI. Consequently, the present study examined risk factors only for continued NSSI frequency. It remains unclear whether these factors are risk factors for the onset of NSSI. Future research should consider using longitudinal designs among younger samples with no prior history of NSSI to test this possibility. Such studies could clarify whether diminished aversion to NSSI and death-relevant stimuli as well as self-criticism are risk factors for the initiation of NSSI, and whether these factors could be targets for prevention.

Fourth, the present sample may demonstrate even greater decreased aversion toward self-injury (i.e., NSSI and suicide/death) stimuli both because they choose to converse about this topic online and because most participants also reported histories of suicidal thoughts and behaviors. It is possible that these risk factors may operate differently in samples that do not use these online forums and in samples that have a less extensive history of suicidal thoughts and behaviors. Future research should consider a more fine-grained examination of how risk factors act among those with a history of NSSI alone and among those with a history of both NSSI and suicidal thoughts and behaviors, using diverse samples recruited online and in person. Such

research could be especially helpful in understanding the role of diminished aversion toward NSSI and suicide/death-related stimuli.

Finally, the sample was limited in several ways. First, the sample was primarily female and European American. Large prevalence studies (Klonsky, 2011) and meta-analyses of prevalence studies (Swannell et al., 2014) have found equal rates of NSSI among males and females, suggesting that our sample may be biased. Notably, research suggests that females engage in more self-cutting whereas males engage in more self-hitting (Barrocas et al., 2012; Sornberger et al., 2012). Accordingly, our inclusion criteria may have played a role in the greater number of females in the study, and results may not generalize to samples including more males or greater racial diversity. Second, our sample had just undergone treatment for NSSI. Although the NSSI treatment effects did not persist over the follow-up period examined, participants and our variables of interest may have been impacted by the treatment in relevant ways. Future studies replicating this effect in novel samples are needed.

In summary, the present study suggests that diminished aversion to NSSI and self-criticism are significant predictors of NSSI frequency over a 4-week follow-up period, above and beyond other theoretically important factors. Future research should further investigate whether more diverse samples with different forms and trajectories of NSSI demonstrate similar associations. This could have important implications for the treatment and prevention of NSSI.

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**Table 1.1. Spearman correlation among variables of interest at baseline**

	1	2	3	4	5	6	7	8
1. Past month NSSI	1.00	0.81**	0.25**	0.05	0.00	-0.02	0.27**	0.25**
2. Past week NSSI		1.00	0.26**	0.10	0.02	-0.04	0.17*	0.24**
3. Number of NSSI methods used			1.00	0.11	-0.12	0.18*	0.11	0.08
4. Implicit affect: NSSI				1.00	-0.02	0.37**	-0.11	-0.02
5. Implicit affect: Self					1.00	-0.09	0.05	-0.07
6. Implicit affect: Death/Suicide						1.00	-0.05	-0.09
7. Emotion Reactivity Scale							1.00	0.54**
8. Self-Rating Scale								1.00
Mean	11.76	3.03	3.19	0.51	0.46	0.39	57.70	44.60
SD	19.27	5.49	1.18	0.31	0.31	0.30	19.05	9.59

**Table 1.2. Univariate Predictors of NSSI Episodes**

<b>Predictors</b>	<b>Zero-Inflated Poisson Regression</b>		
	<b>B (SE)</b>	<b>IRR</b>	<b>95% CI</b>
Past Week NSSI Episodes	0.09 (0.05)	1.07***	(1.06, 1.08)
Past Month NSSI Episodes	0.02 (0.001)	1.02***	(1.02, 1.02)
Number of NSSI methods	0.23 (0.03)	1.26***	(1.20, 1.32)
Implicit Affect: Self	-0.53 (0.10)	0.59***	(0.48, 0.71)
Implicit Affect: NSSI	0.45 (0.10)	1.56***	(1.29, 1.90)
Implicit Affect: Death	-0.14 (0.64)	0.83	(0.68, 1.01)
Self-Rating Scale	0.03 (.003)	1.03***	(1.02, 1.04)
Emotion Reactivity Scale	0.01 (0.01)	1.01	(0.99, 1.02)

B = Beta; SE = Standard error; IRR = Incident Rate Ratio; \* <0.05; \*\* <0.01; \*\*\* <0.001.

**Table 1.3. Multivariate Model of NSSI Prediction**

	<b>Zero-Inflated Poisson Regression</b>		
<b>Predictors</b>	<b>B (SE)</b>	<b>IRR</b>	<b>95% CI</b>
Intercept	1.12 (0.21)	3.06***	(2.04, 4.58)
Past Week NSSI Episodes	0.07 (0.004)	1.07***	(1.06, 1.08)
Number of NSSI methods	0.12 (0.03)	1.13***	(1.07, 1.19)
Self-Rating Scale	0.02 (0.003)	1.02***	(1.01, 1.02)
Implicit Affect: Self	-0.65 (0.10)	0.52***	(0.3, 0.63)
Implicit Affect: NSSI	0.51 (0.09)	1.66***	(1.37, 2.02)

B = Beta; SE = Standard error; IRR = Incident Rate Ratio; \* <0.05; \*\* <0.01; \*\*\* <0.001.

## **Paper 2: Why Does Nonsuicidal Self-Injury Improve Mood? A Preliminary Test of Three Hypotheses**

Fox, K. R., Toole, K. E., Franklin, J. C., & Hooley, J. M. (2017). *Clinical Psychological Science*, 5(1), 111-121.

### **Abstract**

People who engage in nonsuicidal self-injury (NSSI) often state that it helps them feel better. We tested three hypotheses through which this mood modification might occur. Following a negative mood induction, adults reporting past year NSSI were randomized into a control (i.e., sitting alone quietly), mild distraction, or pain condition. All participants completed mood ratings at regular intervals. No mood repair occurred in the control condition. However, distraction improved mood both during and after the activity. Participants who self-administered pain reported no overall mood change, suggesting that contrary to popular NSSI theories, pain likely does not improve mood via distraction. However, as predicted, level of self-criticism moderated mood change during pain. Participants high on self-criticism felt significantly *better* during pain and participants low on self-criticism felt significantly *worse* during pain. Findings shed light on *how* NSSI improves mood by clarifying the circumstances under which different affect regulation processes may operate.

## Introduction

Nonsuicidal self-injury (NSSI), direct and intentional self-injury enacted without suicidal intent (Nock, 2010), is both prevalent and dangerous. Approximately 5.5 - 17.2% of community samples (Swannell et al., 2014) and up to 50% of clinical samples (DiClemente, Ponton, & Hartley, 1991; Nock & Prinstein, 2004) report lifetime NSSI engagement. Moreover, NSSI is associated with suicidal behaviors both concurrently (e.g., Klonsky & Muehlenkamp, 2007; Nock et al., 2006; Whitlock et al., 2006) and prospectively (see Ribeiro et al., 2016), suggesting that NSSI may be an important risk factor for future suicidal behaviors.

NSSI involves behaviors such as cutting or burning that cause pain. Nevertheless, the majority of people who engage in NSSI report that these behaviors help them to feel better (for a review, see Nock, 2010). Over the last decade, a large body of research has linked NSSI with affect regulation (e.g., Nock & Prinstein, 2004; Franklin et al., 2013a). However, it remains unclear how these physically damaging and sometimes dangerous behaviors help people feel better. The present study tested three hypotheses about why mood improves upon NSSI engagement: pain-offset relief, self-punishment, and distraction. We will refer to each of these as potential hypotheses of mood change (i.e., processes that lead to and/or cause changes in mood).

Pain-offset relief is the hypothesis with the most empirical support. A large body of experimental research has demonstrated that the removal of pain leads to emotional relief. Pain-offset relief has been observed in basic research involving humans, rats, and fruit flies (e.g., Andreatta, Muhlberger, Yarali, Franklin et al., 2013a; Gerber, & Pauli, 2010; Smith & Buchanan, 1954; Tanimoto, Heisenberg, & Gerber, 2004; Leknes, Brooks, Wiech, & Tracey, 2008). The relief that follows pain removal can even be used to condition positive responses to neutral stimuli (e.g., Andreatta et al., 2010; Tanimoto et al., 2004). With regard to NSSI, research

suggests people with a history of NSSI both self-report and demonstrate psychophysiological evidence of mood improvement after the removal of pain (Franklin et al., 2010, 2013b; Bresin & Gordon, 2013; Schoenleber et al., 2014). However, the same also appears to be true of people with no history of NSSI. Despite support for the mood improving consequences of pain-offset in people who engage in NSSI, it is not known if pain-offset relief is the only means of affect regulation in people who self-injure. Also unknown is whether certain contexts enhance or diminish pain-offset relief, or if pain-offset relief works in conjunction with other means of affect regulation.

Another hypothesized way that pain may improve mood (independent of pain offset relief) in people who engage in NSSI is through self-punishment. The defective self model of NSSI proposed by Hooley and colleagues (see Hooley et al., 2010; Hooley & St. Germain, 2014; St. Germain & Hooley, 2012) suggests that pain provides emotional benefits for people who engage in NSSI because people who are highly self-critical regard pain as something they deserve. In other words, for highly self-critical individuals, the pain associated with NSSI is hypothesized to improve mood because it gratifies a desire for self-punishment.

Several lines of research have yielded findings consistent with this hypothesis. First, people who engage in NSSI are significantly more self-critical than people who do not engage in NSSI (Hooley et al., 2010; Glassman, Weierich, Hooley, Deliberto, & Nock, 2007; St. Germain & Hooley, 2012). Second, self-punishment is often endorsed as a reason for engaging in NSSI (Swannell et al., 2008; Nock & Prinstein, 2004) and higher levels of self-criticism are associated with an increased likelihood of endorsing self-punishment as a motive for engaging in NSSI (Glassman et al., 2007). Third, correlational and experimental research suggests that among participants with an NSSI history, self-critical beliefs are associated with willingness to endure

pain for a longer period of time (Hooley et al., 2010; Hooley & St. Germain, 2014). Similarly, endorsing self-punishment as motivation for engaging in NSSI is associated with increased pain tolerance and less aversive pain ratings (Hamza, Willoughby, & Armiento, 2014). Together, this research suggests that negatively focused thoughts about the self (e.g., shame, guilt, self-criticism) may increase a person's willingness to experience pain, possibly in an effort to self-punish.

It remains untested whether mood repair occurs during the experience of pain for people who engage in NSSI. If pain improves mood through the gratification of self-punishment desires, we would expect that people with NSSI histories would experience mood benefits during pain. Moreover, these mood benefits would be associated with self-criticism. Demonstrating this would highlight self-criticism as an important part of affect regulation during NSSI and as a potential treatment target. Previous research has shown that directly targeting self-critical beliefs reduces the willingness of participants with NSSI histories to endure pain (Hooley & St. Germain, 2014). Support for the hypothesis that self-criticism enhances the mood benefits of pain would suggest that a similar intervention might reduce NSSI.

An independent line of research has led to the hypothesis that pain improves mood for people who engage in NSSI because pain functions as a potent distractor (see Brown, Comtois, & Linehan, 2002; Briere & Gil, 1998; Selby & Joiner, 2010). Supporting this idea, a large body of research suggests that distraction can improve mood among healthy, dysphoric (i.e., people with some depressive symptoms), and depressed individuals (e.g., Bastian, Jetten, & Fasoli, 2011; Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998; Nolen-Hoeksema & Morrow, 1993). However, people who engage in NSSI report higher levels of emotion reactivity and dysregulation than those who do not (e.g., Bresin, 2014; Franklin et al., 2013; Nock et al., 2008).

Accordingly, some researchers have suggested that mild and non-painful distractions (e.g., listening to music, going for a walk) may be insufficient to regulate negative mood within this population (e.g., Chapman et al., 2006; Selby, Anestis, & Joiner, 2008). Instead, these researchers propose a hypothesis whereby pain acts as a particularly potent form of distraction that is necessary to improve mood (e.g., Chapman, Gratz, & Brown, 2006; Selby et al., 2008; Brown, Comtois, & Linehan, 2002).

Stemming in part from these theories, some treatments (e.g., DBT) recommend non-painful distraction, such as engaging in activities, as a way to forestall NSSI. However, the benefits of distraction alone (painful or otherwise) as an NSSI treatment have not been examined. If pain serves as a particularly strong form of distraction, people with NSSI histories should experience similar or greater mood benefits during pain than during other engaging distractions. Failure to support distraction as a means of affect regulation in NSSI would suggest that distraction may not be a useful treatment target.

Previous experimental research on mood changes as a result of pain has relied on mood assessments taken before pain is experienced and again after pain has been removed. Such designs cannot separate out mood changes that are due to the experience of pain from mood changes that are due to the removal of pain, obscuring their separate contributions. Moreover, if pain improves mood, it is unclear whether it is because pain is a very potent distractor, because it provides psychological benefits to highly self-critical individuals, or both. This knowledge could advance our understanding of how NSSI works, provide new insights into how to disrupt affect regulation in NSSI, and perhaps identify novel treatment targets.

In a laboratory-based procedure, we examined how distraction, pain (and the removal of pain), as well as the simple passage of time affected mood among participants with a past year

history of NSSI. After a negative mood induction, we assessed participants' mood before, during, and after either experiencing a distracting task, a painful task, or a control task that involved sitting alone for a period of time. Because people who engage in NSSI often do so to regulate their negative moods, we did not expect that doing nothing (i.e., the control task) would make them feel better in the short term. Following research suggesting that distraction can help repair mood in other groups, we hypothesized that neutral, low-intensity distraction would result in slight mood improvements for all participants. Given previous research demonstrating that people who engage in NSSI are highly self-critical and previous work associating self-criticism with self-punishment motivations and pain endurance, we hypothesized that pain would facilitate mood improvements for all participants because it combines powerful distraction with self-punishment. We further hypothesized that changes in mood during pain would be associated with self-criticism. Last, replicating previous work, we hypothesized that the removal of pain (pain-offset relief) would result in additional mood improvements for all participants assigned to the pain condition.

## **Methods**

### **Participants**

Participants were 97 adults (76 female), aged 18-38 years (Mean age = 22.53 years, SD = 4.62). The majority of participants identified as Caucasian (73.4%), with the remaining participants identifying as Black/African American (4.3%), Asian (10.6%), Hispanic/Latino (3.2%), and Other (8.5%; most often mixed race).

Participants were recruited via flyers posted in the community, Craigslist, psychiatric outpatient clinics, in and around Boston, Massachusetts. Printed and electronic advertisements asked, "Have you ever purposely hurt yourself without wanting to die?" Inclusion criteria included: past year NSSI engagement resulting in noticeable tissue damage, 18+ years of age,

and English fluency. Interested participants received a semi-structured screening interview over the phone to determine eligibility. Eligible participants who provided consent were scheduled for a two-hour experimental session. Participants were compensated \$30 for their participation. The local committee overseeing the protection of human subjects approved all study components.

## **Measures**

**The Self-Injurious Thoughts and Behaviors Interview (SITBI; Nock, Holmberg, Photos, & Michel, 2007).** The SITBI is a semi-structured interview used to assess history of suicidal and nonsuicidal thoughts and behaviors. The interview has very strong inter-rater reliability (average Kappa = .99). It has also demonstrated strong convergent construct validity, as indexed by its correspondence with other measures of self-injurious thoughts and behaviors (Nock et al., 2007). The measure also predicts future self-injurious thoughts and behaviors (e.g., Franklin et al., 2014).

**Beck Depression Inventory-II (BDI-II; Beck et al., 1996):** The BDI-II a 21-item self-report inventory indexing depressive symptoms. Items are rated on a 4-point Likert-type scale ranging from 0 (not at all) to 3 (most severe). Item responses are summed to yield a total score ranging from 0 to 63, with higher scores representing higher levels of depression. The BDI-II has demonstrated high internal consistency ( $\alpha=.92$  for psychiatric outpatients; Beck, Steer, Ball & Ranieri, 1996). Moreover, the measure demonstrates convergent and discriminant validity with respect to other measures of depression and anxiety among psychiatric outpatients (Steer, Ball, Ranieri, & Beck, 1999).

**Self-Rating Scale (SRS; Hooley et al., 2010).** The SRS is an eight-item measure assessing self-critical beliefs including, “Sometimes I feel completely worthless” and “I am socially inept and undesirable.” Participants are asked to respond to items on a Likert-type scale,

ranging from 1 (strongly disagree) to 7 (strongly agree). The SRS has good internal reliability, with Cronbach's Alpha ranging from 0.73–0.88 (Glassman et al., 2007; Hooley et al., 2010). The measure discriminates between self-injurers and healthy controls (Hooley et al., 2010) and SRS scores have been shown to mediate the relationship between emotional abuse and NSSI engagement (Glassman et al., 2007), highlighting measure validity.

**Visual Analog Scales (VAS).** VASs were used to assess positive and negative mood at regular intervals throughout the study. These scales were presented on a computer screen and participants were instructed to rate their positive and negative mood “right now” on a 0 – 100 (not at all - extremely) scale. VASs have been used to index positive and negative mood in numerous studies (e.g., Hooley & St. Germain, 2014; Sanchez, Vazquez, Gomez, & Joormann, 2014). Supporting the validity of the current measures, baseline VAS ratings for negative mood were significantly and positively associated with past-week depressive symptoms assessed via the BDI-II ( $r(75)=0.36, p < .01$ ). Baseline VAS ratings of positive mood were significantly and negatively associated with past-week BDI-II scores ( $r(74) = - 0.26, p < .01$ ).

## **Procedures**

Participants were interviewed regarding their history of self-injurious thoughts and behaviors. They also completed a brief battery of questionnaires. Participants then received a negative mood induction. Following this, participants were assigned to the pain (n=38), distraction (n=29), or passage of time (i.e., control) condition (n=27). We used a random number generator to assign participants to one of the three conditions; however, because a small number of participants (described in more detail below) either never reported feeling pain *or* terminated the pain task as soon as it was experienced, we assigned additional participants to this condition as replacements. Due to this issue, our research design did not involve true random assignment.

State mood ratings were obtained at twenty seconds intervals before, during, and after completing the tasks associated with the assigned condition. Participants also provided ratings on a 0-10 scale (0 = not at all; 10 = extremely) concerning how engaging the task was and, for participants assigned to the pain condition, how painful the task was. On completion of the study all participants experienced a positive mood induction to ensure their mood was at least as positive as it was prior to beginning the study procedures. Prior to the negative mood induction, participants were trained in the use of the VAS. A member of the researcher team explained the VAS and participants completed 6 practice mood ratings to familiarize themselves with completing these scales at short (12 seconds was used for the training) time intervals.

### **Negative Mood Induction**

We adapted the manipulation used by Bastian, Jetten, and Fasoli (2010) and asked participants to, “Think about all of the times in which you failed or let yourself down in your life.” Next, participants were asked to select the event that had the most negative impact on them and to rate the impact of that event on a 0 (not at all) to 10 (extremely bad) scale. Participants were instructed to write about the event for five minutes, including how they felt about themselves after the event and all the different consequences of the event. If they finished the writing exercise before the five minutes had passed, participants were further instructed to read over and review what they had written. The mean rating of the selected events was 8.83 (SD = 1.63) on the negative impact scale. As a manipulation check, participants were asked to complete VAS ratings of their mood before and after the writing exercise to test if the negative mood induction had the expected effect.

### **Pain Condition**

Previous laboratory studies have used cold (Franklin et al., 2010; Russ et al., 1992), heat

(Bresin & Gordon, 2011), electric shock (Franklin et al., 2013; Weinberg & Klonsky, 2012), and pressure (Bresin et al., 2010; Hooley et al., 2010) to induce pain. We utilized pressure primarily because participants typically endure pain longer using this method, providing more time points to study changes in mood. Pressure pain is also less influenced by physiological factors than other methods (e.g., cold or heat pain; Forgione & Barber, 1971).

For participants randomly assigned to the pain condition, pain was induced using a pressure algometer (Beecher, 1959). The algometer exerts a continuous focal pressure when placed on the finger and creates the sensation of an object, such as a dull butter knife, being pressed into the skin. Over time, this device causes an aching pain that incrementally increases (Forgione & Barber, 1971). Research suggests that the pain algometer reliably produces pain without causing any tissue damage (Hooley & Delgado, 2001; Hooley et al., 2010).

Throughout the pain task participants were alone in a testing room, observed by an experimenter through a one-way mirror. They were instructed to place the pressure point of the algometer between the knuckle and tip of the index finger of their non-dominant hand. (In practice, pain was administered to the left hand for all participants. One participant was left handed, but expressed a preference for using the mouse with her right hand). Participants were instructed to raise their free hand as soon as the pressure began to be experienced as painful (pain threshold). They were told to remove their finger from the device when the pain was no longer tolerable (pain tolerance). Throughout the procedure, participants remained in complete control and were able to terminate the task at any time. At eight minutes, all participants were asked to remove their finger from the algometer if they had not done so prior to this time. Throughout the pain trial, participants were prompted to use their free hand to make VAS mood ratings on the computer every 20 seconds. All participants completed these ratings for a full 11 minutes

regardless of how long they kept their finger in the pressure algometer.

### **Distraction Condition**

We sought to use a distraction task that would fully capture participants' attention without creating positive or negative feelings. Accordingly, we did not employ previously used procedures because these were primarily passive and hence not fully engaging (e.g., visualization of phrases; see Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998; Nolen-Hoeksema & Morrow, 1993) or else had the potential to elicit feelings of failure in the event of poor performance (e.g., Tetris; see Holmes, James, Kilford, & Deeprose, 2010). Instead, we created a new distraction task. Participants were instructed to listen to and write down neutral words (e.g., thud, pin, revert, cab) for four minutes. Neutral words were selected from the Affective Norms for English Words (ANEW; Bradley & Lang, 2010). The 32 chosen words were selected because they had neutral ratings (average score of 4.50 on a 1 - 9 positive to negative scale) and moderate arousal scores (average score of 4.85). Participants wrote these words on a worksheet. Sometimes they were instructed to write the words in lower case letters, sometimes in upper case letters, and sometimes in a mix of lower and upper case letters. This approach was used to ensure participants kept their full attention on the task. As was the case for the pain condition, participants assigned to the distraction condition were left alone in a testing room and observed by an experimenter through a one-way mirror. During the task they were prompted to complete VAS mood ratings on the computer every 20 seconds for a total duration of 11 minutes.

### **Control Condition**

Participants assigned to the control condition were instructed to sit quietly alone in the testing room and informed that they would be prompted to complete the VAS ratings on the computer periodically. As was the case for the other conditions, participants completed mood

ratings for a total of 11 minutes to match the amount of time utilized in the pain and distraction conditions.

### **Data Analytic Plan**

Pearson correlations were used to examine the associations between baseline pain variables (i.e., pain threshold, tolerance, endurance), self-criticism, and NSSI frequency. To confirm that the mood induction worked as expected, two paired samples t-tests were used to compare positive and negative mood before and after the task. Next, we sought to examine whether there were differences in mood changes across the three conditions. We ran a 3 (occasion) x 3 (condition) repeated measures analysis of variance (ANOVA) to compare ratings of negative mood before, during, and after each task (i.e., control, distraction, pain). A similar analysis was used to examine changes in positive mood. We used Mauchly's Test to examine assumptions of sphericity in each ANOVA. When assumptions of sphericity were violated, we report Greenhouse-Geisser corrected tests. Significant differences across conditions were followed up with Tukey tests to determine where group differences arose.

Ratings during tasks were calculated as follows: (1) during-pain ratings were determined by calculating the average reported rating of mood (positive and negative) while participants were experiencing pain; (2) during-distraction ratings were determined by calculating the mean of the seven mood ratings (positive and negative) completed during the distraction task; (3) control ratings were determined by calculating the mean of the first seven positive or negative mood ratings obtained during the control task. For the pain condition, the number of ratings included in the average mood score varied depending on how long participants tolerated the procedure; on average, during-pain mood ratings were based on an average of 5.3 sets of ratings (SD = 5.0). Post task ratings were calculated as the first three ratings after task completion for all

groups. We chose the first three ratings because of previous research demonstrating that pain-offset relief occurs soon after the removal of pain (e.g., Franklin et al. 2013a).

Finally, we tested whether self-criticism moderated changes in mood during conditions in two ways. First, we used Pearson correlations to examine whether self-criticism was associated with averaged changes in mood *during* or *after* each of our three experimental conditions. Second, we used a median split to divide participants into a low self-criticism or a high self-criticism group based on their SRS scores. We then tested whether self-criticism grouping moderated changes in mood during and after relevant condition(s) (i.e., those in which there was a significant correlation with during- or after-condition mood) using 3 (occasion) x 2 (high versus low self-criticism) mixed ANOVAs.

## **Results**

### **NSSI Sample Characteristics**

All participants reported one or more past year NSSI episodes that resulted in noticeable skin damage. Self-cutting was the most commonly endorsed method of NSSI (85.60%). Participants also reported burning (27.80%), hitting (44.30%), scraping skin to the point of drawing blood (23.70%), and other methods (e.g., inserting objects under the skin, 39.20%). Given the wide range of NSSI episodes reported, we provide both means and medians to give more complete descriptive information. The mean number of lifetime NSSI episodes was 321.19 (SD = 466.49; *Mdn* = 70.00). The mean number of past year NSSI episodes was 23.22 (SD = 35.58; *Mdn* = 10), and the mean number of past month NSSI episodes was 3.14 (SD = 5.48; *Mdn* = 1).

The mean age of NSSI onset was 13.93 years (SD = 4.00). On average, participants had engaged in NSSI for an average of 8.61 years (SD = 5.34). The majority (58.80%) of participants reported a history of psychological treatment specifically for NSSI related issues and almost a

quarter (22.70%) reported receiving medical treatment for damage caused by these behaviors. Most of the sample (83.50%) reported having received some form of therapy during their lifetimes, either in an outpatient (60.80%), inpatient (28.90%), partial hospitalization (19.60%), or residential care setting (10.30%). Just over one third (37.10%) of participants were currently taking psychiatric medications. Use of psychiatric medications was not associated with any of the pain variables.

### **Pain Characteristics**

Pain threshold was defined as the time participants took to report the onset of pain after placing their finger in the pressure algometer. On average, participants reported that they began to experience pain (pain threshold) at 90.60 seconds ( $SD = 84.40s$ ) and the mean time to terminate the pain trial (pain tolerance) was 245.86 seconds ( $SD = 168.89s$ ). Pain endurance, which reflects the amount of time that participants spent experiencing pain (i.e., pain tolerance minus pain threshold), had mean of 145.98 seconds ( $SD = 155.00$ ). The majority of participants reported experiencing moderate pain during the pain trial ( $M = 5.08, SD = 2.20$ ), and found the pain-task moderately engaging ( $M = 5.32, SD = 2.53$ ). Notably, there was no significant difference between reported task-engagement across the pain, distraction, and control task groups,  $F(2, 91) = 0.65, p = 0.52, \eta^2 = .01$  (control condition:  $M = 4.63, SD = 2.87$ ; distraction condition:  $M = 5.24, SD = 2.15$ ; pain condition:  $M = 5.32, SD = 2.53$ ).

Ten participants kept their finger in the algometer for the full 8 minutes permitted for the trial. Three participants reported that they *never* felt pain and another three participants removed their finger from the algometer immediately after reporting pain. Because they made no ratings while experiencing pain, these six participants were not included in the analyses.

### **Pain and Self-Criticism**

Consistent with findings from prior studies (e.g., Hooley et al., 2010), people who were more highly self-critical endured pain for longer (see Table 2.1 for correlations). In other words, they took longer to remove the pressure algometer from their fingers following the onset of pain. Self-criticism was not associated with either pain threshold or pain tolerance. Higher self-criticism scores were positively correlated with more past week, month, year, and lifetime NSSI. NSSI frequency was not significantly correlated with any of the pain variables.

### **Mood Induction**

Paired sample t-tests revealed that negative mood increased following the mood induction (pre-induction:  $M = 48.79$ ,  $SD = 21.74$ ; post-induction:  $M = 59.52$ ,  $SD = 21.60$ ),  $t(79) = 5.05$ ,  $p < .001$ ; Cohen's  $d = 0.53$ ). Positive mood also decreased (pre-induction:  $M = 46.78$ ,  $SD = 19.29$ ; post-induction:  $M = 34.52$ ,  $SD = 19.72$ ),  $t(78) = -7.80$ ,  $p < .001$ ; Cohen's  $d = -0.69$ ). As expected, after writing about failure experiences, participants felt significantly worse.

### **Mood Changes Across Conditions**

Two separate 3 (condition) x 3 (occasion) repeated measures ANOVAs were used to examine the effect of distraction, pain, or being left alone on changes in positive and negative mood assessed before, during, and after each condition. Results indicated a main effect of occasion on negative mood,  $F(2, 158) = 12.85$ ,  $p < .001$ ,  $\eta^2 = .22$  but not on positive mood,  $F(1.69, 133.28) = 1.66$ ,  $p = .20$ ,  $\eta^2 = .03$ . In other words, negative mood changed over time. There was also a significant condition x negative mood interaction [ $F(4, 158) = 3.43$ ,  $p < .05$ ,  $\eta^2 = .08$ ] but no interaction of condition with positive mood [ $F(3.37, 133.28) = 1.22$ ,  $p = .31$ ,  $\eta^2 = .03$ ]. Post-hoc Bonferonni tests shows that the distraction condition resulted in significantly larger reductions in overall negative mood compared to both the pain (mean difference = - 6.66,  $SE = 2.63$ ,  $p < .05$ ) and control conditions (mean difference = - 8.28,  $SE = 2.65$ ,  $p < .01$ ). The pain

and control conditions did not significantly differ with respect to changes in overall negative mood (see Figure 1).

### **Self-Criticism as Moderator of Mood Change During Pain**

To test our prediction that changes in mood during pain would be moderated by self-criticism, we first used correlational analyses. We created variables representing changes in mood during pain by subtracting the pre-task mood ratings from the average during-task mood ratings. This was done for both positive and negative mood ratings (e.g., average positive mood during pain minus positive mood prior to pain). Positive values represent increases in positive mood during pain; negative values represent decreases in positive mood during pain. Relatedly, positive values for negative mood represent increases in negative mood during pain and negative values represent decreases in negative mood during pain.

SRS scores were negatively correlated with changes in negative mood during pain ( $r[30] = -0.45, p = .01$ ) and positively correlated with changes in positive mood during pain ( $r[30] = 0.31, p < .05$ ). In other words, the more self-critical people were, the more their negative mood decreased and the more their positive mood increased while they were experiencing pain. This was not the case for the distraction and control conditions. Self-criticism was unrelated to mood changes during both the control condition (positive mood,  $r[27] = -0.07, p = .74$ ; negative mood,  $r[27] = 0.11, p = .57$ ) and the distraction condition (positive mood,  $r[29] = -0.04, p = .82$ ; negative mood,  $r[29] = -0.21, p = .21$ ). Only when people who engage in NSSI are experiencing pain do levels of self-criticism appear to play any role in mood improvement.

We also used similar procedures to test whether self-criticism was correlated with changes in mood *after* each condition. There was no association between self-criticism and mood change after either the distraction (positive mood,  $r[25] = -0.02, p = .91$ , negative mood  $r[29] =$

0.02,  $p = .93$ ) or the control condition had ended (positive mood  $r [27] = -0.03$ ,  $p = .89$ , negative mood  $r [27] = 0.05$ ,  $p = .79$ ). However, SRS scores were negatively correlated with changes in positive mood during the pain-offset relief phase ( $r[27] = -0.40$ ,  $p < .05$ ). Lower levels of self-criticism were not associated with more change in negative mood during pain-offset relief ( $r[27] = 0.30$ ,  $p = .06$ ). In other words, contrary to our prediction, self-criticism was associated with changes in positive mood after the removal of pain, such that *lower* levels of self-criticism were associated with *increased* positive mood following the offset of pain. This was not the case for either of the other two conditions.

To further probe the interaction of self-criticism and mood change before, during, and after pain, we conducted two 3 (Occasion) x 2 (Group; high versus low self-criticism) repeated measures ANOVAs. The first ANOVA tested whether self-criticism moderated changes in positive mood before, during, and after the experience of pain; the second tested the same moderation using negative mood as the dependent variable. We used a median split (median SRS score = 32.00) to divide participants into high and low self-criticism groups. The low self-criticism group ( $N = 16$ ) had a mean SRS score of 24.87 ( $SD = 5.62$ ). The high self-criticism group ( $N = 12$ ) had a mean SRS score of 38.34 ( $SD = 8.27$ ). Scores for both of these groups are within one standard deviation of SRS scores among participants with an NSSI history observed in previous studies (e.g., St. Germain & Hooley, 2012).

Self-criticism grouping significantly moderated overall changes in positive mood,  $F(1.61, 52) = 4.18$ ,  $p = .02$ ,  $\eta^2 = 0.14$ . The same was true for negative mood. There was a significant interaction of SRS group on changes in negative mood during and after pain,  $F(2, 52) = 3.81$ ,  $p =$

.03,  $\eta^2 = 0.13$ ).<sup>2</sup> These results are illustrated in Figure 2. Participants high on self-criticism demonstrated an increase in positive mood and a decrease in negative mood during pain, and a slight decrease in positive mood and increase in negative mood after the removal of pain. In contrast, participants low on self-criticism demonstrated a decrease in positive mood and an increase in negative mood during pain and a subsequent increase in positive mood and decrease in negative mood after the removal of pain. Stated another way, people who score high on self-criticism derive more mood benefit when they are experiencing pain. For participants low on self-criticism, mood benefits are most apparent after the pain is removed (i.e., during pain-offset relief).

### **Discussion**

Despite numerous hypotheses and theories, few experimental studies have examined why NSSI improves mood. Lack of knowledge about how NSSI produces affect regulation has hampered efforts to design effective NSSI interventions. The present study tested three hypotheses of this mood improvement. Results partially supported the self-punishment and pain-offset relief hypotheses, but not the pain as distraction hypothesis. Each of these findings is discussed in more detail below.

Our findings support the self-punishment hypothesis of mood improvements from NSSI for some but not all people. Specifically, results demonstrated that the experience of pain improved mood for participants reporting high self-criticism but not for participants reporting low self-criticism. These findings are consistent with previous research demonstrating that

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<sup>2</sup> Because median splits can be problematic, we also conducted these analyses using SRS as a continuous covariate. Results were similar, with continuous SRS scores significantly moderating changes in positive mood during and after pain and moderating changes in negative mood during pain.

people who are more self-critical endure pain for longer (Hooley et al., 2010; Hooley & St. Germain, 2014), research demonstrating a correlation between self-criticism and self-punishment motives for NSSI engagement (Glassman et al., 2007), and research demonstrating an association between reporting self-punishment as a NSSI motivator and willingness to endure pain (Hamza, Willoughby, & Armiento, 2014). Accordingly, results of this research suggest that to the extent that people high on self-criticism believe they are deserving of punishment, experiencing pain may improve mood because it provides congruence between self-beliefs and behavior. This research thus suggests that self-criticism may be an important treatment target. Specifically, the present results suggest that decreasing self-criticism may actually decrease reinforcing aspects of NSSI engagement (i.e., mood improvement through pain). This may help explain why reducing self-critical beliefs reduced willingness to endure pain in previous research (Hooley & St. Germain, 2014). It is possible that a similar intervention may reduce NSSI itself.

Notably, even among participants with a history of moderate past year NSSI, there was a wide range of self-criticism scores. Although high levels of self-criticism are important for understanding NSSI (see Hooley et al., 2010; St. Germain & Hooley, 2012; Hooley & St. Germain, 2014) not everyone who engages in NSSI is highly self-critical. For such people, the self-punishment hypothesis of mood improvement from NSSI may not be valid. Instead, participants with lower levels of self-criticism experienced positive mood benefits upon the removal of pain. Interestingly, these pain-offset relief benefits were not observed for those participants reporting high levels of self-criticism. Results thus support the pain-offset relief hypothesis for individuals with low levels of self-criticism.

Our findings conflict with previous experimental research demonstrating that pain-offset relief improves mood for all people, including those with and without NSSI histories (Franklin et

al., 2010, 2013b; Bresin & Gordon, 2013; Russ et al., 1992; Schoenleber et al., 2014; Weinberg & Klonsky, 2012). This may be a consequence of our study design. We measured mood during and after pain, allowing us to examine the effects of experiencing pain as well as pain-offset relief. Previous studies may have missed mood changes in these two different situations because mood was only measured after the removal of pain. Such assessments would necessarily fail to distinguish between mood improvements that occurred during pain and those experienced during pain-offset. It is also possible that our findings differ from previous research because changes in mood were based on self-report. Some studies of pain-offset relief have only observed these effects when mood was assessed using physiological approaches rather than self-report (Franklin et al., 2010; Franklin et al., 2013). However, we believe this explanation is unlikely because other studies have demonstrated self-reported mood improvement upon the removal of pain (e.g., Bresin & Gordon, 2011; Bastian, Jetten, & Fasoli, 2011; Leknes, Brooks, Wiech, & Tracey, 2008), and because we were able to observe some self-reported mood changes.

Finally, the present results challenge the idea that distraction is a key process through which the pain associated with NSSI makes people feel better. Some researchers have suggested that pain provides a powerful distraction, and that other less intense distractors are insufficient to redirect attention among people who engage in NSSI (e.g., Chapman et al., 2006; Selby et al., 2008; Brown, Comtois, & Linehan, 2002). Yet if pain were a particularly powerful distractor, we would expect all participants with a history of NSSI to experience mood improvements during pain. We would also expect the mood improvements that occurred during pain to be greater than those that occurred during mild distraction. We found no support for either of these ideas. Instead, mild distraction provided significantly more mood benefits than pain, and pain only improved mood for highly self-critical participants. One possibility is that the pain our

participants experienced was not severe enough to provide the level of distraction needed to provide mood benefits. However, the pain task was rated as being moderately engaging and comparable to the mild distraction task in this respect. Accordingly, results have interesting implications for NSSI treatment. Although pain does not necessarily improve mood via distraction, results suggest that non-painful distraction can be a useful tool for mood improvement. Distraction-based interventions may have the potential to be successful when combined with other treatment approaches (e.g., reducing self-criticism), as this may offer a new way to experience mood improvement in the absence of pain.

The present findings should be interpreted in light of several limitations. One potential concern is our reliance on self-report data. It would certainly have been desirable to assess mood using physiological methods in addition to simply assessing mood via self-report. Self-reported mood and biological indicators of mood do not always converge, and both provide meaningful information. However, given that this, to our knowledge, is the first study to assess changes in mood *during* pain in participants who engage in NSSI, we felt that self-report measures of mood provided a good starting point. This is the information that people themselves have conscious access to and awareness of. As such, it might be expected to play a role in how people feel and in what they do. Now that we have established that self-reported mood changes do indeed occur during and after pain for example, future research can begin to examine in more detail some of the biological processes that may accompany this.

The present study included only individuals with a past year history of NSSI. It remains unclear whether the mood benefits that occurred during pain would generalize to other populations. Future studies should examine whether similar mood benefits are observed in people with high levels of self-criticism who do not engage in NSSI. It is also possible that,

despite having some advantages over other methods, pressure pain may differ from the type of pain experienced while cutting or engaging in other forms of NSSI. In other words, questions remain about whether pressure pain provides a good NSSI proxy. This is clearly a limitation of all other forms of ethical pain inductions that are used in research contexts (e.g., cold-pressor task, heat pain). Nonetheless, it would be valuable to examine whether similar effects are apparent when different types of pain are used.

Notwithstanding these limitations, the present study provides a foundation for additional work in this area and suggests several novel research directions. In future studies, researchers should examine whether altering negative self-beliefs reduces the mood benefits that occur during the experience of pain. If so, it would then be important to test whether these changes lead to corresponding decreases in future NSSI engagement. Hooley and St. Germain (2014) have already shown that, following a brief cognitive intervention designed to improve sense of self, people who engage in NSSI are less willing to endure pain. Recent research has also demonstrated that a treatment targeting self-criticism, in addition to low aversion to self-injury, successfully reduced NSSI engagement in three large-scale online studies (Franklin et al., 2016). The possibility that these interventions targeting self-criticism led people to experience fewer mood benefits during pain clearly warrants further exploration. This type of study could highlight an NSSI treatment target with a clear mechanism of change.

Another way in which the mood benefits of pain might be modified involves over the counter medications. Both pain and pain-offset relief require the experience of pain to provide mood change. Future research should examine whether the effects of pain that we have demonstrated here can be substantially reduced by analgesic medications. Would prior administration of Tylenol, for example, diminish some or all of the mood benefits associated

with pain or pain offset in participants who engage in NSSI? To the extent that pain provides mood related benefits, such an approach might reasonably be expected to decrease these reinforcing aspects of NSSI, at least in the short-term. Whether this approach could provide long-term change in NSSI is questionable, however, because reducing the reinforcing effects of NSSI could potentially create an escalation of the behavior (comparable to an extinction burst) in an effort to regain the expected mood related benefits.

Taken together, our findings shed light on *how* NSSI improves mood by clarifying the mechanisms that produce this phenomenon and the circumstances under which different mechanisms may operate. They further suggest that modifications to current theoretical models used to understand why people choose to engage in NSSI may be appropriate. Finally, our results highlight the importance of cognitive factors and suggest that negative self-beliefs warrant increased attention in treatments for NSSI.

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Table 2.1. *NSSI, Pain, and Self-Criticism*

	1	2	3	4	5	6	7	8
1. SRS Total	1.00							
2. Pain Threshold	-0.05	1.00						
3. Pain Tolerance	0.23	0.37*	1.00					
4. Pain Endurance	0.36*	-0.15	0.85**	1.00				
5. Past Week NSSI	0.27**	-0.11	0.12	0.23	1.00			
6. Past Month NSSI	0.23*	-0.06	0.10	0.21	0.84**	1.00		
7. Past Year NSSI	0.23*	-0.02	0.11	0.17	0.68**	0.85**	1.00	
8. Lifetime NSSI	0.30*	-0.15	0.02	0.17	0.53**	0.59**	0.73**	1.00

*Note: SRS = Self-rating scale; NSSI = Nonsuicidal Self-Injury.*

\*\* Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).

All correlations are Pearson correlations

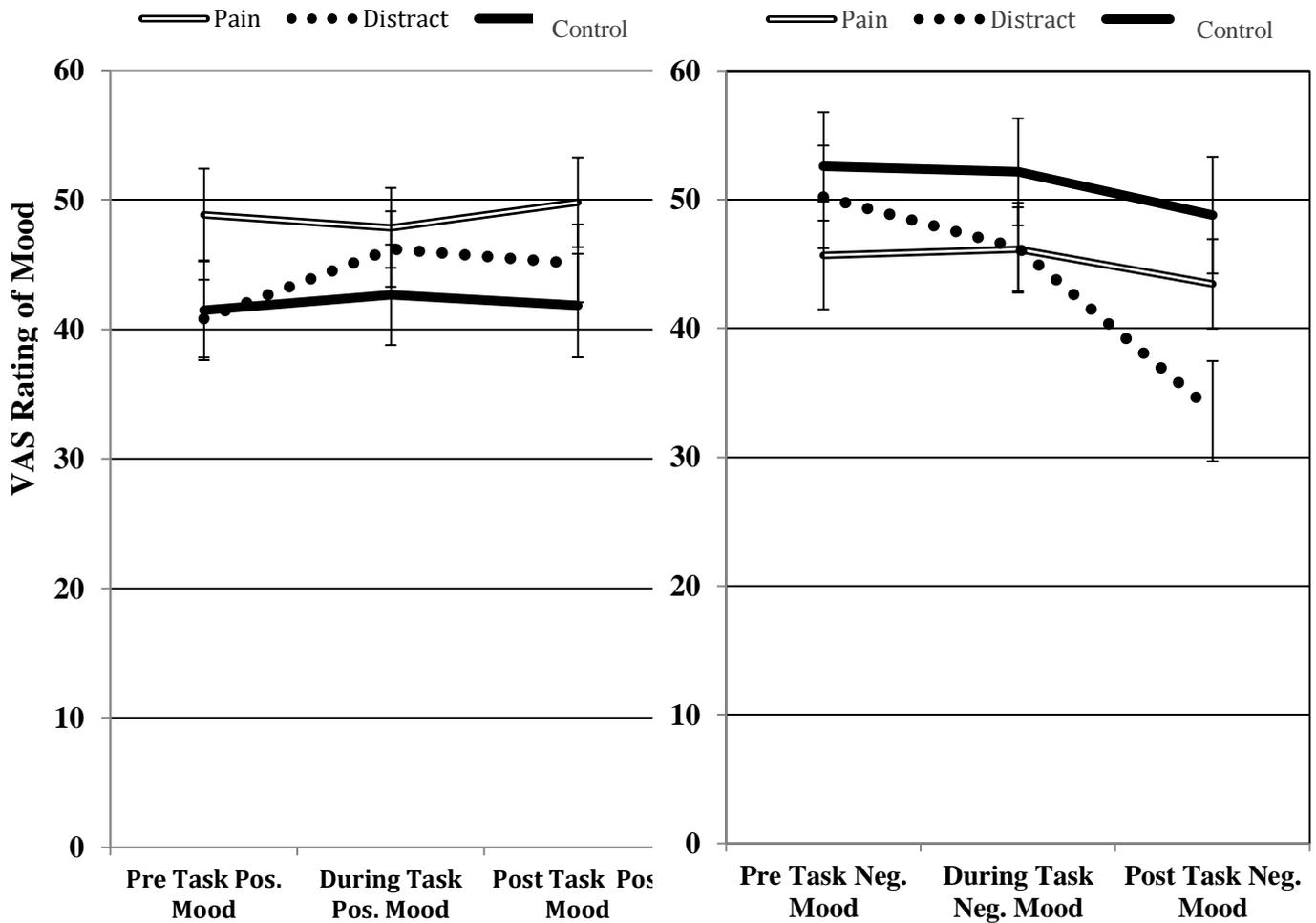


Figure 1.1. Mean positive and negative mood in the pain, distraction and control conditions before, during, and after each task condition.

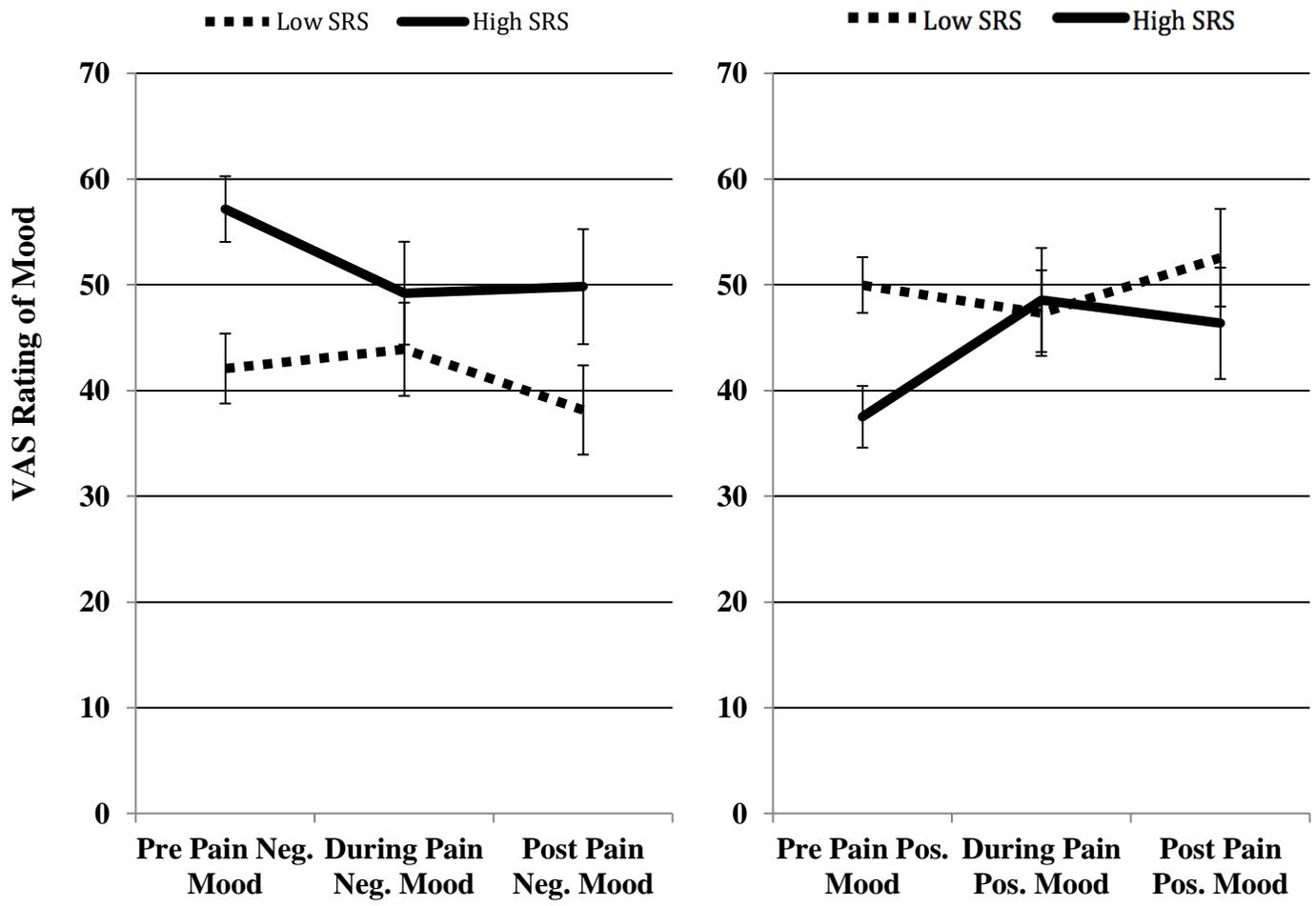


Figure 1.2. Self-criticism and mood before, during, and after experiencing pain

### **Paper 3: Self-Criticism Impacts Emotional Responses to Pain**

Fox, K. R., O'Sullivan, I. M., Wang, S. B., & Hooley, J. M. (Under Review).

#### **Abstract**

Nonsuicidal self-injury (NSSI) is associated with numerous negative outcomes (e.g., suicide attempts), making it a focus of great clinical concern. Yet, mechanisms reinforcing NSSI remain unclear. The Benefits and Barriers Model proposes that NSSI engagement is determined by both benefits of and barriers to NSSI. Benefits include mood improvement, a function reported by most who engage in NSSI; barriers include a desire to avoid pain and bodily harm. Self-criticism is generally understood as a trait *lowering* desire to avoid pain and bodily harm, thus decreasing that specific barrier. However, recent research demonstrates that self-criticism may also increase NSSI benefits. Highly self-critical people may view NSSI and pain in the context of feeling deserving of pain and punishment; thus, pain may improve mood among these individuals. We tested whether self-criticism impacted emotional responding to pain among adult females with ( $n = 44$ ) and without ( $n = 65$ ) NSSI histories. After a negative mood induction, participants rated their moods before, during, and after self-administered pain. While experiencing pain, participants with NSSI histories reported significantly greater mood improvement compared to participants without NSSI histories. Mediation analyses demonstrated that self-criticism significantly and fully explained this effect. Moreover, even in participants without NSSI histories, self-criticism was positively correlated with greater mood improvements during pain. Regardless of NSSI history, self-criticism impacts emotional responses to pain. Results suggest self-criticism may not only decrease an important NSSI barrier but may also enhance NSSI benefits, specifically leading to more mood improvement during pain.

## Introduction

Nonsuicidal self-injury (NSSI), including self-cutting, -hitting, and -burning without wanting to die, typically involves painful and stigmatizing behaviors (Nock, 2010). Yet, despite these and other negative consequences, NSSI is quite common. Upwards of 5.5% of adults and 17% of adolescents (Swannell, Martin, Page, Hasking, & St John, 2014) report engaging in these behaviors at some point in their lifetimes. A key to understanding why people engage in these harmful behaviors is that NSSI functions as a coping strategy. Emotion regulation is the most commonly cited reason for regularly engaging in NSSI (Taylor et al., 2018). Although informative, understanding that NSSI serves as a coping strategy leaves several important questions unanswered. In particular, it remains unclear *why* NSSI improves mood and *why* some people choose to engage in NSSI rather than other, non-painful strategies to improve mood.

A recently proposed theoretical model, the Benefits and Barriers Model of NSSI (Hooley & Franklin, 2018), provides some insight into these questions. Briefly, the Benefits and Barriers Model proposes that NSSI provides important benefits, including mood improvement, that could be experienced by anyone. However, most people avoid NSSI because of potent barriers (e.g., fear of pain, stigma). According to this model, both benefits and barriers to NSSI must be considered to understand why people engage in these behaviors.

Regarding “benefits” of NSSI, several lines of research demonstrate that pain and NSSI can help to improve mood. First, the majority of people who engage in NSSI report that they do so to regulate their mood or current mental state in some way (e.g., to feel better, to feel pain, to interrupt unpleasant memories or emotions; Klonsky, 2009; Nock, Prinstein, & Sterba, 2010; Selby, Nock, & Kranzler, 2014). Second, using ecological momentary assessment, researchers have observed both minor increases in positive mood (Muehlenkamp et al., 2009) and a mix of

increases in positive mood and decreases in negative mood (Claes, Klonsky, Muehlenkamp, Kuppens, & Vandereycken, 2010) after engaging in NSSI. Third, the removal of experimentally induced pain results in mood benefits (e.g., Bastian, Jetten, & Fasoli, 2011; Franklin et al., 2013b; Gerber et al., 2014). This effect is typically understood as *pain offset relief*, and refers to universal mood improvements experienced upon the removal of pain (e.g., Franklin et al., 2013b). Such mood benefits are observed across self-report and psychophysiological measures, and across people with and without NSSI histories. Thus, several lines of research support the idea that the termination of pain (such as occurs when an act of NSSI ends) can improve mood.

Although pain may be instrumental in creating a benefit of NSSI, it also represents a powerful barrier. Pain is typically an experience most people seek to avoid. As such, pain is likely to prevent many people from considering NSSI as a strategy for emotion regulation. Yet a growing body of research suggests that pain processing is altered among people who engage in NSSI. Although it is not clear whether this is a cause or a consequence (or both) of NSSI engagement, across several laboratory-based pain tasks, people who engage in NSSI take longer to report pain (i.e., they have higher pain thresholds). They are also willing to experience pain for longer periods of time (i.e., greater pain endurance) and report pain as less intense (e.g., Glenn, Michel, Franklin, Hooley, & Nock, 2014; Hooley, Ho, Slater, & Lockshin, 2010; Schmahl et al., 2006; St. Germain & Hooley, 2012). Consistent with this, people engaging in NSSI tend to report that these behaviors are only mildly to moderately painful (e.g., Ammerman & Brown, 2016; Bohus et al., 2000; Nock, Joiner, Gordon, Lloyd-Richardson, & Prinstein, 2006). Together, this research suggests that some components of pain processing, including pain perception and severity, may be attenuated among people engaging in NSSI. To the extent that this is true, an important barrier to NSSI onset and/or maintenance will be lowered.

As we have already noted, the removal of pain provides mood benefits (pain offset relief). However, for some people, the *experience* of pain may also improve mood. Fox and colleagues (2017) measured self-reported mood before, during, and after experimentally induced pain among participants with a past year NSSI history. Participants who reported high levels of self-criticism reported improvements in mood *during* pain whereas participants low on self-criticism experienced mood benefits only upon the *removal* of pain, consistent with typical pain offset relief effects. Results suggest that negative self-schemas alter the context in which pain is experienced. Highly self-critical individuals who engage in NSSI may perceive pain as a form of self-punishment. Gratifying the desire to self-punish may then serve to improve mood. This interpretation is in line with research showing that self-criticism is associated with endorsing NSSI for self-punishment purposes (Glassman, Weierich, Hooley, Deliberto, & Nock, 2007).

Although the findings reported by Fox and colleagues are suggestive of a potential cognitive benefit of NSSI, only 38 participants in their study experienced the pain induction and not all of those participants reported experiencing pain. Moreover, whether self-criticism impacts emotional responding to pain among people with *no* history of NSSI remains unknown. If self-criticism moderates mood change during pain for people without NSSI histories, this would suggest that self-criticism not only lowers an important barrier to NSSI (see Hooley & Franklin, 2018) but also provides general emotional benefits during pain. However, if self-criticism *does not* impact emotional responding to pain among people without NSSI histories, this would suggest that there is something unique about both engaging in NSSI and being self-critical that leads to this differential pain processing.

Therefore, the present study aimed to replicate and extend previous research testing self-criticism as a key factor in impacting emotional responses to pain. We tested whether NSSI

history impacted changes in mood during experimental pain and whether self-criticism impacted changes in mood across experimental pain for participants with and without NSSI histories. Finally, we tested whether self-criticism mediated changes in mood during pain observed across participants with and without NSSI histories.

## Methods

### *Participants*

Participants were 109 adult females (*mean age* = 23.72, *standard deviation [SD]* = 7.18). The majority of participants identified as White/Caucasian (73.9%) with remaining participants identifying as Black (6.5%), Asian (10.9%), Other (2.2%), or Mixed (4.4%). Participants were recruited from campus study pool and community advertisements posted in and around Boston, Massachusetts. Participants were offered one study pool credit or \$20 for study completion. Half of all flyers intentionally targeted people with NSSI histories (i.e., flyers asked, “Have you ever purposely hurt yourself without wanting to die?” in addition to providing other study information) to ensure that a substantial percentage of participants had a history of these behaviors.

### *Measures*

**Self-Rating Scale (SRS; Hooley et al., 2010).** The SRS contains eight items that assess self-critical beliefs. Specifically, participants are asked to rate items such as, “I am socially inept and undesirable,” or “I often feel inferior to others” using a 5-point Likert-type scale ranging from *strongly disagree* to *strongly agree*. The SRS has strong internal reliability (Glassman et al., 2007; Hooley et al., 2010) and can discriminate between people with and without NSSI histories (e.g., Hooley et al., 2010; St. Germain & Hooley, 2012).

**Self-Punishment.** Using a 5-point Likert-type scale ranging from *strongly disagree* to *strongly agree*, we asked participants to rate how much they endorsed the following statement: “I am deserving of pain and punishment.” This item was rated directly after the SRS.

**Beck Depression Inventory – II** (BDI-II; Beck, Steer, & Brown, 1996). The BDI-II is a 21-item self-report questionnaire assessing symptoms of depression. All items are rated on a four point Likert scale. Higher scores on the BDI-II index more severe depressive symptoms. The BDI-II demonstrates high internal consistency (Beck, Steer, Ball, & Ranieri, 1996) and strong convergent and discriminant validity among psychiatric outpatients (Steer, Ball, Ranieri, & Beck, 1999).

**Emotion Reactivity Scale** (ERS; Nock, Wedig, Holmberg, & Hooley, 2008). The ERS is a self-report measure assessing emotion sensitivity, intensity, and persistence across 21 items. Each item is rated on a scale ranging from 0 (not at all like me) to 4 (completely like me). The ERS demonstrates high internal consistency as well as convergent and divergent validity among adolescents and young adults (Nock et al., 2008).

**Visual Analog Scales (VAS).** To assess state ratings of mood and self-punishment desires, we created two VASs. Regarding mood, participants were asked to indicate their mood “right now,” from -50 (extremely negative), to 0 (neutral), to 50 (extremely positive). Unlike Fox and colleagues (2017), we assessed positive and negative mood on one scale. This decision was made in light of findings that the two mood ratings were highly correlated and to decrease participant burden. In addition to assessing mood, VAS were also used to assess state desires to experience pain and punishment. Specifically, participants were asked to indicate the degree to which they endorsed the following statement: “I am deserving of pain and punishment right now,” from 0 (not at all) to 100 (extremely).

*Modified Self-Injurious Thoughts and Behaviors Interview* (SITBI; Nock, Holmberg, Photos, & Michel, 2007). The SITBI is typically a semi-structured interview used to assess the presence, frequency, and characteristics of self-injurious thoughts and behaviors, including suicidal and nonsuicidal self-injury. The interview has strong interrater reliability (average  $\kappa = .99$ ) and strong convergent and construct validity, indexed by its association with other measures of self-injurious thoughts and behaviors (Nock et al., 2007). As with other online research studies (e.g., Franklin et al., 2016; Fox, Millner, & Franklin, 2016), we used an online version of the SITBI to assess history of self-injurious thoughts and behaviors. Prior research suggests that online and in-person versions of the SITBI produce similar estimates (Franklin et al., 2014). In addition to questions assessing lifetime history and frequency of self-injurious thoughts and behaviors, the SITBI was used to assess self-reported desire to discontinue NSSI and likelihood of future NSSI from 0 (not at all) to 4 (extremely).

### ***Procedures***

Approximately two weeks before the in-lab visit, participants completed a brief online survey to assess NSSI history using the modified SITBI. During the lab visit, participants completed the brief battery of questionnaires, described above. Then, participants completed a negative mood induction and, subsequently, an experimental pain task. The negative mood induction and pain tasks were identical to the mood inductions and pain tasks used by Fox and colleagues (2017). Briefly, for the negative mood induction, participants were asked to write for a full five minutes about a time they had failed or let themselves down. Before and after this negative mood induction, participants completed ratings of mood. Next, for the pain task, all participants were instructed to place the pressure point of a pressure algometer on the index finger of their non-dominant hand (Beecher, 1959). The pressure algometer exerts a constant

focal pressure on the finger. Over time that pressure begins to feel like an aching pain that increases as time passes (Forgione & Barber, 1971). Of note, the pressure algometer causes no tissue damage. Participants remain in full control at all times and can choose to terminate the trial at any time by raising the pressure point and removing their finger. Participants completed VAS ratings before, during, and after the pain trial. Participants were prompted to provide ratings every 20 seconds after the point of the algometer was placed on the finger. As with Fox and colleagues (2017), participants indicated when they started to feel pain so that VAS ratings could be averaged (a) before the task, (b) while pain was experienced, and (c) after the removal of pain.

Although all participants used the pressure algometer only 96 participants (88.07%) provided mood ratings during pain. Other participants reported never feeling pain ( $n=5$ ) or else quickly terminated the pain task because they found it immediately painful ( $n=9$ ). In such cases, participants were not able to provide any mood ratings during pain. Among participants who provided one or more ratings of mood during pain, VAS scores were averaged to provide “during pain” mood scores. On average, participants completed 4.39 ( $SD = 4.63$ ) during pain VAS ratings. Paralleling prior research (Fox et al., 2017), post pain mood scores were the average VAS reported across the first three ratings after pain termination.

## **Results**

### ***Sample Characteristics***

Of study participants, 44 (40.4%) reported lifetime NSSI engagement and 65 participants reported never engaging in any form of NSSI. There were no significant age differences across participants with ( $M$  age = 25.09,  $SD$  age = 8.58) and without NSSI histories ( $M$  age = 22.80,  $SD$  age = 5.94),  $t(107) = -1.65$ ,  $p = .10$ . However, participants with NSSI histories reported significantly greater BDI scores (NSSI Group:  $M = 16.42$ ,  $SD = 10.86$ ; No NSSI group:  $M =$

11.67,  $SD = 12.60$ ;  $t(104) = 2.01, p = .04$ ), emotion reactivity scores (NSSI Group:  $M = 41.23, SD = 13.46$ ; No NSSI group:  $M = 27.80, SD = 19.32$ ;  $t(102) = 3.93, p < .001$ ), self-criticism scores (NSSI Group:  $M = 31.50, SD = 10.76$ ; No NSSI group:  $M = 22.80, SD = 9.57$ ;  $t(106) = 4.41, p < .001$ ). Moreover, participants with NSSI histories reported significantly greater scores on feeling deserving of pain and punishment (NSSI Group:  $M = 2.93, SD = 1.80$ ; No NSSI group:  $M = 1.69, SD = 1.12$ ;  $t(107) = 4.44, p < .001$ ). Indeed, over half of participants (56.9%) without NSSI histories reported the lowest possible rating (i.e., 1) on the self-punishment item, whereas only 27.3% of those participants *with* NSSI histories gave this rating.

On average, participants with NSSI histories reported 7.31 ( $SD = 18.30$ ) past year and 69.91 ( $SD = 109.52$ ) lifetime NSSI episodes. Most participants endorsed using self-cutting (80.43%) as an NSSI method; a substantial percentage also endorsed self-hitting (56.52%) and scraping skin to the point of drawing blood (43.48%). On average, participants reported that they began engaging in NSSI at age 15.53 ( $SD$  age = 6.29).

### ***Pain Characteristics***

We assessed pain threshold, tolerance, and endurance across all participants. On average, participants reported experiencing pain (i.e., pain threshold) after 78.66 seconds ( $SD = 61.35$ ), terminated the pain task (i.e., pain tolerance) at 239.88 seconds ( $SD = 177.28$ ), and endured pain (pain tolerance – pain threshold) for 156.37 seconds ( $SD = 160.03$ ). One-way analysis of variance tests (ANOVA) revealed that participants with and without NSSI histories did not differ with regard to pain threshold ( $p = .95$ ), tolerance ( $p = .13$ ), or endurance ( $p = .12$ )<sup>1</sup>.

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<sup>1</sup> Equality of population variances assumption (significant Leven's test) was violated for pain endurance; however, results remained insignificant when Welch F ratio omnibus tests were conducted.

Pearson correlations of variables of interest across participants with and without NSSI histories are reported in Tables 3.1 and 3.2. Whereas depressive symptoms (i.e., BDI scores) and emotion reactivity (ERS scores) were not associated with any pain variables, self-criticism (i.e., SRS scores) and feeling deserving of pain and punishment were each significantly associated with pain endurance among participants with NSSI histories, but not participants without NSSI histories. These findings replicate and extend earlier studies showing that self-criticism is associated with pain endurance among people who engage in NSSI (e.g., Hooley et al., 2010; Fox et al., 2017). Moreover, among those participants with NSSI histories, depression, self-criticism, and feeling deserving of pain and punishment were each associated with lifetime NSSI frequencies. Only depressive symptoms and feeling deserving of pain and punishment were associated with past year NSSI frequencies.

### ***Mood Induction***

We used paired sample *t* tests to examine changes in mood resulting from the mood induction. As expected, mood significantly deteriorated following the mood induction (pre-induction:  $M = 14.10$ ,  $SD = 20.53$ ; post-induction:  $M = -3.19$ ,  $SD = 24.07$ ),  $t(95) = -8.92$ ,  $p < .001$ , Cohen's  $d = 0.93$ . Additionally, feeling deserving of pain and punishment significantly increased after the negative mood induction (pre-induction:  $M = 8.10$ ,  $SD = 17.36$ ; post-induction:  $M = 12.93$ ,  $SD = 23.79$ ),  $t(97) = 4.03$ ,  $p < .001$ , Cohen's  $d = 0.48$ .

### ***Mood Changes During and After Pain***

To test whether NSSI history impacted changes in mood during pain we conducted a 3 (Occasion: average pre-, during-, and post- pain mood) by 2 (Group: NSSI history versus no NSSI history) repeated measures analysis of variance (ANOVA). Mauchly's test was used to examine assumptions of sphericity; when assumptions were violated, we report Greenhouse-

Geisser corrected tests. There was a significant main effect of occasion,  $F(1.74, 11.52) = 4.88$ ,  $p = .01$ ,  $\eta^2 = .05$ , indicating significant mood changes across the phases of the pain task.

Moreover, there was a significant Occasion x Group interaction such that NSSI group status significantly moderated overall changes in mood during pain,  $F(1.74, 151.52) = 3.36$ ,  $p = 0.04$ ,  $\eta^2 = .04$ . Figure 1 illustrates average mood reported across the pain task. Contrasts indicated that there was a significant difference in mood changes from before to during pain ( $F(1, 91) = 5.37$ ,  $p = .023$ ,  $\eta^2 = .06$ ) and during to post pain ( $F(1, 91) = 6.26$ ,  $p = .01$ ,  $\eta^2 = .06$ ), but not from before to post pain ( $p = .56$ ,  $\eta^2 = .004$ ), in participants with and without NSSI histories. Overall, participants without NSSI histories show a relative absence of mood changes across the pain task. Participants low on self-criticism show deterioration in mood during pain, and relative improvements in mood upon the removal of pain.

### ***Impact of Self-Criticism on Changes in Mood during and After Pain***

We sought to test whether changes in mood during pain were moderated by self-criticism among participants with NSSI histories. Because participants with versus without NSSI histories differed significantly with regard to self-criticism, we did not include self-criticism as a covariate in the original ANOVA (see Miller & Chapman, 2001). Instead, we used Pearson correlations to examine overall changes in mood during pain (i.e., during pain average mood minus pre-pain average mood) and self-criticism (see Table 3.1). Because mood was assessed from -50 (extremely negative) to +50 (extremely positive), higher change scores indicate more positive mood during pain and lower scores indicate more negative mood during pain. Consistent with prior research, positive changes in mood during pain were significantly and positively associated with self-criticism scores. Moreover, extending prior research, results demonstrated that trait feelings of self-punishment were significantly and positively associated with positive changes in

mood during pain. We also tested whether changes in mood from pre- to post pain were associated with self-criticism scores. Consistent with prior research, self-criticism was not significantly associated with changes in mood after the removal of pain, although there was a trend in this direction. Overall, higher levels of self-criticism were associated with more positive mood changes during but not after the removal of pain.

We also tested whether, among participants with no NSSI history, changes in mood during pain were similarly correlated with self-criticism. Mirroring findings for participants with NSSI histories (see Table 3.2), positive changes in mood during pain for participants without NSSI histories were significantly and positively associated with self-criticism scores. However, there was no significant association between feelings of self-punishment and changes in mood during pain. This may be due to the restricted range of scores provided on this item by participants without NSSI histories. Additionally, we tested whether changes in mood from pre- to post pain were associated with self-criticism scores. In contrast to findings for participants with NSSI histories, self-criticism was positively and significantly associated with changes in mood after the *removal* of pain. In other words, higher levels of self-criticism were associated with more positive mood changes both during and after the removal of pain among participants who did not engage in NSSI.

Finally, we tested whether self-criticism mediated the changes in mood during pain observed between participants with and without NSSI histories. In particular, we used 5,000 bootstrap samples to test indirect effects and to extract bias-corrected 95% confidence intervals for this effect (Preacher & Hayes, 2008). This technique allowed us to examine the unique contribution of self-criticism to variance observed in changes in mood during pain across participants with and without NSSI histories. The total effect of NSSI status on changes in mood

during pain was significant ( $B = 7.09, p = .03$ ). Additionally, NSSI status significantly predicted self-criticism scores (i.e., a path;  $B = 9.52, p < .001$ ) and self-criticism significantly predicted changes in mood during pain (i.e., b path;  $B = 0.67, p < .001$ ). Finally, as illustrated in Figure 3, estimated indirect effects indicated that self-criticism fully mediated the effect of NSSI status on changes in mood during pain (indirect effect = 6.41, 95% bootstrapped confidence interval = 2.90-12.78) while the direct effect of NSSI status on changes in mood during pain was no longer significant (direct effect = 0.68,  $p = .83$ ).

## Discussion

We investigated whether and how self-criticism impacts emotional responses to pain in people with and without NSSI histories. Results indicated that participants with NSSI histories report different emotional responses to pain compared to participants without NSSI histories, and that self-criticism fully mediates this difference. Moreover, results indicated that for all participants (regardless of NSSI engagement), self-criticism is significantly associated with changes in mood during pain. In contrast, neither emotion reactivity nor depressive symptoms were associated with changes in mood during pain for either group.

Results shed light on aberrant pain processing among people engaging in NSSI. Considered with earlier research (Fox et al., 2017), our results provide additional evidence that emotional responses to pain are altered among people engaging in NSSI. Contrary to earlier research, however, in the present sample there were no group differences in terms of pain threshold, tolerance, or endurance. Lack of difference in these variables between groups may relate to our sample, where past year and month NSSI were not required. However, when considered alongside earlier research, results suggest that several aspects of pain processing may be altered among people who engage in NSSI. Together, this body of research indicates that the

pain barrier to NSSI engagement is likely lower among people who choose to engage in these painful behaviors.

Differences in emotional responses to pain observed between those with and without NSSI histories were fully explained by self-criticism. This effect parallels basic pain research indicating that context and expectation can impact the emotional responses to pain (e.g., Leknes et al., 2013). In the case of NSSI, negative self-perception may set the stage for pain to be perceived as a deserved form of self-punishment. This hypothesis is supported by our findings that self-criticism was strongly associated with feeling deserving of pain and punishment, and prior research showing that self-criticism is associated with endorsing NSSI for self-punishment purposes (Glassman et al., 2007). Importantly, the relationship between self-criticism and emotional responses to pain were observed regardless of NSSI history. This suggests that self-criticism may serve as a dimensional trait lowering an important NSSI barrier: typical negative affective responses to pain. Together, results suggest that pain may act as a benefit *and* a barrier to NSSI engagement. Specifically, whereas people high on self-criticism may gain emotional benefits from the pain elicited during NSSI engagement, other people may be deterred from NSSI behavior because pain is perceived as too aversive.

Several limitations should be considered. First, the present study included only female participants. This decision was made in light of evidence that males report pain differently when tested by female participants (Levine & De Simone, 1991) and in light of research suggesting that males and females differ with respect to the perception and experience of some experimentally induced pain (see Bernardes, Keogh, & Lima, 2008 and Racine et al., 2012 for reviews). Future research should consider conducting similar experiments among males and other genders to see whether results would generalize. Second, ratings of mood are based entirely

on self-report. Self-reported mood can be unique from psychophysiological and implicit measures of mood, and both provide meaningful information. Future research should consider assessing mood using multi-modal assessments to gain a fuller picture of how mood changes across pain as a function of self-criticism and NSSI history. Third, results of the present design were based entirely from experimentally induced pain. Although participants were in control of the pain they experienced, it remains unclear whether and how this would compare to other forms of pain (e.g., self-cutting) and pain that is self-inflicted outside of the laboratory. Future research using ecological momentary assessment may be particularly suited to look at whether results generalize to actual NSSI episodes. In addition to these limitations, it remains unclear how aberrant pain processing is related to NSSI longitudinally. Future research assessing how pain processing is related to the onset and maintenance of NSSI and other forms of indirectly self-harming behaviors are needed.

Taken together, results indicate that self-criticism impacts both benefits and barriers to NSSI. In particular, results suggest that pain may be less aversive for people high on self-criticism, thus lowering the pain barrier to NSSI engagement. Moreover, results indicate that self-criticism may alter the mood benefits of NSSI such that mood is improved during the experience of pain itself. More research examining whether these results generalize across genders and to other forms of experimental and real-world pain are needed to better understand these associations.

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Table 3.1. *Pearson Correlations Among Variables of Interest Across Participants with NSSI Histories*

<b>NSSI History</b>	1	2	3	4	5	6	7	8	9	10	11
1. SRS	1.00	0.71**	0.54**	0.45**	0.07	0.30 <sup>t</sup>	0.29	0.29	0.36*	0.51**	0.29 <sup>t</sup>
2. Pain and Punishment		1.00	0.67**	0.25	0.07	0.31*	0.29	0.53**	0.45**	0.58**	0.28
3. BDI			1.00	0.35*	0.13	0.11	0.18	0.46**	0.32*	0.30	-0.02
4. ERS				1.00	0.16	0.09	0.15	0.20	0.09	0.19	0.09
5. Threshold					1.00	-0.13	0.26	0.01	-0.08	0.04	-0.02
6. Endurance						1.00	0.93**	0.29	0.46**	0.34*	0.11
7. Tolerance							1.00	0.29	0.39*	0.35*	0.08
8. Year NSSI Frequency								1.00	0.64**	0.40*	0.21
9. Life NSSI Frequency									1.00	0.40*	0.12
10. $\Delta$ Mood During Pain										1.00	0.82**
11. $\Delta$ Mood Post Pain											1.00

\* Correlation is significant at the 0.05 level (2-tailed); \*\* Correlation is significant at the .01 level (2-tailed); <sup>t</sup>  $p = .08$  (2-tailed)

<sup>a</sup> Self-Rating Scale; <sup>b</sup> Item “I am deserving of pain and punishment.”; <sup>c</sup> Beck Depression Inventory; <sup>d</sup> Emotion Reactivity Scale

Table 3.2. *Pearson Correlations Among Variables of Interest Across Participants without NSSI Histories*

<b>No NSSI History</b>	1	2	3	4	5	6	7	8	9
1. SRS <sup>a</sup>	1.00	0.50**	0.70**	0.55**	-0.06	0.07	0.07	0.37**	0.34**
2. Pain and Punishment <sup>b</sup>		1.00	0.38**	-0.02	-0.01	0.11	0.14	0.09	0.19
3. BDI <sup>c</sup>			1.00	0.55**	0.05	0.15	0.19	0.25	0.24
4. ERS <sup>d</sup>				1.00	-0.06	-0.02	0.03	0.25	0.10
5. Threshold					1.00	0.03	0.44**	0.25	0.06
6. Endurance						1.00	0.91**	0.36**	0.30*
7. Tolerance							1.00	0.44**	0.31*
8. $\Delta$ Mood During Pain								1.00	0.67**
9. $\Delta$ Mood Post Pain									1.00

\* Correlation is significant at the 0.05 level (2-tailed); \*\* Correlation is significant at the .01 level (2-tailed)

<sup>a</sup> Self-Rating Scale; <sup>b</sup> Item “I am deserving of pain and punishment.”; <sup>c</sup> Beck Depression Inventory; <sup>d</sup> Emotion Reactivity Scale

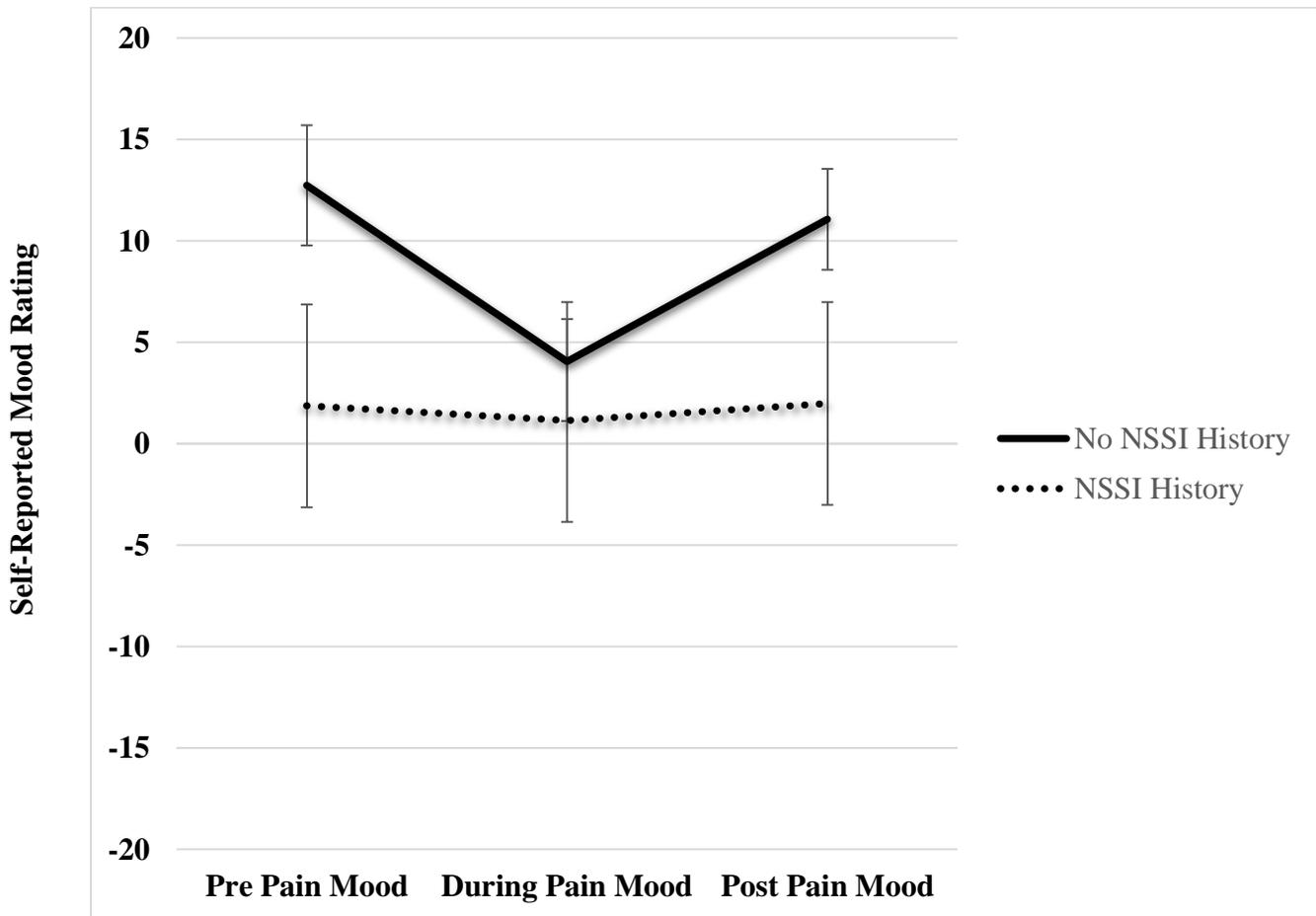


Figure 2.1. Average mood reported before, during, and after pain by NSSI history group.

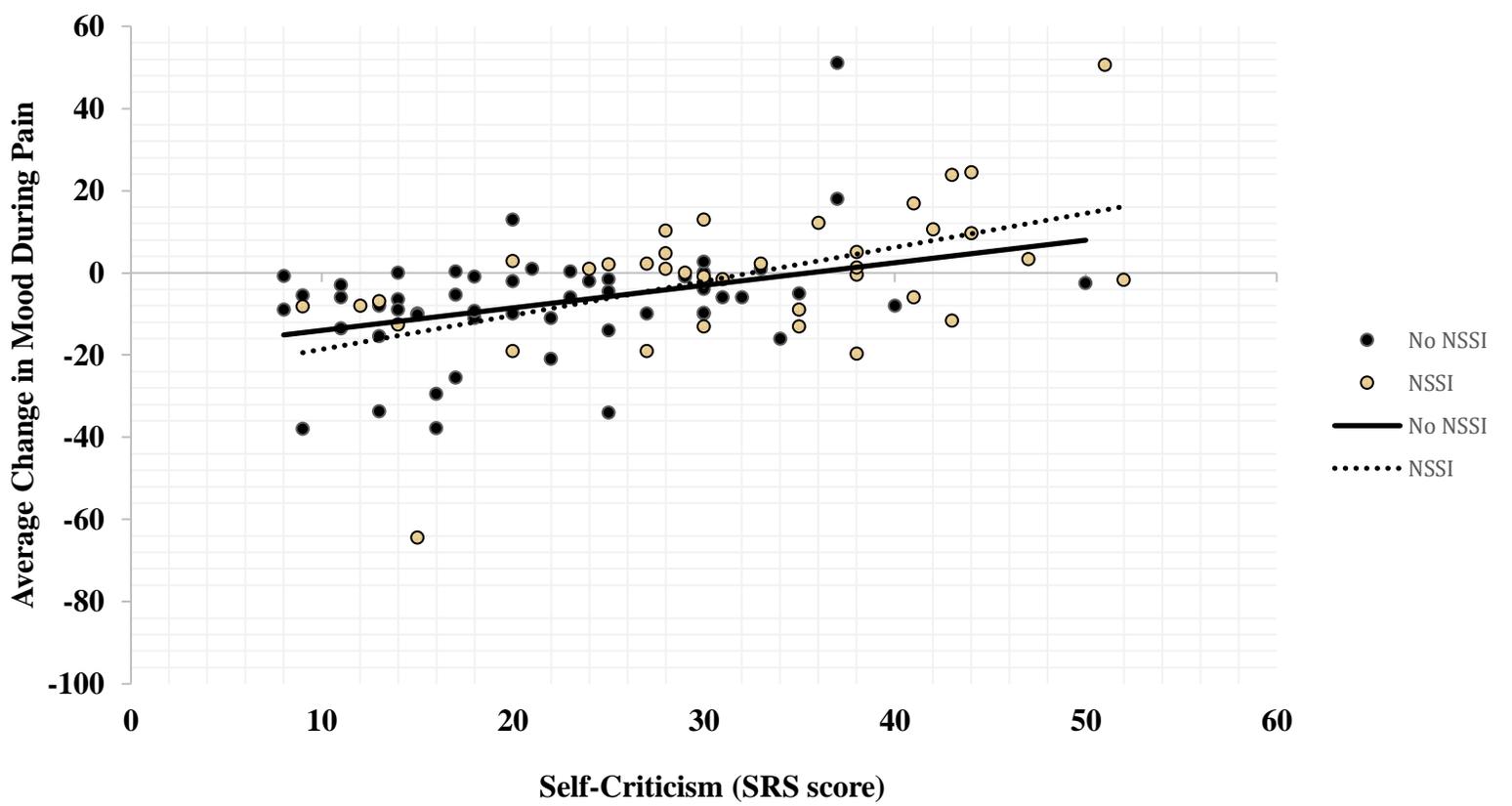


Figure 2.2. Associations between self-criticism scores and average changes in mood during pain among participants with and without NSSI histories.

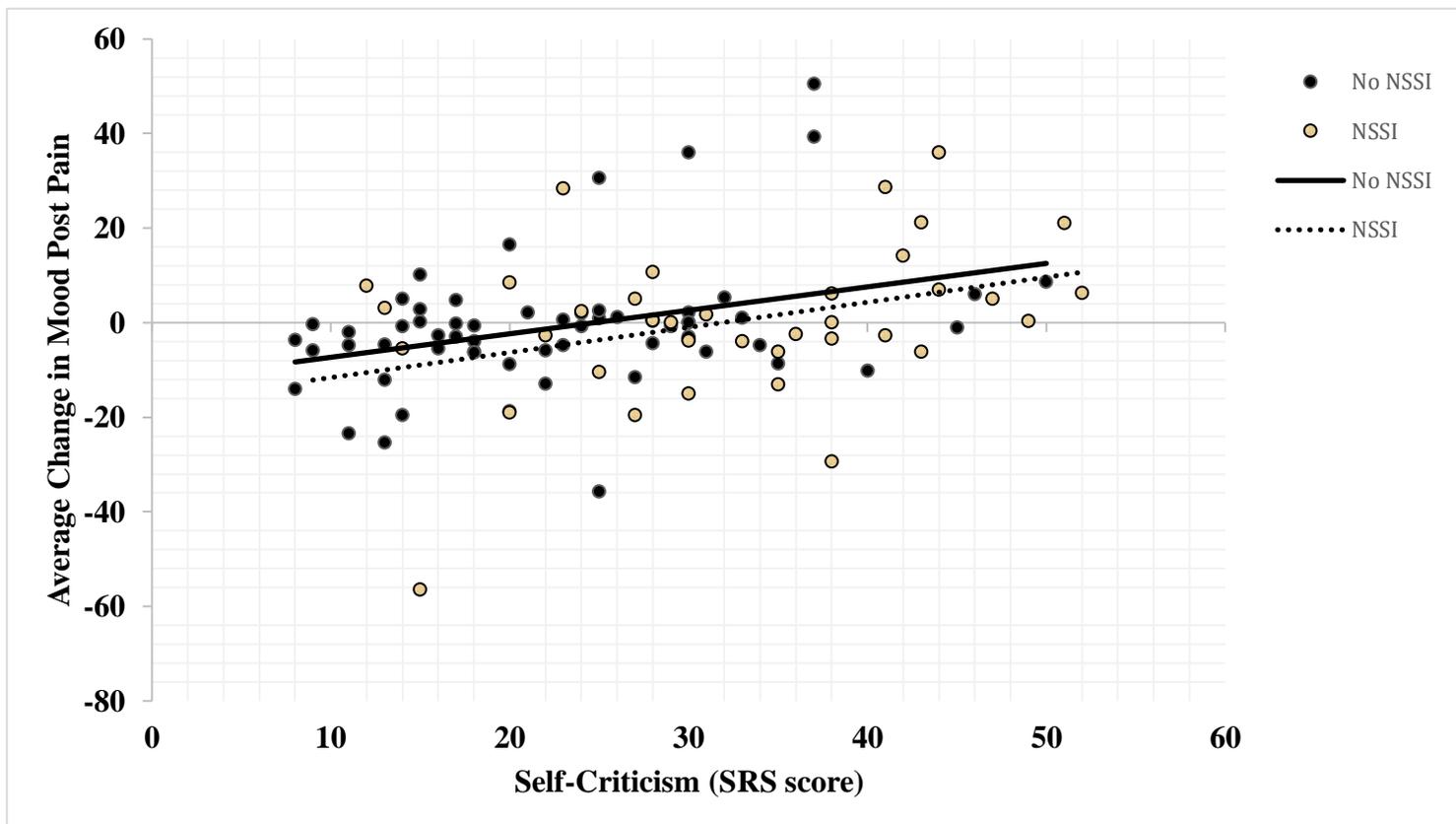


Figure 3. Associations between self-criticism scores and average changes in mood after pain removal among participants with and without NSSI histories

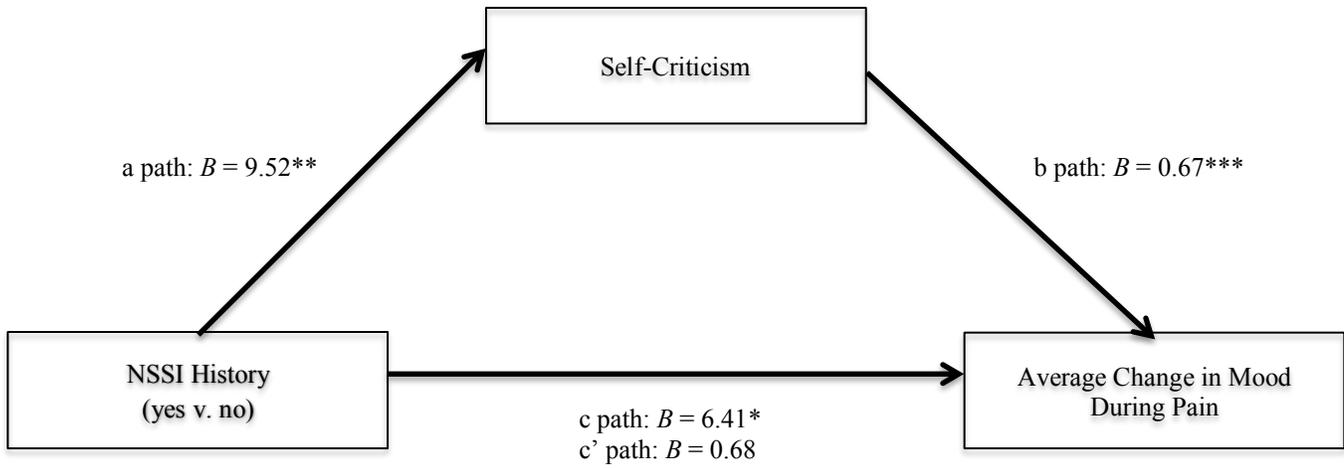


Figure 4. Self-criticism mediates the effects of nonsuicidal self-injury (NSSI) history on changes in mood during pain.  
\*\* $p < .001$ , \* $p < .05$

## Discussion

### Summary of Findings

Understanding who engages in NSSI and why they do so are topics of clear relevance for identifying treatment and prevention targets. The Benefits and Barriers Model (Hooley & Franklin, in Press) provides a useful framework for helping to answer these questions. According to this model, NSSI provides important benefits, including mood improvement, that anyone could receive through engaging in these behaviors. However, several barriers keep most people from ever engaging in NSSI and accessing these benefits.

The present dissertation provided three experimental tests of the Benefits and Barriers Model. Study 1 looked at the erosion of two key barriers, self-worth and aversion toward NSSI, as potential risk factors for continued NSSI engagement. Results showed that both lowered self-worth and lowered aversion toward NSSI stimuli predicted NSSI frequency over a four-week follow-up period in a sample with a recent history of these behaviors. Although more research is needed to assess whether erosion of these barriers predicts NSSI onset, results suggest that rebuilding these two barriers could be an important step in reducing continued NSSI engagement.

Study 2 examined several factors that reinforce NSSI engagement. In addition to demonstrating that distraction can improve mood for people who engage in NSSI and that pain may not function through a distraction mechanism, Study 2 also highlighted how self-criticism affects interpretations of pain. In particular, results suggested that self-criticism impacts mood changes during pain among people who engage in NSSI. Study 3 further probed how self-criticism impacts changes in mood during pain among people with and without NSSI histories. Results demonstrated that, in general, people who engage in NSSI gain more mood benefits during pain than those without NSSI histories. However, differences between groups are explained by self-criticism: self-criticism fully mediated the relationship between NSSI status and changes in mood during pain. Moreover, there was a significant and positive correlation

between self-criticism and positive mood changes during pain among participants with *and without* NSSI histories. Results suggest that self-criticism impacts the context in which pain is experienced. Rather than experiencing pain as aversive, self-criticism sets the stage for pain to be perceived as deserved.

## **Implications**

Together, findings from this dissertation shed light on how diminished aversion to NSSI and self-criticism relate to NSSI engagement. Results highlighted that these factors predict continued NSSI engagement and that these factors may influence why it is that NSSI, and in particular pain, improves mood. Results of this dissertation also suggest that lowered self-worth may serve to reduce barriers to NSSI engagement *and* alter the benefits of NSSI engagement. In terms of lowering a barrier, self-criticism may lower the desire to protect one's body from pain and harm (i.e., lower the barrier to NSSI). Regarding benefits, self-criticism may impact why it is that NSSI improves mood (i.e., alter the benefits of NSSI). This work provides a foundation for numerous additional studies, described in more detail after discussion of limitations below.

## **Limitations and Future Directions**

Although interesting, it is important to note that this work is far from complete. Limitations of individual studies are described above, but more broadly, it is important to consider how specific the findings conducted in this dissertation were. Regarding Study 1, although self-criticism and lower aversion toward NSSI predicted continued NSSI engagement, this test was conducted in a sample of individuals with established NSSI histories. Thus, it is unclear whether and how these variables might predict the *onset* of NSSI which is necessary when considering prevention efforts. Moreover, effect sizes for these variables were not large, suggesting that numerous additional factors are likely involved in the decision to engage in NSSI. More research examining simple and complex interactions among these variables may be

particularly useful for the accurate prediction of NSSI engagement. Looking toward Studies 2 and 3, in addition to more basic limitations described above, there are again broader limitations that should be considered before drawing firm conclusions from this research. First and foremost, there are numerous additional factors that may lead NSSI to improve mood. For example, if engaging in self-cutting results in recruiting friends or family to provide social-emotional support, or in receiving therapy that had previously been unavailable, this may result in mood improvements through very different mechanisms. Moreover, the present studies were conducted in a lab, and based entirely on self-report. Ongoing collaborative efforts are comparing the results in this dissertation to both self-reported mood and psychophysiological changes occurring before, during, and after experimental pain among individuals with and without NSSI histories. However, once this work is completed, effort to compare laboratory findings to real-world NSSI engagement are needed.

Finally, the present work highlights that self-criticism is related *both* to emotional benefits gained during pain and to NSSI frequency. It is thus difficult to disentangle whether self-criticism in and of itself is leading to mood benefits during pain, perhaps because of its ability to satisfy a desire to self-punish, or if this association is due to more repeated pairings of mood benefits gained from the removal of pain with the experience of pain itself. Study 3 provides insight into this question, showing that those with high levels of self-criticism and *no* NSSI history tend to find pain less aversive than those with lower levels of self-criticism. However, more research on this topic is needed to further examine these competing explanations. Large-scale, longitudinal research among high-risk adolescents (e.g., youth 10-12 whose parents have a history of suicidal behaviors) may be particularly suited to answer this question. For example, yearly studies examining changes in mood across experimental pain tasks in these

high-risk youths may shed light on how aberrant pain processing is related to later engagement in NSSI and on how pain processing changes after NSSI engagement begins.

**Ecological Validity.** More real-time (e.g., EMA) assessment of people's mood and self-worth before, during, and after *actual* NSSI episodes are necessary to better understand whether and how self-criticism impacts mood changes across pain elicited from NSSI engagement. Linking EMA with new technology that can better assess psychophysiological changes (e.g., heart rate, skin conductance) before, during, and after NSSI episodes may be particularly useful. Given the high comorbidity between NSSI and other painful and self-harming behaviors enacted with mixed intentions, such as restrictive eating, bingeing, and purging, it would also be interesting to compare mood changes across these behaviors as well. In particular, it would be informative to compare effectiveness in mood regulation of these different behaviors across short and longer-term periods, and to examine whether self-criticism shows similar effects on these processes. Additionally, given that pain can be experienced because of self-directed actions (e.g., NSSI) or through other, environmental experiences (e.g., accidental injury, other-inflicted injury), it would also be informative to examine whether and how self-criticism impacts these different types of pain experiences in both experimental and real-world settings. I would hypothesize that self-criticism impacts mood changes across only self-directed, but not other forms of pain. However, this hypothesis should be tested.

**Prevention and treatment.** A natural and important extension of this research is its application to prevention and treatments for NSSI. In particular, if high self-criticism and a lower aversion toward self-harm are important factors in understanding *who* engages in NSSI, these will likely represent important treatment targets. Providing preliminary support for this possibility, Franklin and colleagues created an online, app-based treatment specifically testing these two factors. Across three randomized control trials, Therapeutic Evaluative Conditioning

(TEC) resulted in significant reductions in NSSI compared to an active control treatment. TEC used evaluative conditioning (i.e., a form of Pavlovian conditioning; Hofmann et al., 2010) to increase aversion to NSSI and to decrease aversion to the self. Although this work was encouraging, NSSI reductions did not persist after treatment termination. Moreover, even during the treatment, NSSI episodes were fewer but not extinct within the active treatment group. Lack of complete or enduring effects may be due to several factors. However, one factor that cannot be ignored is that levels of self-criticism and aversion toward self-harm, although altered, did not change substantially in the RCTs. That is, levels of these factors were still different from those typically observed in samples without NSSI histories. Similar results were observed in a more recent online treatment seeking to reduce self-criticism and subsequent NSSI engagement (Hooley et al., in Preparation). Specifically, a novel treatment approach, Autobiographical Self-Enhancement Training, resulted in only minor decreases in self-criticism compared to two active treatment groups, despite that being a primary treatment target (Hooley et al., in Preparation). Results suggest that we need more work to develop strong, enduring interventions to repair self-worth.

Examining treatments to reduce self-criticism or increase self-compassion in other fields may provide a useful framework for doing so in the context of NSSI engagement. For example, mindfulness based meditations, including those involving loving kindness, may provide an additional treatment approach for self-criticism. For example, across two randomized control trials, meditation-based treatments resulted in increases in self-compassion (Shahar et al., 2014; Albertson et al., 2014) and in one case, decreases in certain forms of self-criticism (Shahar et al., 2014) compared to waitlist conditions. Limiting excitement, even compared to a non-active control condition, this treatment did not reduce self-hatred subscales of the self-criticism

measures employed. Results across these literatures suggests that we may need to keep considering novel treatment approaches for self-criticism.

**High Self-Criticism Among Individuals Outside of NSSI engagement.** Findings from Paper 3 suggest that highly self-critical individuals who *do not* engage in NSSI may experience aberrant emotional responses to pain. More research examining similarities and differences between people with high self-criticism who do and do not engage in NSSI may be useful in understanding risk factors for NSSI. For example, research examining attitudes and stigma toward NSSI, friends or relatives who engage in NSSI, and the types of coping strategies that these individuals engage in could be helpful for understanding why some self-critical people engage in NSSI whereas others do not.

### **Conclusion**

Together, the present research provided several tests of the Benefits and Barriers Model of NSSI. Results suggest that this model may provide a useful framework for understanding NSSI engagement. In particular, results shed light on self-criticism and diminished NSSI aversion as potential risk factors for NSSI engagement. Moreover, results highlight a specific mechanism, alteration of pain processing, through which self-criticism may confer risk for NSSI. Future research should consider examining these constructs in adolescents, prior to NSSI onset; to examining whether these results replicate to real-world NSSI engagement using EMA methods; to understanding factors that differentiate people with high self-criticism who do not engage in NSSI; and to developing more effective and powerful treatment targets for self-criticism.

## References (Introduction and Discussion)

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