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## Self-Criticism Impacts Emotional Responses to Pain

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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 demonstrated 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 for self-critical 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. In participants with and without NSSI histories, self-criticism was positively correlated with mood improvements during pain. Thus, regardless of NSSI history, self-criticism impacted emotional responses to pain. Together, results suggest that self-criticism may not only decrease an important NSSI barrier but also enhance NSSI benefits, specifically leading to more mood improvement during pain.

**Keywords:** self-criticism; nonsuicidal self-injury; pain; mood

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NONSUICIDAL SELF-INJURY (NSSI), including self-cutting, -hitting, and -burning without wanting to die, involves painful and stigmatizing behaviors (Nock, 2010). Yet, despite these and other negative consequences, NSSI is quite common. Upward 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, Jomar, Dhingra, Forrester, Shahmalak, & Dickson, 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.

A recently proposed theoretical model, the benefits and barriers model of NSSI (Hooley & Franklin, 2017), provides some insight into this question. 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 of 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 NSSI may serve 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 (Armey, Crowther, & Miller, 2011; 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., 2013; 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., 2013). 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.

Whereas pain removal may be instrumental in creating a benefit of NSSI, pain itself may represent a powerful barrier. Pain is typically an experience most people seek to avoid and, as such, it likely prevents 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 intensity, may be attenuated among people engaging in NSSI. To the extent that this is true, an important barrier to NSSI onset and/or maintenance may be lowered.

As previously noted, the removal of pain provides mood benefits (pain offset relief). However, for some people, the *experience* of pain may also improve mood. Fox, Toole, Franklin, and Hooley (2017) measured self-reported mood before, during, and after experimentally induced pain among participants reporting past-year NSSI histories. Participants who reported high levels of self-criticism reported

improvements in mood *during* pain, whereas participants reporting low self-criticism experienced mood benefits only upon the *removal* of pain, consistent with typical pain offset relief effects. Results suggest that negative self-schemas may 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, it remains unclear whether self-criticism impacts emotional responding to pain among people with *no* history of NSSI. If self-criticism moderates mood change during pain for people without NSSI histories, results would suggest that self-criticism decreases the negativity associated with pain and thus lowers a key barrier to engaging in these behaviors (see Hooley & Franklin, 2017). 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 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. We also assessed the role of emotion reactivity and depressive symptoms in these relationships, given the strong associations observed among these variables (e.g., Fox et al., 2017) and prior evidence that emotion reactivity affects changes in mood after pain removal (Bresin, Gordon, Bender, Gordon, & Joiner, 2010). Finally, we tested whether self-criticism mediated changes in mood during pain observed across participants with and without NSSI histories.

## Method

### PARTICIPANTS

Participants were 109 young adults reporting female sex ( $M$  age = 23.72,  $SD$  = 7.18). Only female participants were included in the present study to prevent sex differences in pain perception and experience from impacting results (see Bernardes, Keogh, & Lima, 2008; Racine et al., 2012, for reviews). 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. Inclusion criteria included lifetime history of NSSI that resulted in tissue damage (NSSI group only), 18+ years of age, English fluency, and ability to complete an online assessment 2 weeks before a visit to our research laboratory.

#### 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). Moreover, the SRS has been used in numerous studies to examine associations between self-criticism and aberrant pain perception (e.g., Fox et al., 2017; Glenn et al., 2014; Hooley et al., 2010; Hooley & St. Germain, 2014; 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 4-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*). Prior research indicates that the ERS moderates changes in negative affect from before to after pain (Bresin et al., 2010). The ERS demonstrates high internal consistency as well as convergent and divergent validity among adolescents and young adults (Nock et al., 2008).

##### *Visual Analogue Scales (VASs)*

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 to decrease participant burden, in light of findings that the two mood ratings were highly correlated. In addition to assessing mood, VASs 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 previous online research studies (e.g., Fox, Millner, & Franklin, 2016; Franklin, Fox, Franklin, Kleiman, Ribeiro, et al., 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, Puzia, Lee, & Prinstein, 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*).

#### PROCEDURE

Approximately 2 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 those used by Fox and colleagues (2017). Briefly, for the negative mood induction, participants were asked to write for a full 5 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 nondominant hand (Beecher, 1959). Participants remained in full control at all times and could 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. Participants raised their hands and checked a box to indicate when they started to feel pain so that VAS ratings could be averaged (a) before the pain task, (b) while pain was experienced, and (c) after experimental pain was removed. A diagram of study procedures is provided in Figure 1. The university Institutional Review Board approved of all study materials, measures, methods, and procedures.

Although all participants completed the pain task, only 96 participants (i.e., 56 [86.15%] participants with no NSSI histories and 40 [90.91%] participants with NSSI histories) provided mood ratings during pain. Other participants reported never feeling pain ( $n = 4$ ) or else quickly terminated the pain task because they no longer wanted to experience the pain ( $n = 9$ ). In both cases, participants were not able to provide any mood ratings during pain. We used list-wise deletion to handle these missing data. 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. Parallelizing 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 participants (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, as expected, 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:  $M = 27.80$ ,  $SD = 19.32$ ),  $t(102) = 3.93$ ,  $p < .001$ ; and 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.

Approximately half of participants with NSSI histories reported engaging in NSSI in the past year (54.55%). Means and standard deviations ( $SD$ s) for lifetime and past-year NSSI episodes are listed in Table 1. 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 years ( $SD$  age = 6.29). Regarding suicidal thoughts and behaviors, of those participants reporting NSSI

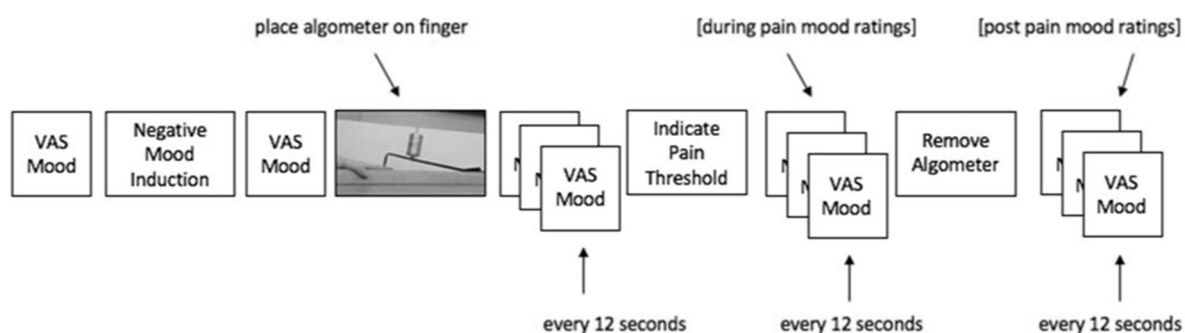


FIGURE 1 Diagram of study procedures.

Table 1  
Pearson Correlations Among Variables of Interest Across Participants With NSSI Histories

| NSSI History                        | 1     | 2      | 3      | 4      | 5     | 6                 | 7      | 8      | 9      | 10     | 11                |
|-------------------------------------|-------|--------|--------|--------|-------|-------------------|--------|--------|--------|--------|-------------------|
| 1. SRS <sup>a</sup>                 | 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 <sup>b</sup> |       | 1.00   | 0.67** | 0.25   | 0.07  | 0.31*             | 0.29   | 0.53** | 0.45** | 0.58** | 0.28              |
| 3. BDI <sup>c</sup>                 |       |        | 1.00   | 0.35*  | 0.13  | 0.11              | 0.18   | 0.46** | 0.32*  | 0.30   | -0.02             |
| 4. ERS <sup>d</sup>                 |       |        |        | 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. Δ Mood during pain              |       |        |        |        |       |                   |        |        |        | 1.00   | 0.82**            |
| 11. Δ Mood post pain                |       |        |        |        |       |                   |        |        |        |        | 1.00              |
| Mean                                | 31.50 | 2.93   | 16.42  | 41.23  | 79.12 | 185.61            | 271.09 | 7.65   | 69.65  | -0.31  | 1.78              |
| SD                                  | 10.76 | 1.80   | 10.86  | 13.46  | 67.33 | 172.70            | 177.79 | 18.66  | 110.91 | 17.02  | 15.84             |

Note. NSSI = nonsuicidal self-injury.

\* Correlation is significant at the 0.05 level (two-tailed),

\*\* correlation is significant at the .01 level (two-tailed),

<sup>t</sup>  $p < .08$  (two-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.

histories, 38 (86.36%) reported a lifetime history of suicidal thoughts, 28 (63.64%) reported a lifetime history of suicide plans, and 10 (22.73%) reported a lifetime history of suicide attempts. In contrast, among participants with no NSSI histories, 24 (36.92%) reported a lifetime history of suicide ideation, 13 (20%) reported a lifetime history of suicide plans, and 1 (1.54%) reported a suicide attempt history. Given that suicide planning and suicidal behaviors may impact changes in mood during pain, results of key analyses were conducted twice: once including all participants with no NSSI histories and once including only those participants with no NSSI histories who also denied any history of suicide planning and suicidal behaviors (i.e., aborted suicide attempts, interrupted suicide attempts, suicide attempts).

#### 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 ( $p = .12$ ). Of note, the equality of

population variances assumption (i.e., Levene'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 1 and 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., Fox et al., 2017; Hooley et al., 2010). 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:  $M = -3.19$ ,  $SD = 24.07$ ),

Table 2  
Pearson Correlations Among Variables of Interest Across Participants Without NSSI Histories

| No NSSI History                            | 1     | 2       | 3       | 4       | 5     | 6      | 7       | 8       | 9       |
|--|-------|---------|---------|---------|-------|--------|---------|---------|---------|
| 1. <i>SRS</i> <sup>a</sup>                 | 1.00  | 0.50 ** | 0.70 ** | 0.55 ** | -0.06 | 0.07   | 0.07    | 0.37 ** | 0.34 ** |
| 2. <i>Pain and punishment</i> <sup>b</sup> |       | 1.00    | 0.38 ** | -0.02   | -0.01 | 0.11   | 0.14    | 0.09    | 0.19    |
| 3. <i>BDI</i> <sup>c</sup>                 |       |         | 1.00    | 0.55 ** | 0.05  | 0.15   | 0.19    | 0.25    | 0.24    |
| 4. <i>ERS</i> <sup>d</sup>                 |       |         |         | 1.00    | -0.06 | -0.02  | 0.03    | 0.25    | 0.10    |
| 5. <i>Threshold</i>                        |       |         |         |         | 1.00  | 0.03   | 0.44 ** | 0.25    | 0.06    |
| 6. <i>Endurance</i>                        |       |         |         |         |       | 1.00   | 0.91 ** | 0.36 ** | 0.30 *  |
| 7. <i>Tolerance</i>                        |       |         |         |         |       |        | 1.00    | 0.44 ** | 0.31 *  |
| 8. $\Delta$ Mood during pain               |       |         |         |         |       |        |         | 1.00    | 0.67 ** |
| 9. $\Delta$ Mood post pain                 |       |         |         |         |       |        |         |         | 1.00    |
| Mean                                       | 22.80 | 1.69    | 11.67   | 27.80   | 78.34 | 135.06 | 219.07  | -8.61   | -1.19   |
| SD   | 9.57  | 1.12    | 12.60   | 19.32   | 71.10 | 147.99 | 164.50  | 16.13   | 14.82   |

Note. NSSI = nonsuicidal self-injury.

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

\*\* correlation is significant at the .01 level (two-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.

$t(95) = -8.92, p < .001$ , 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  $d = 0.48$ . One-way ANOVA indicated that participants in the NSSI group experienced greater mood deterioration than those participants without NSSI histories,  $F(1, 95) = 6.83, p = .01, \eta^2 = .07$ .

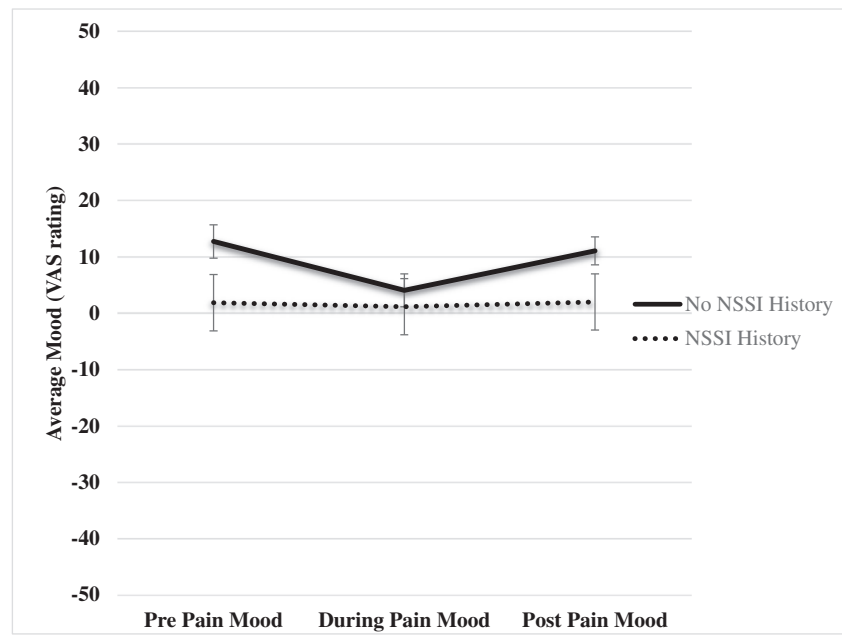
#### MOOD CHANGES DURING AND AFTER PAIN

To test whether NSSI history impacted changes in mood during pain we conducted a 3 (occasion: average pre-, during-, and post pain mood)  $\times$  2 (group: NSSI history vs. no NSSI history) repeated measures 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,  $F(1.74, 11.52) = 4.88, p = .01, \eta^2_{\text{partial}} = .05$ , indicating significant mood changes across the phases of the pain task. Moreover, there was a significant Occasion  $\times$  Group interaction such that NSSI group status significantly moderated overall changes in mood during pain,  $F(1.74, 151.52) = 3.36, p = 0.04, \eta^2_{\text{partial}} = .04$ . Of note, results of this ANOVA were nearly identical when participants in the "no NSSI" group only included those reporting no history of any history of suicide plans or suicidal behaviors—these results are available upon request. Figure 2 illustrates average mood reported across the pain task. Contrasts indicated that there was a significant difference in mood changes from before to

during pain,  $F(1, 91) = 5.37, p = .023, \eta^2_{\text{partial}} = .06$ , and during to post pain,  $F(1, 91) = 6.26, p = .01, \eta^2_{\text{partial}} = .06$ , but not from before to post pain ( $p = .56, \eta^2_{\text{partial}} = .004$ ), 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 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 (see Figure 3). Moreover, extending prior research, results demonstrated that trait feelings of self-punishment were significantly and positively associated with positive

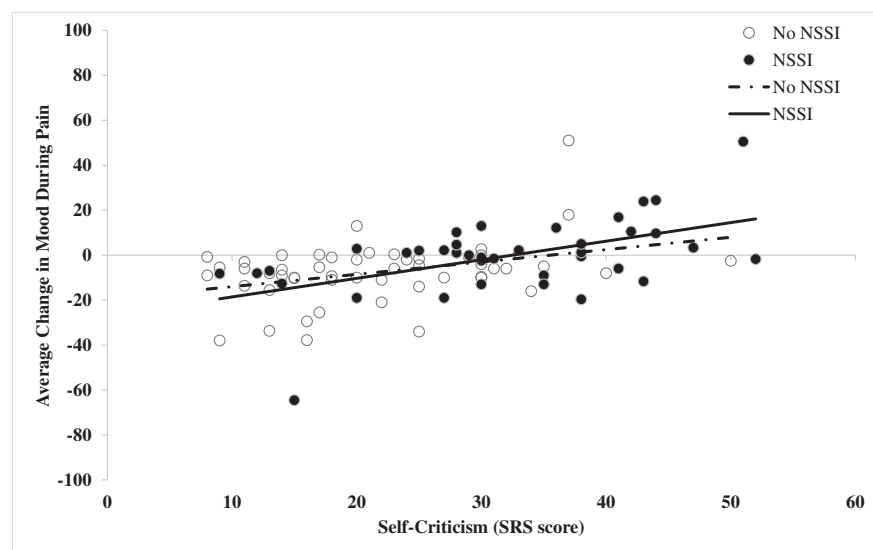


**FIGURE 2** Average mood reported before, during, and after pain by NSSI (nonsuicidal self-injury) history group.

changes in mood during pain. No significant associations were observed between depression or emotion reactivity scores and changes in mood during pain, indicating specificity of self-criticism and self-punishment with NSSI (see Table 1). We also tested whether changes in mood from pre-to post pain were associated with self-criticism scores. Self-criticism was not significantly associated with changes in mood after the removal of pain, although there was a trend in this direction (see Figure 4). Overall, results indicate that higher levels

of self-criticism, but not depressive symptoms or emotion reactivity, were associated with more positive mood changes during pain, 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, positive changes in mood during pain for participants without NSSI histories were significantly and positively associated with self-criticism scores



**FIGURE 3** Associations between self-criticism scores and average changes in mood during pain among participants with and without NSSI (nonsuicidal self-injury) histories.



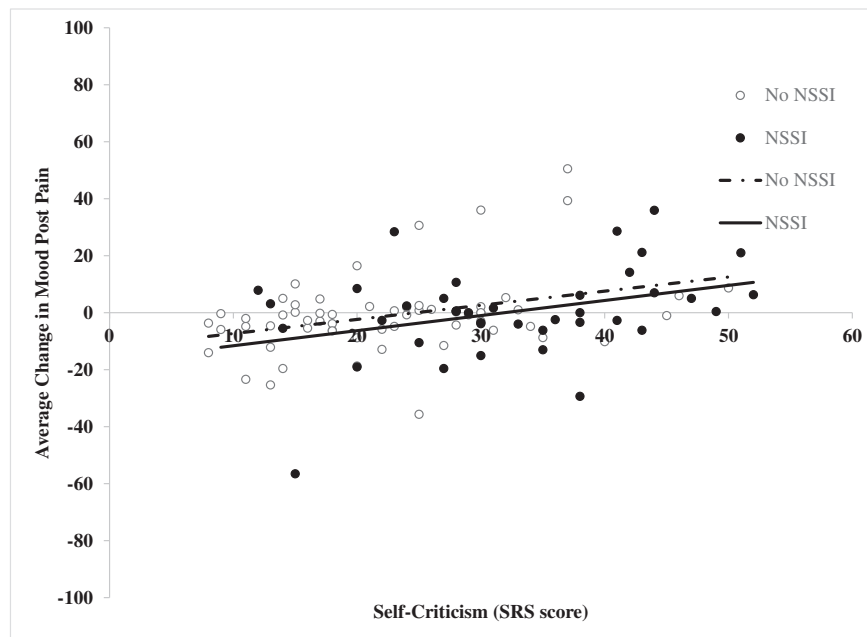


FIGURE 4 Associations between self-criticism scores and average changes in mood after pain removal among participants with and without NSSI (nonsuicidal self-injury) histories.

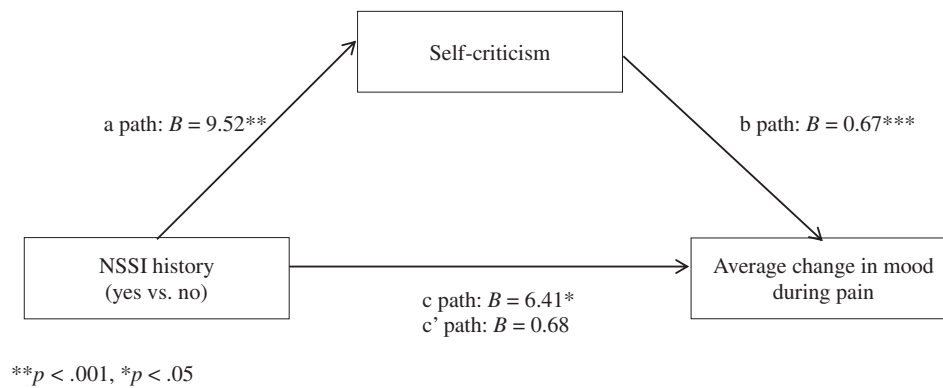
(see Figure 3). There was no significant association between feelings of self-punishment, depressive symptoms, or emotion reactivity and changes in mood during or after pain (see Table 2). Additionally, we tested whether changes in mood from pre- to post pain were associated with self-criticism scores. 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 (see Figure 4). In other words, higher levels of self-criticism—but not depressive symptoms or emotion reactivity—were associated with more positive mood changes both during and after the removal of pain among participants who did not engage in NSSI (see Table 2). Results of these correlations were similar when including only those participants in the “no NSSI” group who also reported *no* history of suicide plans or suicidal behaviors. Specifically, the association between self-criticism and changes in mood during pain remained significant ( $r = .32, p = .03$ ), although the correlation between self-criticism and changes in mood after pain became slightly weaker and nonsignificant ( $r = .27, p = .06$ ).

Finally, we tested whether self-criticism mediated the changes in mood during pain observed between participants with and without NSSI histories. 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 (i.e.,  $c$  path;  $B = 7.09, p = .03$ ). 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 5, estimated indirect effects indicated that self-criticism significantly 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. Participants with NSSI histories reported different emotional responses to pain compared to participants without NSSI histories, and self-criticism mediated this difference. Results indicated that for all participants (regardless of NSSI engagement), self-criticism was significantly associated with changes in mood during pain. In contrast, neither emotion reactivity nor depressive symptoms were significantly associated with changes in mood during pain for either group.



**FIGURE 5** Self-criticism mediates the effects of NSSI (nonsuicidal self-injury) history on changes in mood during pain.

Emotional responses to pain, regardless of NSSI history, were significantly associated with self-criticism. This effect parallels basic pain research indicating that context and expectation can impact the affective components of 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). Results thus have important implications for the benefits and barriers model of NSSI (Hooley & Franklin, 2017). In particular, results indicate that self-criticism may serve as a dimensional trait lowering an important NSSI barrier, typical negative affective responses to pain, among people without NSSI histories. In contrast, among those participants with NSSI histories, results indicate that self-criticism may lead pain, outside of the context of pain offset relief, to be a potential NSSI benefit. Results may also inform understanding of NSSI in the context of the cognitive-emotional model of NSSI (Hasking, Whitlock, Voon, & Rose, 2016). In particular, self-criticism may impact NSSI-related cognitions regarding pain and expectations about how pain will impact mood, thus leading to differential mood responses across those with high versus low self-criticism.

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. Although lifetime NSSI frequency was positively associated with pain endurance, in the present sample there were no group differences in terms of pain threshold, tolerance, or endurance. Lack of group difference in these variables may

relate to our sample, where past-year and -month NSSI were not required (i.e., just over half of participants with NSSI histories reported past-year NSSI engagement). Indeed, research suggests that pain processing may normalize within 6 months of NSSI discontinuation (Ludäscher et al., 2009). When considered alongside earlier research, results suggest that both sensory and affective components of pain may be altered among people who engage in NSSI, and particularly among people who are currently engaging in NSSI.

Several limitations should be considered. First, the present study included only female participants. This decision was made because of research indicating that males report pain differently when tested by female researchers (Levine & De Simone, 1991) and because of research indicating that males and females may differ with respect to the perception and experience of some experimentally induced pain (see Bernardes et al., 2008; Racine et al., 2012, for reviews). Future research should consider conducting similar experiments among males and other genders to see whether results would generalize. This replication is particularly important considering lower endorsement of self-punishment motivations for NSSI among males who engage in NSSI (Whitlock et al., 2011).

Second, the present study included participants with *any* lifetime NSSI history. Unfortunately, the relatively small sample sizes that would result by splitting those with past-year versus lifetime-only NSSI precluded meaningful comparisons between these groups. Given research demonstrating normalization of pain processing after NSSI discontinuation (Ludäscher et al., 2009), it remains unclear whether and to what degree mood changes during pain are similar or unique among people who are currently engaging in NSSI compared to those who have discontinued these behaviors. Future research should consider examining whether recency of NSSI

impacts emotional responding to pain. In particular, conducting such experiments on samples where participants report similar NSSI frequencies but differential recency of these behaviors could shed light on the impact of both recency and frequency on this perception.

Third, ratings of mood were 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 multimodal assessments to gain a more comprehensive picture of how mood changes across pain as a function of self-criticism and NSSI history. Fourth, results of the present design were based entirely on experimentally induced pressure 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., heat pain) 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, and particularly to NSSI onset. Future research assessing how sensory and affective components of pain processing are 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 of 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 among highly self-critical individuals who engage in these behaviors. 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.

#### Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

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