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Why Does Nonsuicidal Self-Injury Improve Mood? A Preliminary Test of Three Hypotheses

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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.

Keywords
nonsuicidal self-injury, self-criticism, pain, distraction, pain offset relief

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Nonsuicidal self-injury (NSSI), direct and intentional self-injury enacted without suicidal intent (Nock, 2010), is both prevalent and dangerous. Approximately 5.5% to 17.2% of community samples (Swannell, Martin, Page, Hasking, & St. John, 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, Joiner, Gordon, Lloyd-Richardson, & Prinstein, 2006; Whitlock, Eckenrode, & Silverman, 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 past decade, a large body of research has linked NSSI with affect regulation (e.g., Franklin, Lee, Hanna, & Prinstein, 2013; Nock & Prinstein, 2004). 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 on NSSI engagement: pain-offset relief, self-punishment, and distraction. We refer to each of these as potential hypotheses of mood change (i.e., processes that lead to 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, Gerber, & Pauli, 2010; Franklin, Lee, Hanna, et al., 2013; Leknes, Brooks, Wiech, & Tracey, 2008; Smith & Buchanan, 1954; Tanimoto,

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Heisenberg, & Gerber, 2004). 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 (Bresin & Gordon, 2013; Franklin et al., 2010; Franklin, Puzia, et al., 2013; Schoenleber, Berenbaum, & Motl, 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, Ho, Slater, & Lockshin, 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 (Glassman, Weierich, Hooley, Deliberto, & Nock, 2007; Hooley et al., 2010; St. Germain & Hooley, 2012). Second, self-punishment is often endorsed as a reason for engaging in NSSI (Nock & Prinstein, 2004; Swannell, Martin, Scott, Gibbons, & Gifford, 2008), 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 suggest that among participants with NSSI histories, 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 indicates that negatively focused thoughts about the self (e.g., shame, guilt, self-criticism) and endorsement of self-punishment as a motivator for engaging in NSSI increase a person's willingness to experience pain and make it more likely that pain will be interpreted positively.

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 Briere & Gil, 1998; Brown, Comtois, & Linehan, 2002; Selby, Connell, & 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, Lee, Hanna, et al., 2013; Nock, 2008). Accordingly, some researchers have suggested that mild and nonpainful distractions (e.g., listening to music, going for a walk) may be insufficient to regulate negative mood within this population (e.g., Chapman, Gratz, & Brown, 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., Brown et al., 2002; Chapman et al., 2006; Selby et al., 2008).

Stemming in part from these theories, some treatments (e.g., dialectical behavior therapy) recommend nonpainful 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.

Method

Participants

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

Participants were recruited via flyers posted in the community, on Craigslist, and at 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 or older, and English fluency. Interested participants received a semistructured screening interview over the phone to determine eligibility. Eligible participants who provided consent were scheduled for a 2-hr 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). The SITBI (Nock, Holmberg, Photos, & Michel, 2007) is a semistructured interview used to assess history of suicidal and nonsuicidal thoughts and behaviors. The interview has very strong interrater reliability (average κ = .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, Puzia, Lee, & Prinstein, 2014).

Beck Depression Inventory–II (BDI-II). The BDI-II (Beck, Steer, & Brown, 1996) is 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 (α = .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). The SRS (Hooley et al., 2010) 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 .73 to .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 to 100 (*not at all* to *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, $r(75) = .36$, $p < .01$. Baseline VAS ratings of positive mood were significantly and negatively associated with past week BDI-II scores, $r(74) = -.26$, $p < .01$.

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 later) 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 20-s intervals before, during, and after completing the tasks associated with the assigned condition. Participants also provided ratings on a 0 to 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 research team explained the VAS, and participants completed six practice mood ratings to familiarize themselves with completing these scales at short (12 s were used for the training) time intervals.

Negative mood induction

We adapted the manipulation used by Bastian et al. (2011) 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 5 min, 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 5 min 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, Roth, Kakuma, Harrison, & Hull, 1994), heat (Bresin, Gordon, Bender, Gordon, & Joiner, 2010), electric shock (Franklin, Puzia, 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 nondominant 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 8 min, 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 s. All participants completed these ratings for a full 11 min 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 et al., 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 4 min. Neutral words were selected from the Affective Norms for English Words (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 lowercase letters, sometimes in uppercase letters, and sometimes in a mix of lower- and uppercase 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 s for a total duration of 11 min.

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 min 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 sample *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) × 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: (a) During-pain ratings were determined by calculating the average reported rating of mood (positive and negative) while participants were experiencing pain; (b) during-distraction ratings were determined by calculating the mean of the seven mood ratings (positive and negative) completed during the distraction task; (c) 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). Posttask 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, Lee, Hanna, et al., 2013).

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) × 2 (Group: 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 more than 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 s (*SD* = 84.40s), and the mean time to terminate the pain trial (pain tolerance) was 245.86 s (*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 s (*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, $F(2, 91) = 0.65$, $p = .52$, $\eta^2 = .01$ (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 min 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 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 (preinduction: *M* = 48.79, *SD* = 21.74; postinduction: *M* = 59.52, *SD* = 21.60), $t(79) = 5.05$, $p < .001$; Cohen's $d = 0.53$. Positive mood also decreased (preinduction: *M* = 46.78, *SD* = 19.29; postinduction: *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) × 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

Table 1. NSSI, Pain, and Self-Criticism

	1	2	3	4	5	6	7	8
1. SRS total	1.00							
2. Pain threshold	−.05	1.00						
3. Pain tolerance	.23	.37*	1.00					
4. Pain endurance	.36*	−.15	.85**	1.00				
5. Past week NSSI	.27**	−.11	.12	.23	1.00			
6. Past month NSSI	.23*	−.06	.10	.21	.84**	1.00		
7. Past year NSSI	.23*	−.02	.11	017	.68**	.85**	1.00	
8. Lifetime NSSI	.30*	−.15	.02	.17	.53**	.59**	.73**	1.00

Note: NSSI = nonsuicidal self-injury; SRS = Self-Rating Scale. All correlations are Pearson correlations. *Correlation significant at the .05 level (2-tailed). **Correlation significant at the .01 level (2-tailed).

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 × 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 Bonferroni tests shows that the distraction condition resulted in significantly larger reductions in overall negative mood compared with 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 Fig. 1).

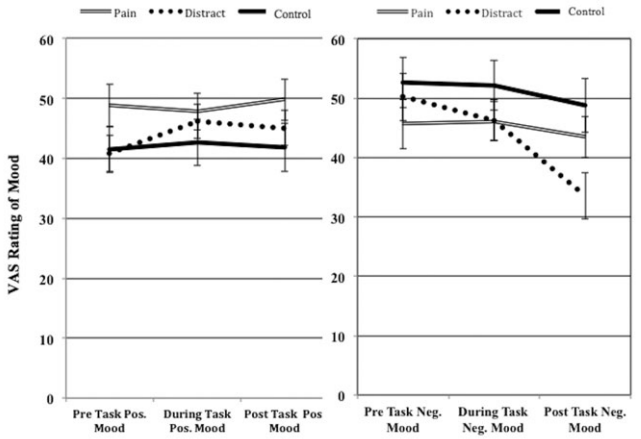

Fig. 1. Mean positive and negative mood in the pain, distraction, and control conditions before, during, and after each task.

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 pretask 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. Related to this, 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, $r(30) = -.45$, $p = .01$, and positively correlated with changes in positive mood during pain, $r(30) = .31$, $p < .05$. 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, $r(27) = -.07$, $p = .74$; negative mood, $r(27) = .11$, $p = .57$, and the distraction condition, positive mood, $r(29) = -.04$, $p = .82$; negative mood, $r(29) = -.21$, $p = .21$. 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, $r(25) = -.02$, $p = .91$, negative mood, $r(29) = .02$, $p = .93$, or the control condition had ended, positive mood, $r(27) = -.03$, $p = .89$, negative mood, $r(27) = .05$, $p = .79$. However, SRS scores were negatively correlated with changes in positive mood during the pain-offset relief phase, $r(27) = -.40$, $p < .05$. Lower levels of self-criticism were not associated with more change in negative mood during pain-offset relief, $r(27) = .30$, $p = .06$. 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) × 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, $F(1.61, 52) = 4.18$, $p = .02$, $\eta^2 = .14$. The same was true for negative mood. There was a significant interaction of SRS group on changes in negative mood during and after pain, $F(2, 52) = 3.81$, $p = .03$, $\eta^2 = .13$.[1] 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

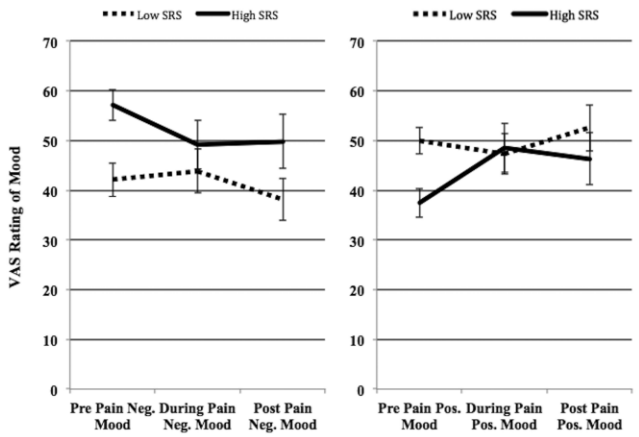

Fig. 2. Mean positive and negative mood before, during, and after experiencing pain.

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 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 et al., 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; Hooley & St. Germain, 2014; St. Germain & Hooley, 2012), our results highlight that not everyone who engages in NSSI is highly self-critical. For such people, the self-punishment hypothesis of mood improvement from NSSI may not apply. In the present study, participants with lower levels of self-criticism only 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 (Bresin & Gordon, 2013; Franklin et al., 2010; Franklin, Puzia, et al., 2013; Russ et al., 1994; 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 observed these effects only when mood was assessed using physiological approaches rather than self-report (Franklin et al., 2010; Franklin, Puzia, 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., Bastian et al., 2011; Bresin & Gordon, 2013; Leknes et al., 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 and change mood among people who engage in NSSI (e.g., Brown et al., 2002; Chapman et al., 2006; Selby et al., 2008). 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 greater mood benefits than pain, and pain only improved mood for highly self-critical participants. It is possible 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 nonpainful 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. Therefore, 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.

Author Contributions

K. R. Fox developed the study concept, and K. R. Fox and J. M. Hooley designed the study. K. R. Fox and K. E. Toole collected the data, and K. E. Toole assisted with data preparation. K. R. Fox and J. C. Franklin performed the data analysis and interpretation under the supervision of J. M. Hooley. K. R. Fox drafted the manuscript, and J. M. Hooley and J. C. Franklin provided critical revisions. All authors approved the final version of the article for submission.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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Note

1. 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.

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