



A lab-based study exploring the associations among nonsuicidal self-injury, pain, and emotion among university students



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ABSTRACT

Nonsuicidal self-injury (NSSI; e.g., self-cutting without lethal intent) is a widespread mental health concern among emerging adults in university. Although accumulating evidence suggests that NSSI is primarily an emotion coping behaviour, little is known about variability in emotional response to pain among individuals who self-injure. Recent theory on NSSI suggests that individuals who engage in NSSI to self-punish may experience additional affective gains in response to pain compared to individuals without self-punishment motivations for NSSI and individuals who do not self-injure. To test this hypothesis, 82 undergraduate students (Mage = 21.52 years) were recruited from a mid-sized university, and reported on their emotions three times: at baseline, following a stress-induction task, and after a cold-pressor task. Although all participants showed decreased negative emotions (e.g., hostility, fear) and increased serenity following cold pain, students who engaged in NSSI specifically to self-punish also showed decreased guilt and sadness. The present findings demonstrate that pain may serve to regulate different emotions for students who self-injure depending on their motivations for engaging in NSSI. Additionally, findings suggest that prevention and intervention efforts aimed at reducing the need to self-punish may help to reduce some of the emotionally reinforcing properties of NSSI.

1. Introduction

One out of every five university students has engaged in nonsuicidal self-injury (NSSI) (Swannell et al., 2014), and recent research suggests that the rates of NSSI on university campuses may be increasing (Wester et al., 2017). NSSI is defined in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) as the direct and deliberate destruction or alteration of bodily tissue in the absence of lethal intent, and includes behaviours such as self-cutting, burning, and severe scratching (American Psychiatric Association, 2013). NSSI frequently has its onset in early adulthood (Heath et al., 2008; Whitlock et al., 2011). Moreover, emerging adults in university are twice as likely to engage in NSSI as compared to young adults who are not in university, suggesting that university students may represent a unique at-risk group (Swannell et al., 2014; Whitlock et al., 2011). Studies have consistently underscored the role of NSSI in the regulation of affect (Andover and Morris, 2014; Hamza and Willoughby, 2015; Klonsky 2007); however, less is known about heterogeneity in emotional response to NSSI among individuals who self-injure. In particular, it has

recently been proposed that engaging in NSSI specifically to self-punish may afford individuals unique emotional benefits (Hooley and Franklin, 2017). The present study specifically tests this hypothesis by exploring emotional responses to pain among emerging adults with and without self-punishing motivations for NSSI, and a comparison group of non-injuring students. Elucidating the emotional context in which NSSI occurs, and is reinforced among individuals, is critically important to develop evidenced-informed and targeted prevention and intervention programs for NSSI.

1.1. NSSI and emotion regulation

Emotion dysregulation is a broad construct which includes emotional reactivity (e.g., intensity and duration of an emotion in response to an event), difficulty labelling and expressing emotions, as well as difficulty modulating one's emotional response (Gratz and Roemer, 2004; Gross and Munoz, 1995; Werner and Gross, 2009). Emotion dysregulation has been widely implicated as a contributing factor for NSSI engagement (Andover and Morris, 2014; Chapman et al., 2006;

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Klonsky, 2009). Young adults who engage in NSSI report more frequent negative emotions (Bresin, 2014; Victor and Klonsky, 2014), greater difficulty regulating their emotions (Muehlenkamp et al., 2010; Voon et al., 2014), and greater emotional intensity and reactivity than individuals who do not engage in NSSI (Anderson and Crowther, 2012; Arbuthnott et al., 2015). Emotion regulation is also the most commonly endorsed motivation for engaging in NSSI (Hamza and Willoughby, 2015; Klonsky, 2007, 2009; Turner et al., 2012). For example, when asked why they self-injure, university students overwhelming report that NSSI serves as a way to reduce negative affect (e.g., stress, anxiety, frustration) (Klonsky and Glenn, 2009; Saraff and Pepper, 2014).

Recent research utilizing experience sampling techniques (which capture emotions prior to and after engagement in NSSI in real time) also provide compelling evidence (Davidson et al., 2017). These studies have shown that self-reported negative emotions tend to increase prior to engaging in NSSI (Muehlenkamp et al., 2009), and decrease following the act (Armeij et al., 2011; Kranzler et al., 2017; Nock et al., 2009). In addition, in a recent study NSSI urges were predicted by the intensity of negative emotions experienced, even after taking into account other risk factors for NSSI such as symptoms of depression and borderline personality disorder (Kranzler et al., 2017). Although there is some evidence to suggest that positive emotions, particularly low arousal emotions (e.g., content, calm, relieved) may also increase following an act of NSSI (Kranzler et al., 2017; Muehlenkamp et al., 2009), the link between NSSI and positive emotions is less consistently reported in these studies (Armeij et al., 2011).

In an effort to understand the emotionally reinforcing properties of NSSI, researchers also have utilized pain induction tasks in laboratory settings (Hamza and Willoughby, 2015). For example, Weinberg and Klonsky (2012) showed that undergraduate students reported decreased emotional arousal following low and high intensity pain inductions. However, students who self-injured reported greater declines in arousal following high intensity pain than students who did not self-injure (Weinberg and Klonsky, 2012). Similarly, Bresin et al. (2013) found that self-reported negative affect decreased following cold pain for undergraduate students who engaged in NSSI, as well as a comparison group of participants without a history of NSSI. Notably, students who self-injured showed greater declines in negative affect for painful, rather than non-painful stimulation (i.e., warm water), suggesting painful stimulation was more effective in moderating affect for students who self-injured (Bresin et al., 2013). Franklin et al. (2013) also found that there were affective gains following pain in their study of university students, but they did not find these gains were more pronounced among individuals who self-injured (Franklin et al., 2013). Taken together, these findings are consistent with other research and theory which suggest that pain may provide short-term affective gains among most individuals (Bresin et al., 2010; Franklin et al., 2013; Hooley and Franklin, 2017; Leknes et al., 2008). It has been suggested that because similar neural circuitry may underline both physical and emotional pain, relief from physical pain may also confer emotional benefits (i.e., “pain-offset relief”) (Franklin et al., 2013; Hooley and Franklin, 2017). That said, findings are mixed as to whether the emotional gains associated with pain may be more pronounced for individuals who self-injure.

1.2. NSSI and self-punishment

Despite emerging evidence that the administration of pain may be emotionally reinforcing, it is less clear whether there is heterogeneity in emotional response to pain among individuals who engage in NSSI. Although research and theory on NSSI have long underscored the role of NSSI in the regulation of affect (Chapman et al., 2006; Klonsky and Glenn, 2009; Nock and Prinstein, 2004), another commonly endorsed motivation for engaging in NSSI is to self-punish (Hamza et al., 2013; Klonsky and Glenn, 2009; Taylor et al., 2017). In their new conceptual model on NSSI (i.e., the Benefits and Barriers Model), Hooley and

Franklin (2017) suggest that although brief exposure to pain may provide affective gains to most individuals, individuals who engage in NSSI to self-punish may experience added benefits. Specifically, for individuals who engage in NSSI to express feelings of worthless, self-directed anger, and self-disgust, the physical act of self-derogation may satiate the desire to self-punish (Hooley and Franklin, 2017). In other words, for individuals who believe that they are deserving of pain, NSSI may not only afford pain-offset relief benefits, but also lead to emotional benefits through self-affirmation (also see Fox et al., 2017; Hooley et al., 2010; St. Germain and Hooley, 2012).

Self-beliefs have long been underscored in the onset and maintenance of NSSI. Individuals who engage in NSSI report lower levels of self-esteem (Forrester et al., 2017), and higher levels of self-criticism (Fox et al., 2018; Hooley et al., 2010), self-dissatisfaction (Claes et al., 2010; Victor and Klonsky, 2014), self-hatred (Xavier et al., 2016) and self-disgust (Smith et al., 2015) than individuals who not self-injure. Negative self-evaluations have been associated with self-punishing motivations for engaging in NSSI (Glassman et al., 2007). It is also interesting to note that brief interventions aimed at improving self-worth have been shown to reduce willingness to endure pain in the lab (Hooley and St. Germain, 2014) and reduce NSSI engagement over time in a brief intervention study (Franklin et al., 2016). These findings suggest that satiating the need to self-punish may be a significant motivator for NSSI behaviour, particularly among individuals with low self-worth. It is less clear whether individuals who engage in NSSI specifically to regulate the need to self-punish experience more pronounced affective gains than individuals who engage in NSSI to regulate affect more generally, as proposed by Hooley and Franklin's (2017) Benefits and Barriers Model of NSSI. In one recent study, researchers found that the administration of pressure pain was associated with improved mood during pain (decreased negative mood, increased positive mood), but only for young adults high in self-criticism (Fox et al., 2017). These findings highlight the need for additional research exploring variability in emotional response to pain among individuals who self-injure.

1.3. The present study

To further elucidate the role of pain in NSSI, the present study examined whether individuals who engaged in NSSI to self-punish differed in emotional response to pain from individuals who engaged in NSSI but not to self-punish, and a comparison group of students without a history of NSSI. Given that developmental theory on NSSI suggests that NSSI often occurs following a stressful event (Nock, 2010), and that NSSI overwhelming occurs in the context of a negative mood state (Armeij et al., 2011; Klonsky, 2009; Muehlenkamp et al., 2009), we utilized a stress induction task prior to assessing emotional response to pain. We predicted that all groups would show affective benefits following the administration of cold pain (i.e., pain-offset relief). Consistent with the Benefits and Barriers Model (Hooley and Franklin, 2017), we also expected that individuals who engaged in NSSI to self-punish would experience added affective benefits associated with the administration of pain.

Several researchers have suggested that self-punishment may serve a role in modulating feelings of guilt (Bastian et al., 2011; Chapman et al., 2006; Leibenluft et al., 1987), but it is less clear whether there are other emotions an individual who engages in NSSI to self-punish may experience following the act of pain (and how these emotions may vary for individuals without self-punishment motivations for NSSI). Research suggests that some negative emotions may be differentially related to NSSI engagement; for example, Nock et al. (2009) found that anger towards the self and self-hatred increased risk for NSSI in their daily diary study, but feelings of sadness and worthlessness actually reduced the likelihood of NSSI (even though all of these emotions fall within the spectrum of negative affect) (Nock et al., 2009). To provide a nuanced examination of the emotions involved in pain, we chose to

assess several different emotions before and after the pain induction (e.g., guilt, hostility, sadness, serenity, etc.) for all three groups (NSSI + punish, NSSI + no punish, no NSSI). Understanding the processes through which NSSI may be emotionally reinforced (and which emotions are reinforced for different individuals) is important for understanding how to disrupt pathways to NSSI. For example, if individuals who engage in NSSI to self-punish experience unique emotional gains following the administration of pain, it may be important to target self-beliefs to reduce the self-affirming functions of pain.

2. Method

2.1. Participants

The present sample consisted of 82 fourth year undergraduate students (70% female, M age = 21.52) who were recruited from a larger longitudinal research project examining university adjustment and academic achievement at a mid-sized university in Canada ($N = 832$). In total 87% of the present sample ($N = 82$) were born in Canada, with 13% identifying as born in other countries (i.e., Middle East, Asia, Africa, Europe, Caribbean, South or Central America). 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.”

2.2. Measures

2.2.1. Demographics

Participants reported on age (in years), gender (1 = male, 2 = female), whether they were born in Canada (and if no, where), and parental education from 1 (*did not finish high school*) to 6 (*completed a professional degree*).

2.2.2. Nonsuicidal self-injury

As part of a larger longitudinal research project, participants completed an adapted version of the inventory of statements about self-injury, which was adapted to assess past year, rather than lifetime frequency, of eight NSSI behaviours (Glenn and Klonsky, 2011; Klonsky and Glenn, 2009). Participants indicated the frequency with which they engaged in NSSI within the past year: 1 incident, 2–4 incidents, 5–10 incidents, 11–50 incidents, 51–100 incidents, more than 100 incidents (see Heath et al., 2008 for a similar categorization). Participants also indicated whether they experienced pain when self-injuring, how much time typically elapsed between when they had the urge and when they self-injured, whether they were alone when self-injuring, and if they wanted to stop self-injuring. Participants also reported on the extent to which eight commonly endorsed functions for NSSI were relevant to them (i.e., affect regulation, self-punishment, anti-dissociation, interpersonal boundaries, interpersonal influence, peer bonding, marking distress) on a scale from 1 = *not at all relevant* to 3 = *very relevant* (Klonsky and Glenn, 2009). Participants' responses for each function subscale were averaged. Participants who indicated that they engaged in NSSI to self-punish (i.e., a score of 2 or higher, indicating that the self-punishment function was somewhat to very relevant) were included in the NSSI + punish group, and participants who indicated that they engaged in NSSI but not to self-punish (i.e., not at all relevant) were included in the NSSI + no punish group.

2.2.3. Emotions

At each assessment point (baseline, post-stress task, post-cold-pressor task) participants completed 35 items from the Positive and Negative Affect Schedule-Extended (PANAS-X) (Watson and Clark, 1994; Watson et al., 1988), which is one of the most widely used and validated assessments of current emotions among community-based samples (Crawford and Henry, 2004). Participants indicated the extent

to which they experienced several emotions (e.g., happiness, fear, sadness) “right now” on a scale from 1 (*very slightly to not at all*) to 5 (*extremely*). For the purposes of this study, the following nine subscales were examined: total negative affect, total positive affect, fear, hostility, guilt, sadness, joy, attentiveness, and serenity.

2.2.4. Stress task

In an effort to trigger participant stress response prior to pain, participants completed an adapted version of the trier social stress task (Franklin et al., 2011; Kirschbaum et al., 2008). Participants were given four minutes to prepare a one-minute speech about whether the government should enforce the death penalty. Participants performed their one-minute 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 later shown to a group of their peers, who would evaluate them on the articulateness of their speech and the compellingness of their arguments. We used one-item from the PANAS as a manipulation check, which required participants to indicate the extent to which they were feeling relaxed pre- and post-stress task. Results showed that participants showed decreased relaxation after the stress task, $t(81) = 10.256$, $p < 0.001$ ($M = 3.35$ at baseline, $M = 2.04$ after stress task).

2.2.5. Pain induction

To examine changes in emotions following the administration of pain, participants completed the cold-pressor task. Participants were asked to submerge their non-dominant hand into cold water maintained at three degrees Celsius until they could no longer tolerate the cold pain (or until a time of two minutes was reached). The cold-pressor task is one of the most widely used (and safest) forms of experimental pain induction (Franklin et al., 2010; Gratz et al., 2011).

2.3. Procedure

2.3.1. Screening and recruitment

Participants completed the ISAS (Klonsky and Glenn, 2009) as part of a larger research project. At this assessment wave, 75 participants reported a past year history of NSSI (40 with self-punishing motivations and 35 without self-punishing motivations). We also attempted to recruit a comparison group of participants matched on age, sex, and parental education ($n = 34$). We reached out to all eligible participants via phone and email to participate in an in-person lab-based study. Of those eligible participants, 31 participants with self-punishing motivations for NSSI, 25 without self-punishing motivations, and 26 without a history of NSSI agreed to participate in the present study (a 75% response rate). Groups did not differ with respect to age, sex, whether they were born in Canada, and parental education ($p < 0.05$).

2.3.2. Study procedure

When participants arrived at the lab, they completed the PANAS-X questionnaire to assess their baseline emotional states. Next, participants completed the stress task (i.e., an adapted version of the Trier Social Stress Test), and then completed the PANAS-X questionnaire again. For the last component of the study, participants completed the cold-pressor task, followed by the PANAS-X. At the end of the study, participants also completed the ISAS, and demographics questionnaire. 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, and participants were given \$30 to participate in the study.

3. Results

3.1. Preliminary analyses

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 11 to 50 times within the past year (37%), five engaged in NSSI 51 to 100 times within the past year (9%), and 11 participants engaged in NSSI 100 or more times (20%). In total, 16% of students who self-injured reported that they engaged in self-cutting, 7% engaged in burning behaviours, 59% engaged in self-hitting or head banging, 70% engaged in pinching behaviours, 34% engaged in self-biting, 34% engaged in severe scratching to the point of bleeding and 38% prevented wounds from healing. Participants who engaged in NSSI to self-punish did not differ from students who engaged in NSSI but not to self-punish on frequency of NSSI, NSSI characteristics (including the presence of pain during NSSI), or any of the other motivations for engaging in NSSI ($p > 0.05$).

3.2. Primary analyses

Group scores on the PANAS-X at each assessment point (i.e., baseline, post-stress, post-cold pain) are presented in Table 1. To examine changes in emotions across assessments, mixed ANOVAs were run with the different emotions (e.g., total negative affect, fear, hostility, guilt) as the within-subjects factors, and group membership as the between-subjects factor. Multivariate tests are reported, given that the Mauchly's tests of Sphericity were significant for these analyses (Field, 2009). There was a main effect of time on negative affect, Wilk's $\lambda = 0.616$, $F(2, 78) = 24.281$, $p < 0.05$, $\eta^2 = 0.384$, fear, Wilk's $\lambda = 0.617$, $F(2, 78) = 24.17$, $p < 0.05$, $\eta^2 = 0.383$, and hostility Wilk's $\lambda = 0.741$, $F(2, 78) = 24.17$, $p < 0.05$, $\eta^2 = 0.359$, such that these emotions increased after the stress task, and decreased following the cold pain. In addition, serenity, Wilk's $\lambda = 0.360$, $F(2, 78) = 24.281$, $p < 0.05$, $\eta^2 = 0.640$ decreased after the stress task, and increased after the cold pain. There were significant time by group interactions for the emotions of guilt, Wilks' $\lambda = 0.806$, $F(4,156) = 4.440$, $p < 0.05$, $\eta^2 = 0.102$, and sadness, Wilks' $\lambda = 0.872$, $F(4,156) = 2.773$, $p < 0.01$, $\eta^2 = 0.07$, and a trend effect for attentiveness, Wilks' $\lambda = 0.905$, $F(4,156) = 2.005$, $p = 0.092$, $\eta^2 = 0.05$. No significant effects were observed for total positive affect, or joviality ($p < 0.05$). Significant time by group interactions were followed up with mixed ANOVA analyses for each group. There was a main effect of guilt $F(1.571, 47.137) = 6.179$ $p < 0.05$ and sadness $F(1.642, 49.272) = 11.197$, $p < 0.05$ for the NSSI + punish group,¹ but not the other two groups. For the NSSI + punish group, guilt and sadness significantly decreased following the administration of pain (see Figs. 1 and 2).²

4. Discussion

Research suggests that the pain associated with engaging in NSSI may serve to regulate emotions (Armey et al., 2011; Bresin and Gordon, 2011; Nock et al., 2009; Weinberg and Klonsky, 2012). However, recent theoretical frameworks (e.g., the Benefits and Barriers Model) (Hooley and Franklin, 2017) suggest that emotional response to pain may vary depending on an individual's motivations for engaging in NSSI. In the present study, we examined whether students who engaged in NSSI specifically to self-punish experienced different emotional responses to pain in a laboratory setting compared to students who engaged in NSSI but not to self-punish, and students who did not engage in NSSI. Consistent with previous research (Bresin et al., 2013; Leknes et al., 2008) and recent theoretical frameworks on NSSI (Hooley et al., 2010; Hooley and Franklin, 2017; Hooley and St. Germain, 2014), the administration of pain was associated with decreased negative affect

Table 1

Mean emotion scores by group at baseline, post-stress task and after cold pain.

	Group		
	NSSI + punish	NSSI + no punish	No NSSI
Baseline			
Negative affect (total)	1.76(0.53)	1.61(0.60)	1.36(0.36)
Positive affect (total)	2.54(0.66)	2.66(0.88)	2.73(0.70)
Fear	1.84(0.62)	1.76(0.61)	1.41(0.46)
Hostility	1.39(0.41)	1.27(0.43)	1.16(0.37)
Guilt	1.76(0.78)	1.38(0.73)	1.13(0.30)
Sadness	1.82(0.60)	1.64(0.73)	1.43(0.42)
Joy	2.06(0.85)	2.32(1.09)	2.50(0.86)
Attentive	2.76(0.66)	3.06(0.82)	3.13(0.81)
Serenity	3.02(1.04)	3.37(1.00)	3.49(0.85)
Post-stress task			
Negative affect (total)	2.08(0.65)	1.85(0.52)	1.57(0.61)
Positive affect (total)	2.33(0.75)	2.70(1.03)	2.55(1.02)
Fear	2.37(0.75)	2.22(0.66)	1.73(0.73)
Hostility	1.64(0.56)	1.41(0.45)	1.47(0.59)
Guilt	1.89(0.83)	1.35(0.38)	1.25(0.54)
Sadness	1.76(0.54)	1.51(0.57)	1.32(0.48)
Joy	1.98(0.86)	2.32(1.11)	2.29(1.27)
Attentive	2.62(0.92)	3.06(0.95)	2.89(1.11)
Serenity	1.98(0.93)	2.09(0.63)	2.20(1.07)
Post-cold pain			
Negative affect (total)	1.62(0.49)	1.55(0.67)	1.26(0.44)
Positive affect (total)	2.37(0.73)	2.75(1.02)	2.62(0.83)
Fear	1.77(0.60)	1.67(0.66)	1.42(0.47)
Hostility	1.35(0.52)	1.29(0.45)	1.13(0.29)
Guilt	1.39(0.50)	1.21(0.46)	1.19(0.30)
Sadness	1.44(0.46)	1.45(0.72)	1.28(0.50)
Joy	2.02(0.91)	2.34(1.12)	2.42(1.07)
Attentive	2.56(0.97)	3.42(1.34)	2.84(1.00)
Serenity	2.27(0.81) ^a	2.41(0.97)	2.53(0.99)

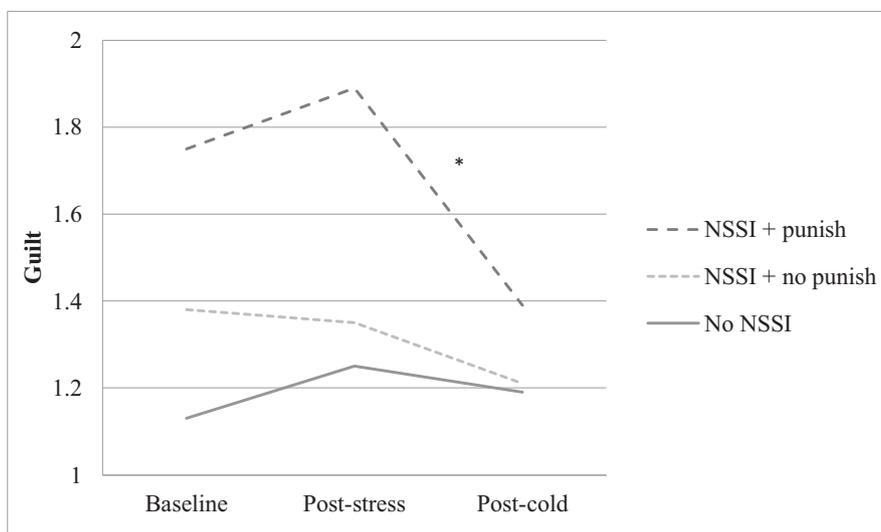
among undergraduate students regardless of group condition (i.e., "pain-offset relief"). As an extension to previous research, we also found that students who engaged in NSSI to self-punish reported declines in guilt and sadness following cold pain that were not reported by the other two groups. These findings are in line with the notion that individuals who engage in NSSI specifically to self-punish may experience added emotional benefits from engagement in NSSI (Fox et al., 2017).

Consistent with previous research (Bresin and Gordon, 2011; Franklin et al., 2010; Weinberg and Klonsky, 2012), participants reported increases in total negative affect, fear, and hostility, and declines in serenity following the stress task, regardless of group condition. These findings suggest that the stress task successfully induced a negative mood state among participants prior to the administration of cold pain. Following the administration of cold pain, all participants reported decreases in negative affect, fear, and hostility, and increases in serenity. These results are in line with other research (Bresin and Gordon, 2011; Franklin et al., 2013; Leknes et al., 2008; Weinberg and Klonsky, 2012), and suggest that brief exposure to pain may provide relief from emotional distress regardless of whether or not an individual self-injures. This shared emotional response to pain has been referred to as "pain-offset relief" in recent research, and is regarded in the Benefits and Barriers Model of NSSI as a potentially widely accessible benefit of NSSI (Hooley and Franklin, 2017). Although research is only beginning to explore the processes through which pain-offset relief happens, it has been proposed that shared neural circuitry may mean that relief from physical pain also provides emotional relief (Franklin et al., 2013)

Recently, it has been theorized that individuals who engage in NSSI to self-punish may experience added affective benefits from NSSI engagement, as compared to individuals who engage in NSSI for other reasons (e.g., affect regulation; Hooley and Franklin, 2017). More specifically, it has been proposed that when individuals think they are deserving of pain, NSSI may be self-affirming (also see Hooley et al., 2010; Hooley and St. Germain, 2014). It is thought that this self-

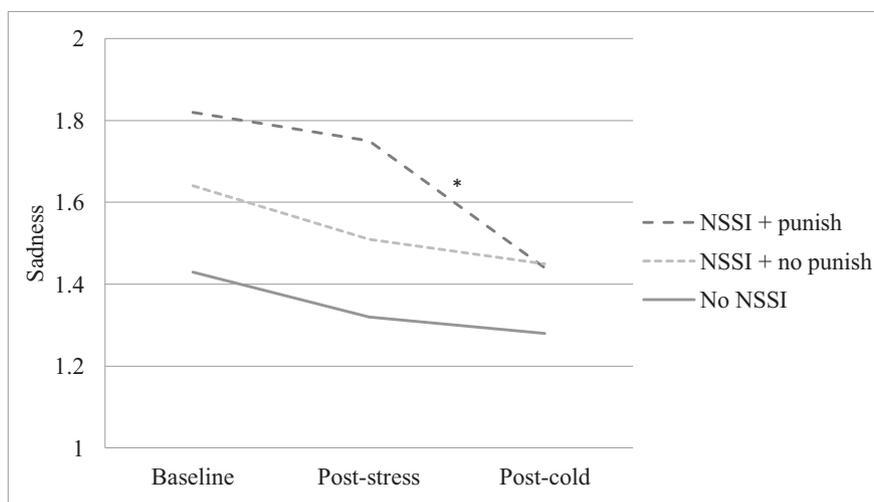
¹ Greenhouse–Geisser corrected degrees of freedom reported.

² Note, these associations were maintained even after controlling for duration of time participants kept their hands in the water during the cold-presser task.



Note. * = significant at $p < 0.05$

Fig. 1. Significant group by time interactions for guilt. Note: * = significant at $p < 0.05$.



Note. * = significant at $p < 0.05$

Fig. 2. Significant group by time interactions for sadness. Note: * = significant at $p < 0.05$.

affirmation through pain (which is regarded as a cognitive benefit of NSSI), may then provide unique mood benefits as well (Hooley and Franklin, 2017). The results of this study support this hypothesis. Individuals who engaged in NSSI to self-punish showed the same affective gains following pain as the other group groups (i.e., decreased negative affect, fear and hostility, increased serenity); however, unlike the other two groups, these individuals also showed decreased guilt and sadness. Previous research has shown that NSSI may regulate guilt well (Armey et al., 2011; Bastian et al., 2011; Nock et al., 2009), and our results suggest these gains may be specific to individuals who engage in NSSI to self-punish. Our findings may help to account for mixed findings about whether individuals who engage in NSSI have greater pain offset relief (Bresin et al., 2013; Franklin et al., 2013; Weinberg and Klonsky, 2012). Indeed, our study suggests that there may be variability among individuals who self-injure in emotional response to pain. Although some individuals may show greater benefits in response to pain than those who do not engage in NSSI (i.e., the NSSI + punish group), others may show comparable gains (i.e., the NSSI + no punish group). Our findings underscore the importance of further exploring individual variability in emotional response to pain, particularly among individuals who engage in NSSI.

One other notable finding is that there was a trend effect for the emotion of attentiveness, such that participants who engaged in NSSI, but not to self-punish, had higher attentive scores following the cold pain relative to participants who engaged in NSSI to self-punish. Although trend effects should be interpreted cautiously, this finding warrants noting given its theoretical relevance. The subscale of attentiveness used in the present study included items about alertness and concentration, so it is interesting that some participants seemed to report higher attentiveness after pain. It is possible that pain may help some participants who self-injure to focus their attention, which would be consistent with recent theory that NSSI serves to distract from distressing thoughts and emotions (Selby et al., 2013, 2014; Selby and Joiner, 2013). Relatedly, participants who engage in NSSI to self-punish may be less easily distracted from their emotions (and in fact could be focusing on their self-punishing thoughts while affirming these thoughts through pain), and have less success using pain as a form of distraction. Future research involving a larger sample size could explore this hypothesis further.

Despite the strengths of the present study, including a laboratory approach to examine the role of pain in emotion regulation, and a focus on heterogeneity in emotional response to pain, the present study is not

without limitations. First, the present sample was small, predominantly Caucasian and female, and recruited from a mid-sized undergraduate institution in Canada. As a result, the study findings may not be generalizable to a more diverse sample, clinical samples with more severe NSSI engagement, or other geographic regions. Further, the small sample size may have limited statistical power in the present analyses. Nevertheless, our findings offer an initial examination of heterogeneity in a geographically representative sample, and support continued research in this area involving larger and more diverse participant pools. Second, although participants in all three groups were matched on age, sex, whether they were born in Canada, and parental education, it is possible that the groups differed in other unmeasured ways (e.g., depressive symptoms). Thus, there is the possibility that other unmeasured variables may have contributed to the differences observed between groups. Although this limitation is not uncommon in quasi-experimental research, it will be worthwhile for future research to consider other factors that may contribute to differences in emotional responses to pain (aside from self-punishment motivations for NSSI).

Although laboratory-based approaches afford an opportunity to examine responses to pain in real time, another limitation is that the use of pain induction may lack ecological validity (Bresin et al., 2013; Franklin et al., 2010). Future research could specifically examine changes in emotion preceding and following NSSI in-vivo, through the use of experience sampling techniques. Additionally, although our findings seem to support the affect regulating function of brief exposure to pain, it is also possible that participants were relieved the pain task was over (and thus showed reductions in negative affect following task completion). That said, at the time of study recruitment and consent, participants were informed about the cold pain task (an ethics requirement). Importantly, serenity ratings were highest at baseline (suggesting that the anticipation of cold pain did not seem to be associated with heightened negative affect at study onset), which may reduce concerns about relief following task completion. Finally, the measure used to assess emotional states did not include a measure of shame. Some researchers have suggested that shame may be an important emotion that is regulated by NSSI, particularly among individuals with self-punishing motivations (Schoenleber et al., 2014). Although research suggests that shame and guilt are often strongly correlated (Muris et al., 2014; Roos et al., 2014), future research should specifically examine if pain may reduce shame as well as guilt, as both emotions may be related to self-punishment motivations for NSSI.

4.1. Conclusions and implications

NSSI is a widespread mental health concern among university students (Swannell et al., 2014; Wester et al., 2017), and mounting evidence suggests that NSSI serves as a form of emotion coping behaviour (Chapman et al., 2006; Fox et al., 2018; Hamza and Willoughby, 2015; Klonsky and Glenn, 2009; Nock and Prinstein, 2004). Our study adds to this literature, demonstrating that the administration of brief cold pain seems to reduce negative emotions and increase feelings of relaxation (serenity) among students who do and do not self-injure. These findings are consistent with the pain-offset relief explanation (Hooley and Franklin, 2017), which suggests that relief from brief physical pain may confer emotional benefits (and not just for those who self-injure). Another important finding of the present study was that for students who engaged in NSSI to self-punish, pain provided added benefits following the administration of pain. Specifically, only students who engaged in NSSI to self-punish showed decreased guilt and sadness following the administration of pain. The results from the present study are consistent with recent theoretical frameworks (e.g., the Benefits and Barriers Model of NSSI), which suggest that while most individuals may be able to experience emotional benefits from NSSI (e.g., pain-offset relief), for individuals with low self-worth, NSSI may also confer added emotional benefits.

Our findings underscore that NSSI may be differentially emotionally

reinforcing, depending on a particular individual's motivations for engaging in NSSI. These findings can support efforts to identify the emotional antecedents and consequences of NSSI among individuals who self-injure, and inform targeted efforts to prevent NSSI behaviours. For example, equipping students with emotion-specific coping strategies may be helpful to circumvent the use of NSSI for regulating aversive emotions such as fear and hostility, as well as emotions related to self-punishment (e.g., guilt). Our findings also suggest that targeting an individual's sense of self-worth may help to reduce the belief one is deserving of pain, and remove the self-affirming function of NSSI. Specifically, when NSSI is primarily engaged in for self-punishing motivations, reducing the belief that one is worthy of punishment may also reduce the reinforcing affective benefits associated with NSSI engagement.

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