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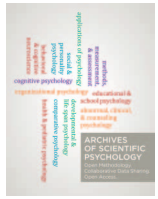

A Laboratory Examination of Pain Threshold and Tolerance Among Nonsuicidal Self-Injurers With and Without Self-Punishing Motivations

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ABSTRACT

Nonsuicidal self-injury (NSSI), which refers to self-directed destruction of bodily tissue in the absence of suicidal intent (e.g., cutting, carving, burning) is a widespread health concern. Recent research suggests that individuals who engage in NSSI have heightened tolerances for pain relative to noninjurers, but little attention has been given to how self-injurers overcome the pain involved in self-directed injury. Understanding the process through which self-injurers tolerate pain, however, may have important implications for prevention and intervention efforts, as heightened tolerance for pain has been associated with increased suicidal risk. In the present study, we addressed this gap in the literature by examining whether self-punishment motivations for engaging in NSSI were associated with increased pain thresholds and tolerances among 82 undergraduate students (i.e., 31 self-injurers with self-punishment motivations, 25 self-injurers without self-punishment motivations, 26 age-matched controls). Following a stressful task, self-injurers who engaged in NSSI to self-punish tolerated pain significantly longer and rated this pain as less aversive than self-injurers without self-punishment motivations and the comparison group of noninjurers. Our findings, therefore, suggest that willingness to tolerate painful stimulation may be an important part of the self-injury experience among individuals who engage in NSSI to self-punish. Moreover, our findings suggest that motivational factors underlying NSSI should be integrated into theories on the link between NSSI and pain sensitivity.

SCIENTIFIC ABSTRACT

Despite recent findings that individuals who engage in nonsuicidal self-injury (NSSI), have heightened tolerances for pain relative to noninjurers, little attention has been given to how self-injurers overcome the instinct to avoid the pain involved in NSSI. Understanding the process through which self-injurers are willing to tolerate pain, however, may have important implications for prevention and intervention efforts, as heightened tolerance for pain has been associated with increased suicidal risk. In the present study, we examined whether one factor that may influence a self-injurer's willingness to tolerate pain is whether they engage in NSSI to regulate the need to self-punish (i.e., "I engage in NSSI to punish myself, express anger at myself"). Participants included 82 fourth-year undergraduate students from a midsized Canadian university (i.e., 31 self-injurers with self-punishment motivations, 25 self-injurers without self-punishment motivations, 26 age-matched controls) recruited from a larger ongoing project examining stress and coping among university students (N = 832, 69.5% female, M_{age} = 21.52). Following a stress task, pain threshold, pain tolerance, and pain intensity ratings were assessed using the cold-pressor task. ANOVA analyses revealed that self-injurers who engaged in NSSI to self-punish tolerated pain significantly longer and rated this pain as less aversive than self-injurers without self-punishment motivations and the comparison group of noninjurers. Our findings, therefore, suggest that willingness to tolerate painful stimulation may be an important part of the self-injury experience among individuals who engage in NSSI to self-punish. Moreover, our findings suggest that motivational factors underlying NSSI should be integrated into theories on the link between NSSI and pain sensitivity.

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Nonsuicidal self-injury (NSSI) refers to behavior that causes direct and deliberate destruction of bodily tissue without lethal intent (Nock & Favazza, 2009). Estimates indicate that as many as 30% to 40% of adolescents and 21% of adults in clinical care engage in NSSI (Briere & Gil, 1998; Darche, 1990; Jacobson, Muehlenkamp, Miller, & Turner, 2008). NSSI is not only a clinical health concern, however, as 13% to 38% of adolescents and young adults (Brausch & Gutierrez, 2010; Gratz, Conrad, & Roemer, 2002; Ross & Heath, 2002; Sornberger, Heath, Toste, & McLouth, 2012; Whitlock et al., 2011) and 4% to 6% of older adults report lifetime histories of NSSI (Briere & Gil, 1998; Klonsky, 2011). To engage in NSSI, presumably one must overcome the pain inherent in self-directed injury (e.g., self-cutting, burning, scratching to the point of bleeding; Franklin, Lee, Puzia, & Prinstein, 2014). Indeed, recent theory and research suggest that over time, individuals may develop increased pain thresholds (i.e., length of time until a stimulus becomes painful) and pain tolerances (i.e., length of time until a painful stimulus is terminated) in response to self-injury (Franklin et al., 2012; Joiner, 2005; Hooley, Ho, Slater, & Lockshin, 2010; Kemperman et al., 1997; Russ et al., 1996). Despite increased research on the link between NSSI and pain sensitivity, however, little attention has been given to how self-injurers overcome the instinct to avoid the pain involved in NSSI. In the present study, we addressed this gap in the literature by examining whether one factor that may influence a self-injurer's willingness to tolerate pain is whether they engage in NSSI to regulate the need to self-punish (i.e., assessed with items such as "I engage in NSSI to punish myself," "I engage in NSSI to express anger at myself"). Importantly, understanding the process through which self-injurers are willing to tolerate pain may have important implications for prevention and intervention efforts, as heightened tolerance to pain has been associated with risk for suicidal behavior (Nock, Joiner Jr., Gordon, Lloyd-Richardson, & Prinstein, 2006; Orbach, Mikulincer, King, Cohen, & Stein, 1997; St. Germain & Hooley, 2013).

NSSI and Pain

There is mounting evidence that individuals who engage in NSSI report aberrant pain perception relative to noninjurers. For example, several researchers have found that individuals with borderline personality disorder (BPD) who engage in NSSI (up to 60%) report that they do not experience pain when self-injuring (Kemperman et al., 1997; Russ et al., 1996; Russ et al., 1992), and demonstrate decreased sensitivity to pain in lab-based tasks as compared to noninjurers (Bohus et al., 2000; Kemperman et al., 1997; Russ et al., 1992, 1999). Recently, researchers also have started to examine pain sensitivity among self-injuring individuals in non-BPD and community-based samples. In these studies, researchers often have employed NSSI-proxy tasks (e.g., electric shocks, cold-pressor task, pressure pain) to create painful stimulation similar to NSSI, and then asked participants to indicate when the stimulus becomes painful (i.e., pain threshold), and when the pain has to be terminated (i.e., pain tolerance; Franklin et al., 2012; Franklin, Hessel, & Prinstein, 2011; Hooley et al., 2010; McCoy, Fremouw, & McNeil, 2010; St. Germain & Hooley, 2013). In one study, McCoy et al. (2010) examined whether self-injuring young adults from a university population could be differentiated from noninjurers on pain measures (i.e., threshold and tolerance) using the algometer pressure device (i.e., a measure that applies increasing focal pressure directly to the skin). Although the two groups did not differ in pain threshold, self-injurers tolerated pain significantly longer than noninjurers, leading the researchers to conclude that self-injury may be more strongly associated with pain tolerance than threshold. Importantly, the link between NSSI and pain tolerance remained even when controlling for anxiety, depressive symptoms, dissociative experiences, and hopelessness. Similarly, Franklin et al. (2012) found that self-injurers had higher pain thresholds and tolerances than noninjurers during a cold-pressor task, and rated this pain as less intense than noninjurers (also see Franklin et al., 2011). Although the link between NSSI and pain tolerance was partially mediated by emotion dysregulation (i.e., emotionally dysregulated individuals tolerated pain longer), NSSI still directly accounted for variance in tolerance to pain, suggesting that differences in pain sensitivity between self-injurers and noninjurers cannot be attributed entirely to differences in emotion regulation capacities. Finally, Hooley et al. (2010) also found that self-injurers had decreased sensitivity to pain (i.e., higher pain thresholds and endurances) during a pressure algometer pain task, relative to noninjurers, in their study of young adults.

Given findings that NSSI is associated with decreased pain sensitivity, an important question for researchers to address is *why* self-injurers may have higher pain thresholds and tolerances relative to noninjurers. One possibility is that individuals who have decreased pain sensitivity may be more likely to engage in NSSI than individuals with higher sensitivity to pain (Nock, 2010; Hooley et al., 2010). For example, Nock has suggested that individuals with high pain thresholds and tolerances may be more likely to engage in NSSI because they find the behavior less aversive, as compared to individuals who regard the act as frightening and painful. Inconsistent with this hypothesis, however, Franklin et al. (2011) found that self-injurers did not report more painful and provocative life events, such as playing contact sports, getting a tattoo, physical fighting, or jumping from heights, than noninjurers. If individuals with high pain thresholds were more likely engage in painful behaviors, it would be expected that self-injurers should also report more other painful life events than noninjurers.

Alternatively, individuals who engage in NSSI may be able to overcome the instinct to avoid pain. One theory to account for the link between NSSI and heightened pain tolerance, proposed by Joiner (2005), is that engagement in NSSI leads to gradual desensitization to pain over time through opponent processes (Franklin et al., 2011; Joiner, Ribeiro, & Silva, 2012). According to proponents of Opponent Process Theory (Solomon & Corbit, 1974; Solomon, 1980), when a stimulus causes an individual to deviate from a state of equilibrium (i.e., primary response), a secondary reaction occurs that serves to return the individual to a state of homeostasis when the stimulus is terminated (i.e., an opponent process; Leknes, Brooks, Wiech, & Tracey, 2008). Researchers have suggested that an act of NSSI, therefore, may be reinforced by an opponent process (i.e., relief; Joiner, 2005; Joiner et al., 2012), which is strengthened over time (with increasingly frequent NSSI), while pain sensitivity is decreased. Although researchers are only beginning to examine this theory empirically, findings for an opponent process explanation are mixed. Inconsistent with opponent process theory, recent research has found that more intense pain does not generally lead to greater relief, and NSSI frequency is not associated with greater pain offset relief (Franklin et al., 2010; Franklin et al., 2013). Moreover, some researchers have found that more frequent and longer engagement in NSSI does not appear to be associated with greater pain thresholds and tolerances (Hamza & Willoughby, 2013; Nock et al., 2006), whereas others have found only partial support (e.g., NSSI frequency was not related to pain threshold, but was associated with greater pain endurance, St. Germain & Hooley, 2013). Nevertheless, researchers have found that self-injurers report greater pain thresholds and tolerances relative to noninjurers (Franklin et al., 2012; Hooley et

al., 2010), that self-injurers report decreased negative affect following NSSI (Armey, Crowther, & Miller, 2011; Bresin & Gordon, 2013; Russ et al., 1992; Weinberg & Klonsky, 2012), and that heightened pain tolerance is associated with suicidal risk (Nock et al., 2006; Orbach et al., 1997).

Few researchers have examined the process through which the instinct to overcome pain among self-injurers may be diminished. In their study on the link between NSSI and sensitivity to pain, Hooley et al. (2010) observed that during interviews with self-injurers, participants often expressed highly self-critical attitudes toward themselves (e.g., when others criticize me, they must be right; making mistakes is intolerable). Hooley et al. proposed, therefore, that individuals who hold more negative attitudes toward themselves may tolerate pain longer because they perceive that they are more deserving of pain. To test this hypothesis, Hooley et al. examined whether a measure of self-criticism derived post hoc from other measures (i.e., self-rating scale) predicted pain sensitivity. Although self-criticism did not predict pain threshold, self-criticism was positively associated with higher levels of pain tolerance, leading Hooley et al. to conclude that individuals who hold negative attitudes toward themselves may be more willing to tolerate pain than individuals with more positive attitudes toward themselves. In further support of this contention, in a recent study Hooley et al. (2013) demonstrated that a brief intervention designed to improve attitudes about self-worth (i.e., a focus on positive personal attributes), decreased the amount of time self-injurers tolerated painful stimulation in lab-based task (i.e., pressure algometer).

Although Hooley et al.'s (2010) findings suggest that individuals who hold self-critical beliefs may have diminished sensitivity to pain, a more direct factor that may influence self-injurers willingness to tolerate pain may be the extent to which they desire to self-punish. More specifically, although self-punishment motivations for engagement in NSSI are commonly reported among self-injurers (Briere & Gil, 1998; Laye-Gindhu & Schonert-Reichl, 2005; Nock & Prinstein, 2004; Klonsky & Glenn, 2009), no previous research has examined whether self-injuring to self-punish is a specific risk factor for heightened pain threshold or tolerance among self-injurers. In theory, if an individual's intent is to self-punish, the administration of pain may be an effective way to regulate this need. For example, Nock (2010) suggested that NSSI is a seemingly quick and useful way to degrade one's self, given that NSSI is an immediate and direct form of self-abuse. Consistent with this hypothesis, researchers have found that individuals who experience the need to self-punish are more likely to choose NSSI, as compared to other behaviors, to specifically regulate this need (Hamza, Willoughby, & Good, 2013). Individuals who engage in NSSI to self-punish, therefore, may be more able (and more willing) to tolerate pain, as compared to individuals who engage in NSSI but are not motivated to self-punish. To our knowledge, however, no previous research has tested this hypothesis, or explored individual differences in pain threshold and tolerance among self-injuring groups. Conducting this research, however, may provide new insight into the processes through which individuals overcome the instinct to avoid pain, and can serve to inform theory on NSSI and pain (e.g., Joiner's theory).

Present Study

In the present study, we extended previous research on NSSI and sensitivity to pain by testing the hypothesis that self-punishment motivations for NSSI engagement are associated with increased pain threshold and tolerance. To test this hypothesis, we examined differences in pain threshold and tolerance among three groups: (a) a group of self-injurers who engaged in NSSI to regulate the need to self-punish, (b) a comparison group of self-injurers who engaged in NSSI but not to regulate the need to self-punish, and (c) a comparison group of noninjurers matched to the self-injury groups on age, sex, and level of parental education. We expected that individuals who engaged in NSSI to self-punish would be more willing to tolerate pain, and thus would demonstrate increased pain thresholds and tolerances relative to self-injurers without self-punishment motivations, and noninjurers.

In addition, we also extended the previous literature in several other important ways. First, much of the research on sensitivity to pain has been among clinical samples, particularly individuals with BPD. Given the widespread prevalence of NSSI among community-based samples, particularly young adults (Brausch & Gutierrez, 2010; Gratz et al., 2002; Klonsky & Glenn, 2009; Whitlock et al., 2011), an understanding of the link between NSSI and sensitivity to pain in young adults represents an important area of research inquiry. Thus, we surveyed a sample of young adults enrolled at an undergraduate institution. Second, there is extensive evidence that NSSI typically occurs in the context of negative emotional states. Indeed, several studies have found that NSSI is preceded by an increase in negative emotions such as stress, anger, and frustration (Armey et al., 2011; Muehlenkamp et al., 2009; Nock, Prinstein, & Sterba, 2009; See Klonsky, 2009 for a review). Although research consistently demonstrates that NSSI occurs in the context of negative emotions (Armey et al., 2011; Nock, 2010), researchers often have examined sensitivity to pain among self-injurers in neutral mood state conditions (Hooley et al., 2010; McCoy et al., 2010; St. Germain & Hooley, 2013). To best emulate the conditions under which NSSI would typically occur, and to increase the ecological validity of our experiment, in the present study we used a commonly used measure of stress induction prior to administering the cold pain task (see Franklin et al., 2011; Franklin et al., 2013). Our study, therefore, seeks to examine differences in pain threshold and tolerance among self-injurers under conditions of distress, as would typically occur during NSSI engagement (Armey et al., 2011; Bresin & Gordon, 2013; Franklin et al., 2011). Third, research using laboratory-based assessments of pain threshold and tolerance are limited, and often rely on the use of small samples of self-injurers. In addition, researchers often have included self-injurers on the basis of lifetime engagement in NSSI, but recent advances in the assessment of NSSI suggest that past year NSSI engagement may a more appropriate way to characterize self-injurers (American Psychiatric Association, 2013). To address these gaps in the literature, we recruited a large sample of self-injurers who were screened for past year engagement in NSSI, and assessed pain threshold and tolerance, as well as self-reported pain intensity, using a laboratory pain task. Finally, given that emotion dysregulation, self-criticism and prior painful life events may be associated with whether an individual is willing to tolerate pain (Franklin et al., 2012; Hooley et al., 2010), we examined group differences on these measures to determine if the link between self-punishment and NSSI was maintained, even after controlling for these factors.

Method

Participants

Participants were 82 fourth-year undergraduate students at a mid-sized Canadian university (69.5% female; $M_{age} = 21.52$) recruited from a larger ongoing project examining stress and coping among university students ($N = 832$). In total, 87.5% of the participants from

this original sample were born in Canada. Consistent with the broader demographics of the region (Statistics Canada, 2006), the most common ethnic backgrounds reported other than Canadian were British (19%), Italian (16.8%), French (9.5%), and German (9%) Data on socioeconomic status indicated mean levels of education for mothers and fathers falling between "some college, university or apprenticeship program" and "completed a college/apprenticeship/technical diploma." Furthermore, 15% of respondents lived at home with one or both parents, 9% lived off-campus with roommates, and 76% lived in campus residences.

Measures

Demographics. Age and sex (1 = male, 2 = female) were assessed at the Time of experiment.

Nonsuicidal self-injury. Participants completed the Inventory of Statements about Self-injury (ISAS, Klonsky & Glenn, 2009), which required participants to indicate their frequency of engagement in eight self-injurious behaviors within the past year, without lethal intent (e.g., cutting, burning and head banging). A normalized measure of NSSI frequency was created by collapsing participants' responses into six categories: 1 incident, 2–4 incidents, 5–10 incidents, 11–50 incidents, 51–100 incidents, more than 100 incidents (see Hamza & Willoughby, 2013; Heath et al., 2008 for a similar categorization). Participants also were asked to indicate whether they experienced physical pain while self-injuring, the amount of time elapsed between the urge to self-injure and the act of NSSI (i.e., 1 = less than 1 hr to 6 = more than 1 day), whether they self-injured alone, and whether they wanted to stop self-injuring. In addition, participants indicated the extent to which 19 statements assessing motivations for engaging in NSSI (i.e., affect regulation, self-punishment, interpersonal boundaries, mark distress, interpersonal influence, peer bonding) applied to them on a scale of 1 (*not at all relevant*) to 3 (*very relevant*). Based on their responses to the self-punishment questions on the ISAS (e.g., "When I self-injure, I am pushing myself"), participants were grouped into two subgroups. Participants who indicated that they engaged in NSSI to self-punish (i.e., a rounded score of 2 or higher) were included in the NSSI + self-punish group, and participants who indicated that they did not engage in NSSI to self-punish (i.e., not at all relevant) were grouped into the NSSI + no punish group. The ISAS has been shown to have good internal consistency and construct validity in previous research (Glenn & Klonsky, 2009; Glenn & Klonsky, 2011).

Stress task. To induce stress prior to the administration of the pain task, we utilized Franklin et al.'s, 2012 procedure (also see Franklin et al., 2011), which is an adapted version of the Trier Social Stress Test (Kirschbaum, Pirke, & Hellhammer, 1993). Participants were given 4 min to prepare a short speech (1 min) about whether the government should enforce the death penalty. Participants performed their 1-min speech in front of a video camera, and their live image was displayed and recorded on a small TV screen. Participants were told that their speech would be shown later to a group of their peers, who would evaluate the participant's quality of arguments, and the participant's ability to articulate these arguments.

Manipulation check. To ensure participants were stressed prior to engaging in the cold-pressor task, participants were asked to indicate the extent to which they felt relaxed in the current moment on a scale of 1 (*very slightly or not at all*) to 5 (*extremely*) before and after the stress task.

Cold-pressor task. The cold-pressor task is one of the most widely used forms of experimental pain induction (see Bohus et al., 2000; Franklin et al., 2012; Franklin et al., 2011; Gratz et al., 2011; Hollin & Derbyshire, 2009; Russ et al., 1992; Russ, Campbell, Kakuma, Harrison, & Zanine, 1999). Participants submerged their nondominant hand up to the wrist into a cold water basin maintained at three degrees Celsius. The temperature used in this study is consistent with other studies using cold-pain (e.g., 1–4° Celsius, Gratz et al., 2011; Hollin & Derbyshire, 2009; Franklin et al., 2011, 2012). Water temperature was maintained by an external cold water chiller, which circulated water in and out of the water basin. Participants were instructed to indicate the point at which the water became painful, but still tolerable, by pressing a yellow button (i.e., pain threshold). Participants also were instructed to press a red button when the water became too painful for them to keep their hand submerged, and to remove their hand from the water (i.e., pain tolerance). Participants also were asked to rate the pain intensity on a scale from 1 (*not at all painful*) to 10 (*extremely painful*) when they pressed the yellow button and when they pressed the red pain (i.e., intensity at threshold and tolerance, respectively; Franklin et al., 2012; Weinberg & Klonsky, 2012). Stop watches were used to record the time in seconds from start to pain threshold and tolerance. Participants were asked to remove their hand from the water if they reached the maximum time of 2 min.

Difficulties with emotion regulation. Participants completed the Difficulties with Emotion Regulation Scale (DERS, Gratz & Roemer, 2004), which required participants to indicate the extent to which they agreed with 36 statements (e.g., "When I'm upset, I have difficulty concentrating") on a scale from 1 (*not at all like me*) to 5 (*completely like me*). The DERS has been shown to have good internal consistency and discriminant validity among university students (Gratz & Roemer, 2004; Weinberg & Klonsky, 2009). The Cronbach's alpha was .94.

Painful and provocative experiences. Participants completed 25 items assessing the number of painful and provocative events that they have experienced (e.g., played contact sports, got a piercing, sky dived, physical/sexual abuse) using the Painful and Provocative Experiences (PPE) Scale (Bender, Gordon, Bresin, & Joiner, 2011). Participants responded on a scale from 1 (*never*) to 5 (*more than 20 times*). The PPE Scale has been used in other research to assess exposure to painful life experiences (Franklin et al., 2011; Joiner et al., 2007).

Self-criticism. Self-criticism was assessed using the 12-item self-criticism subscale from the Depressive Experiences Questionnaire (DEQ, Blatt, D'Afflitti, & Quinlan, 1976). Participants were asked to what extent they agree with statements (e.g., "I tend to be very critical of myself") on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*). The Self-Criticism subscale of the Depressive Experiences Scale was designed to assess self-criticism among college students (e.g., perceived failure to live up to one's expectations and standards), and is one of the most widely used measures of self-criticism among young adults to date. Among college students, the measure has demonstrated strong construct validity (Blatt et al., 1976; Mongrain & Zuroff, 1995; Zuroff & Mongrain, 1987; Zuroff, Moskowitz, Wielgus, Powers, & Franko, 1983) and internal consistency (Zuroff et al., 1983). The Cronbach's alpha for the scale was .87.

Procedure

Screening and recruitment. Participants completed the ISAS (Klonsky & Glenn, 2009), which included assessments of past year NSSI engagement and motivations for engaging in NSSI (e.g., "When I self-injured, I was punishing myself") as part of a larger research project ($N = 832$). Participants who reported a history of NSSI within the past year ($N = 40$ with self-punishment motivations, 35 without self-punishment motivations) and a sample of noninjuring participants, matched on age, sex, and parental education ($N = 34$) were invited to participate in a lab-based study. Of those participants who met the study inclusion criteria, 31 self-injurers with self-punishment

motivations, 25 self-injurers without self-punishment motivations, and 26 noninjuring participants agreed to participate in the present study.

Experiment procedure. After providing informed consent, participants were asked to self-report on the extent to which they felt relaxed. Participants were then given 4 min alone to prepare the speech (which was timed). After a timer sounded, the experimenter returned to the experiment room and began recording the participant on video camera. After participants completed the stress task, participants again were asked to indicate the extent to which they felt relaxed. To measure pain threshold and tolerance, participants then completed the cold-pressor task. After the cold-pressor task, participants were asked to complete a short booklet of questionnaires, which included the basic demographic questionnaire, the DERS (Gratz & Roemer, 2004), the PPE Scale (Bender et al., 2011) and the Self-Criticism Scale (Blatt et al., 1976). Participants were given a full debriefing at the end of the study, and given a list of contact information for several available local mental resources.

Ethics. The study was approved by the University Ethics Board prior to study administration and all participants provided informed active consent before participation. The survey was administered by trained research personal who were specifically trained in handling distressed participants (no participants became distressed during survey administration, however). Students were given $30 to complete the experiment.

Results

Descriptive Statistics

Correlations among the study measures are presented in Table 1. Means and standard deviations for the pain measures are presented in Table 2. Of the 56 participants with a history of NSSI, one participant engaged in NSSI once within the past year (2%), nine participants engaged in NSSI two to four times within the past year (16%), nine participants engaged in NSSI five to 10 times (16%), 21 participants engaged in NSSI engaged in NSSI 11 to 50 times within the past year (37%), five engaged in NSSI 51 to 100 times within the past year (9%), and 11 engaged in NSSI 100 or more times (20%). The most commonly occurring types of self-injury included self-pinching, self-hitting, and head banging. The NSSI groups (NSSI + punish, NSSI + no punish) did not significantly differ on age, sex, NSSI characteristics (i.e., frequency of NSSI, pain experienced during NSSI, whether they were alone while injuring, or whether they wanted to stop self-injury), or motivations (other than self-punishment) for self-injuring (all ps $> .05$).[1]

For the primary analyses, non-normal variables (i.e., pain threshold, pain tolerance, and pain intensity at tolerance) were transformed using visual binning. ANOVAs indicated that there was a main effect of group membership on emotion regulation, $F(2, 79) = 14.93$, $p < .01$, partial $\eta^2 = .27$, and self-criticism, $F(2, 79) = 14.17$, $p < .01$, partial $\eta^2 = .26$. For the post hoc analyses, all possible mean comparisons among the three groups were conducted using Fisher's least significant difference tests. This test provides added power while ensuring that the familywise error rate remains equal to alpha when making comparisons among three means (Field, 2009; Howell, 2010). Compared to the group of noninjurers, self-injurers reported significantly higher levels of emotional dysregulation, but the self-injury groups did not significantly differ from each other ($M = 2.67$ for NSSI + punish, $M = 2.40$ for NSSI + no punish, and $M = 1.93$ for noninjurers). In addition, both self-injuring groups reported significantly higher levels of self-criticism than noninjurers, and the NSSI + self-punish group reported higher levels of self-criticism than NSSI + no punish group ($M = 4.71$ for NSSI + punish, $M = 4.08$ for NSSI + no punish, and $M = 3.46$ for noninjurers). All three groups (i.e., NSSI + punish, NSSI + no punish, noninjurers) did not significantly differ on the painful life events measure (which included questions about physical and sexual abuse).

Manipulation Check

As expected, a repeated-measures analysis revealed that all groups (i.e., NSSI + punish, NSSI + no punish, noninjurers) were significantly less relaxed following the stress task $F(1, 79) = 108.04$, $p < .01$, partial $\eta^2 = .578$ ($M = 3.30$ prestress, and $M = 2.03$ poststress). There was no significant Group × Time interaction ($p > .05$), suggesting that all groups showed similar decreases in ratings of relaxation pre and poststress task.

Pain Threshold

An ANOVA was used to examine mean differences in pain threshold (i.e., the point at which the cold water became painful) among the three groups (i.e., NSSI + punish, NSSI + no punish, control). There was a main effect of group membership on pain threshold, $F(2, 79) = 3.192$, $p = .046$, partial $\eta^2 = 0.075$. Post hoc analyses indicated that NSSI + self-punish group reported significantly greater pain threshold than the control group ($M = 30.97$ for NSSI + punish, $M = 15.29$ for noninjurers). The NSSI + no punish group ($M = 19.31$) did not significantly differ from the NSSI + punish group, or the noninjurers. Groups did not significantly differ in self-reported pain intensity at threshold ($p > .05$).

Pain Tolerance

An ANOVA analysis was used to examine mean differences in pain tolerance (i.e., the point at which participants removed their hand from the cold-water) among the three groups (i.e., NSSI + punish, NSSI + no punish, control). Groups significantly differed on pain tolerance, $F(2, 79) = 5.382$, $p < .01$, partial $\eta^2 = 0.12$. Post hoc analyses revealed that the NSSI + punish group had a significantly higher pain tolerance than the NSSI + no punish group, and the comparison group of noninjurers. The NSSI + no punish group and the noninjuring group did not significantly differ ($M = 60.78$ for NSSI + punish, $M = 40.54$ for NSSI + no punish, $M = 38.02$ for noninjurers). Groups also significantly differed on pain intensity at tolerance, $F(2, 79) = 5.451$, $p < .01$, partial $\eta^2 = 0.12$. Because the assumption of homogeneity of variance was violated for this analysis, Games-Howell follow up analyses were used. The NSSI + punish group rated their pain intensity at tolerance as significantly less than the NSSI + no punish group and the noninjuring group, while the NSSI + no punish and noninjurers did not significantly differ (M = 7.63 for NSSI + punish, M = 8.88 for NSSI + no punish, M = 8.88 for noninjurers; see Table 2).[2]

Self-Criticism, Self-Punishment, and Pain Measures

Given that the two self-injury groups only differed on the self-criticism measure, we examined whether the link between self-

[1] The two self-injury groups were compared using t tests for normally distributed variables. For non-normal distributions, Mann-Whitney rank comparisons were used.

[2] When we reran the analyses including only self-injurers who reported severe NSSI behaviors (i.e., cutting, burning, self-hitting, severe scratching to the point of bleeding, $N = 44$), the overall pattern of our results did not differ.

Table 1
Correlation Table

	1	2	3	4	5	6	7	8	9
1. Age	—								
2. Sex	−.03	—							
3. Pain threshold	.16	−.09	—						
4. Pain intensity at threshold	.02	.09	−.15	—					
5. Pain tolerance	.13	−.23*	.74**	−.28*	—				
6. Pain intensity at tolerance	−.12	.09	−.31**	.58**	−.35**	—			
7. DERS	−.22*	−.03	.18	−.02	.24*	−.17	—		
8. Self-criticism	−.16	.05	.13	.09	.13	−.10	.77**	—	
9. PPE	.01	−.26*	.02	−.28*	.24*	−.24*	.12	.01	—

Note. Higher scores indicate higher age, sex (1 = male, 2 = female), greater pain threshold, greater pain intensity at threshold, greater pain tolerance, greater pain intensity at tolerance, higher DERS (i.e., the Difficulties with Emotion Regulation Scale), higher self-criticism, and higher scores on the PPE (i.e., Painful and Provocative Experiences Scale score).
* $p < .05$. ** $p < .01$.

punishment and the pain measures were maintained even after taking into account differences in self-criticism among self-injurers using regression analyses (results are presented in Table 3). In the first hierarchal regression analysis, self-criticism was regressed onto pain threshold on Step 1, and group status (NSSI + punish, NSSI + no punish) was regressed onto pain threshold on Step 2. With the inclusion of self-criticism, differences in pain threshold were no longer significant ($ps < 0.05$). In the second hierarchal regression analysis, self-criticism was regressed onto pain tolerance on Step 1, and group status (NSSI + punish, NSSI + no punish) was regressed onto pain tolerance on Step 2. After statistically controlling for self-criticism, group membership still predicted pain tolerance $t(53) = 3.06$, $p < .05$. In the third hierarchal regression analysis, self-criticism was regressed onto pain intensity at tolerance on Step 1, and group status (NSSI + punish, NSSI + no punish) was regressed onto pain intensity at tolerance on Step 2. After statistically controlling for self-criticism, group membership still predicted pain intensity at tolerance $t(53) = -2.71$, $p < .05$.

Discussion

Recent research indicates that individuals who engage in NSSI report greater pain thresholds and tolerances relative to noninjurers. Despite increased research on the link between NSSI and pain sensitivity, however, little attention has been given to how self-injurers overcome the instinct to avoid the pain involved in NSSI. In the present study, we addressed this gap in the literature by examining whether one factor that may influence a self-injurer's willingness to tolerate pain is whether they engage in NSSI to regulate the need to self-punish. Consistent with study predictions, self-injurers who engaged in NSSI to regulate the need to self-punish tolerated pain significantly longer and rated this pain as less intense than self-injurers who did not self-punish and a comparison group of noninjurers. Our findings suggest that engaging in NSSI to self-punish, in particular, may be associated with willingness to tolerate pain. Moreover, our findings suggest that motivational factors underlying NSSI should be integrated into theories on the link between NSSI and tolerance to pain.

Table 2
Groups Differences on Measures of Pain Sensitivity

	NSSI + punish	NSSI + no punish	Non-injurers
Pain threshold	30.97 (32.54)$_a$	19.31 (21.73)$_a$	15.29 (12.23)$_a$
Pain intensity at threshold	5.50 (2.01)$_a$	5.86 (1.62)$_a$	5.98 (1.45)$_a$
Pain tolerance	60.78 (42.81)$_b$	40.54 (29.53)$_a$	38.02 (27.82)$_a$
Pain intensity at tolerance	7.63 (2.43)$_a$	8.88 (0.85)$_b$	8.88 (1.30)$_b$

Note. Means in the same row with different subscripts are significantly different at $p < .05$. Raw means are shown.

We expected that self-punishing motivations for engaging in NSSI would be associated with heightened pain tolerance among self-injurers, given that causing oneself to tolerate pain may be an effective way to regulate the need to self-punish (see Nock, 2010 for a similar discussion). Consistent with this prediction, although both self-injury groups experienced pain at the same time (i.e., no difference on pain threshold; pain intensity at threshold), self-injurers with self-punishing motivations tolerated this pain significantly longer than self-injurers without self-punishing motivations (and a comparison group of noninjurers). Thus, our findings suggest that tolerating painful stimulation may be an important part of the self-injury experience among individuals who engage in NSSI to self-punish (because self-inflicted pain may serve an important function in regulating the need to self-punish). Moreover, our results suggest that engaging in NSSI to specifically regulate the need to self-punish may lead to pain desensitization over time. Indeed, self-injurers who engaged in NSSI to self-punish not only withstood the pain longer than the other two groups, they also found this pain less aversive than self-injurers without self-punishing motivations and noninjurers (i.e., pain desensitization). Van Orden, Witte, Gordon, Bender, and Joiner (2008) have suggested that NSSI may affect an individual's tolerance for pain by influencing the individual's cognitive appraisal of whether painful self-directed injury will be bearable. Our study indicates, therefore, that self-injurers may learn to overcome the instinct to avoid the pain inherent in NSSI through practice in tolerating pain (i.e., self-injuring to self-punish).

Our finding that individuals who engaged in NSSI specifically to regulate the need to self-punish differed from the other two groups (i.e., NSSI + no punish, noninjurers) on measures of pain tolerance and pain intensity at tolerance has important implications for Joiner's (2005) theory. Recall that Joiner proposed that individuals who engage in NSSI gradually become desensitized to pain, because the affective gains of NSSI are strengthened over time while the primary response of pain is diminished through opponent processing (Joiner, 2005; Joiner et al., 2012). On the basis of Joiner's theory, we might expect that self-injuring groups (regardless of motivations for engaging in NSSI) would show increased pain thresholds and tolerances during the cold-pressor task relative to noninjurers if repetitive en-

Table 3
Regression Analyses

	Variables	B	*SE* B	β	*p*
Regression 1					
DV = pain threshold					
Step 1	Self-criticism	.068	.123	.075	.583
Step 2	Self-criticism	.002	.128	.002	.988
	Group membership	.425	.256	.233	.103
Regression 2					
DV = pain tolerance					
Step 1	Self-criticism	.022	.089	.034	.803
Step 2	Self-criticism	−.601	.087	−.093	.488
	Group membership	.536	.175	.408	.003
Regression 3					
DV = pain intensity at tolerance					
Step 1	Self-criticism	−.026	.153	−.023	.867
Step 2	Self-criticism	.103	.152	.091	.503
	Group membership	−.825	.305	−.366	.009

Note. For regression 1, $R^2 = .006$, $\Delta R^2 = .049$. For regression 2, $R^2 = .001$, $\Delta R^2 = .150$. For Regression 3, $R^2 = .001$, $\Delta R^2 = .121$. DV = dependent variable.

gagement in NSSI diminished pain perception over time. Only self-injurers who engaged in NSSI to regulate the need to self-punish, however, showed decreased sensitivity to pain as compared to non-injurers (note that both self-injury groups did not differ even on measures of NSSI frequency). Clearly then, repetitive engagement in NSSI alone was not sufficient to produce heightened pain tolerance, as would be expected by opponent process theory. Our findings, however, are consistent with Joiner's central notion that NSSI may desensitize individuals to self-inflicted pain over time, and suggest that one important motivational factor that may contribute to an individual's willingness to tolerate pain, is self-punishment (likely through altering one's cognitive appraisal of whether one can or should endure pain). Our findings support intervention programming (such as that of Hooley et al., 2013), that suggest that targeting individuals' self-perceptions may help reduce NSSI engagement.

That self-punishment may be an important marker of pain tolerance is further strengthened by our finding that self-injury groups did not significantly differ on *any* other measures of NSSI characteristics (e.g., frequency of engagement in the past year, time elapsed between urge and act, desire to stop self-injuring). Moreover, the two self-injury groups did not differ on whether they reported experiencing pain during NSSI, which has been shown to be associated with sensitivity to pain on laboratory tasks among individuals with BPD (Bohus et al., 2001; Kemperman et al., 1997; Russ et al., 1992, 1999). Groups also did not differ on measures of emotion dysregulation or painful life events, suggesting that the link between self-punishment orientations and pain tolerance was not accounted for by these factors (also see Franklin et al., 2011, 2012). Finally, although the self-punishment group reported greater self-criticism than the no punishment group, we found that the link between self-punishment and NSSI was maintained even after taking into account measures of self-criticism. Although self-criticism and self-punishment are likely conceptually similar, our findings suggest that self-punishment may be a more proximal predictor of pain tolerance than self-criticism. Future research, however, could further disentangle associations among self-criticism, self-punishment, and pain tolerance.

Future research should examine the link between self-punishment motivations for NSSI and risk for suicidal behavior. Recent research consistently has shown that NSSI is a robust predictor of suicidal behavior (Asarnow et al., 2011; Klonsky et al., 2013; Guan et al., 2012; Whitlock et al., 2013; Wilkinson et al., 2011), and several researchers have reported that a heightened threshold for pain increases an individual's risk for suicidal behavior (Nock at al., 2006; Orbach et al., 1997; St. Germain & Hooley, 2013). If individuals who engage in NSSI are at increased risk for the development of heightened tolerances to pain, these individuals also may be at increased risk for suicidal behavior. Future research, therefore, should examine whether self-punishment motivations for NSSI are associated with increased risk for suicidal behavior through increased tolerance to pain (i.e., mediational model).

Another important avenue for future research will be to address how self-punishing motivations for NSSI engagement develop among self-injurers. The link between NSSI and early exposure to aversive family environments has been widely documented (Briere & Gil, 1998; Bolen, Winter, & Hodges, 2013; Glassman, Weierich, Hooley, Deliberto, & Nock, 2007). Some researchers have proposed that early exposure to invalidating family environments (e.g., neglect, physical or sexual abuse) may lead to increased self-criticism, which in turn leads to self-directed abuse, such as NSSI (Glassman et al., 2007; Linehan, 1993; Wedig & Nock, 2007). It is interesting to note, however, that we found that the link between self-punishment motivations for NSSI and pain tolerance was maintained even after taking into account self-criticism. Moreover, self-criticism was not correlated with any of the pain measures in the present study. Our findings suggest, therefore, that the development of self-punishment motivations may a more important developmental pathway to explore in future research. Interestingly, we did not find any differences between our two self-injury groups on exposure to abuse histories. Our findings suggest, therefore, that abuse history may not necessarily lead to self-punishment motivations for NSSI engagement. A critical extension for future research, therefore, will be to examine the correlates, as well as the development of self-punishment motivations over time.

Limitations

Although the present study has many strengths, including a focus on an unexplored risk factor for pain threshold and tolerance (i.e., self-punishment motivations), the use of a relatively large sample of nonclinical self-injurers with past year NSSI engagement, and the assessment of pain using both lab and self-report measures, our study has several significant limitations. First, given the concurrent design on the present study, we cannot be certain about the directionality of effects. Although recent theory and research suggests that NSSI may lead to decreased sensitivity to pain (Joiner, 2005; Joiner et al., 2012; Franklin et al., 2011), we could not directly test whether self-punishment motivations facilitate pain tolerance, or whether individuals with higher pain tolerances are more likely to engage in NSSI to self-punish. Longitudinal research is necessary to explicitly test bidirectional associations among NSSI and sensitivity to pain over time. We did find, however, that self-injurers (including those with self-punishment motivations) did not report more painful life events than noninjurers (e.g., combat sports, getting a tattoo). Presumably if individuals with high tolerances for pain sought out painful life events, we would expect self-injurers to report a greater frequency of painful life events. Regardless, to our knowledge, our study offers the first examination of the link between self-punishment and tolerance to pain, and can serve to inform future longitudinal research in this area.

Second, although the present sample was drawn from a large sample representative of a particular university in Canada, the majority of the participants enrolled in the study were of western descent and born in Canada; therefore, our findings may not generalize to other geographic regions, including those with differing ethnic and/or demographic backgrounds. Furthermore, our study specifically sam-

pled fourth-year university students and therefore may not be generalizable to the wider student population (i.e., lower-year students) or young adults not attending university. Moreover, although we specifically sampled students who reported past year engagement in NSSI as outlined in the new *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (American Psychiatric Association, 2013), it is unclear whether our results would be comparable among clinical samples, who engage in more frequent and severe NSSI. Thus, although our results offer a preliminary examination of the association between self-punishment motivations and tolerance to pain, future research could serve to replicate findings using nonclinical samples, as well as specifically examine the link between self-punishment orientations and tolerance to pain in more diverse samples (e.g., different ethnicities, clinical groups).

Another potential limitation of the present work that is important to acknowledge is that group differences in the study measures could be attributed to differences in other unmeasured factors. For example, Hooley et al. (2010) found that individuals who self-injured scored higher on a dissociative symptoms scale (e.g., assessing disturbances in memory, cognition, and identity) relative to noninjurers. It is possible, therefore, that other third variables also may contribute to differences in pain measures identified in the present study. To reduce the influence of third variables, however, our self-injury groups were matched on age and sex, and self-injurers did not differ on NSSI characteristics (i.e., frequency of engagement, the experience of pain during NSSI, whether the individual is alone when self-injuring, time elapsed between urge and act, and desire to stop), NSSI motivations, emotion dysregulation, and painful life events. Importantly, associations between self-punishment and tolerance were maintained, even after taking into account other factors that have been implicated in pain threshold and tolerance (Franklin et al., 2011, 2012; Hooley et al., 2010). Nevertheless, future research should explore possible third variables, which may contribute to differences in pain tolerance between self-injurers with and without self-punishing motivations, as well as noninjurers (e.g., dissociative symptoms, depressive symptoms).

Finally, as has been noted by other researchers, it is difficult to determine whether the pain experienced during the cold-pressor task is similar to the pain that may be experienced during NSSI. Although the cold-pressor task has been used in previous research on self-injury (Bohus et al., 2000; Franklin et al., 2012; Franklin et al., 2011; Gratz et al., 2011; Russ et al., 1992, 1999), is unclear to what extent this pain maps onto actual NSSI engagement. Nevertheless, we chose a very cold water temperature (three degrees Celsius), which Franklin et al. (2011, 2012) suggested might best create the quick and immediate pain produced by an episode of NSSI. Moreover, because research has demonstrated that NSSI consistently occurs in the context of negative mood states (Armey et al., 2011; Bresin & Gordon, 2013; Franklin et al., 2010), we included a stress task prior to engagement in the cold pain task to best recreate the conditions of NSSI engagement occurs. Future research, however, should explore whether perception to pain varies depending on whether pain occurs in the context of distress.

Conclusions

Despite increased research on the link between NSSI and sensitivity to pain in recent years (McCoy et al., 2010; Franklin et al., 2012), little attention has been given to which self-injurers may be most able (or willing) to tolerate pain. In the present study, we examined whether individuals who engaged in NSSI specifically to regulate the need to self-punish demonstrated heightened pain thresholds and tolerances relative to self-injurers without self-punishing motivations and a comparison group of noninjurers. Consistent with expectations, individuals who engaged in NSSI to self-punish had greater pain tolerances, and rated this pain as less intense, than the other two groups. To our knowledge, our findings are the first to provide empirical evidence that tolerating painful stimulation may be an important part of the self-injury experience among individuals who engage in NSSI to self-punish. Specifically, these individuals may be particularly motivated to tolerate the pain involved in NSSI as a way to self-punish. Importantly, self-injurers who endorse self-punishment motivations for engaging in NSSI should be targeted by future prevention and intervention efforts, as increased tolerance for pain is an important risk factor for suicidal behavior (Nock at al., 2006; Orbach et al., 1997; St. Germain & Hooley, 2013). In addition to replicating findings on the link between self-punishment motivations and pain, future research also should examine the link between self-punishment and risk for suicidal behavior.

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