

SHORT TITLE: Emotional experience and non-suicidal self-injury

Non-suicidal self-injury-related differences in the experience of negative and positive emotion

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Abstract

Objective: Emotional experience is argued to contribute to the initiation and maintenance of non-suicidal self-injury (NSSI). We investigated whether individuals with/without a history of NSSI differed in their dispositional experience of negative and positive emotion, as well as their state responses to negatively and positively-valenced movie clips. **Method:** Undergraduates ($n = 214$, $M_{\text{age}} = 21.33$, 73.8% female, 35.5% reporting NSSI) completed measures of NSSI and dispositional emotional experience. Participants also viewed a sad and amusing movie clip, and provided sadness/amusement ratings at seven time-points. **Results:** Relative to participants with no history of self-injury, participants reporting NSSI indicated more reactivity, intensity, and perseveration of dispositional negative emotion; however, differences were negated after adjusting for mental illness. Unexpectedly, individuals with a history of NSSI responded less intensely to the sad clip, although they demonstrated perseveration of sadness over time. Participants reporting NSSI also indicated less reactivity, intensity, and perseveration of dispositional positive emotion and, in response to the amusing film, reported less amusement at all time-points. **Conclusions:** Considering different dimensions of negative and positive emotion may enhance understanding of NSSI. Future research should disentangle which dimensions of emotional experience are unique to NSSI and which are shared with mental illness more generally.

Keywords: Non-suicidal self-injury, NSSI, emotion, negative, positive, sadness, amusement

Non-suicidal self-injury (NSSI) is the deliberate and direct damage to one's own body tissue without suicidal intent (e.g., cutting, self-battery) and for purposes not socially or culturally sanctioned (International Society for the Study of Self-Injury, 2018). Approximately 17% of adolescents and 13% of young adults (20% among university students) report a history of NSSI (Swannell, Martin, Page, Hasking, & St John, 2014). NSSI is associated with a range of negative consequences including permanent scarring (Lewis & Mehrabkhani, 2015), psychological distress for the individual as well as their friends and family (Curtis et al., 2018), and increased risk of future suicidal thoughts and behaviour (Kiekens et al., 2018). Due to its prevalence and adverse outcomes, NSSI is listed as a condition requiring further study in the DSM-5. Most people who self-injure report doing so to alleviate intense or unwanted emotion (P. J. Taylor et al., 2018), and it has been theorised that people who self-injure are more sensitive to emotional stimuli and experience their emotions with heightened intensity relative to people who do not self-injure (e.g. Chapman, Gratz, & Brown, 2006; Selby & Joiner, 2009). However, empirical studies investigating NSSI-related differences in emotional experience are equivocal.

The Emotion Reactivity Scale (Nock, Wedig, Holmberg, & Hooley, 2008) is the primary measure of dispositional emotional experience used in NSSI-related research. Using this scale, individuals with a history of self-injury, compared to those without, consistently report heightened emotional reactivity (Claes, Smits, & Bijttebier, 2014; Glenn, Blumenthal, Klonsky, & Hajcak, 2011; Smith, Hayes, Styer, & Washburn, 2017). In contrast, laboratory studies measuring state emotional experiences have produced mixed results. For example, consistent with self-report studies, Nock and Mendes (2008) reported that adolescents with a history of NSSI exhibited significantly more skin conductance (a measure of emotional arousal) during a stressful card-sorting task than participants with no history of NSSI. In contrast, a number of laboratory studies have not found any evidence of NSSI-related differences in emotional arousal in response to affective images (e.g. T. S. Davis et al., 2014; Glenn et al., 2011) or the Trier Social Stress Test (e.g. Tatnell, Hasking, Lipp, Boyes, & Dawkins, 2018).

One possible explanation for the divergent findings between self-report studies and laboratory experiments is that people who self-injure may be prone to a recall bias that may influence dispositional responding (Hasking, Di Simplicio, McEvoy, & Rees, 2018). An alternative explanation is that methods used to induce emotion in the laboratory may lack ecological validity or are too mild (e.g. affective pictures) or too intense (e.g. Trier Stress Test) to differentiate groups (Tatnell et al., 2018). A further consideration relates to potential differences in emotional valence and dimension of emotional experience being investigated. For the most part, experimental studies measure individual differences in arousal (an index of the intensity of an emotional response) to negatively-valenced stimuli. In contrast, self-report studies using the Emotional Reactivity Scale use a global emotional reactivity score that does not distinguish between negative and positive emotional experiences.

Although conceptualised as encompassing sensitivity, intensity, and duration of emotional response, psychometrically the Emotion Reactivity Scale is unidimensional in structure (Nock et al., 2008). Additionally, items on the scale conflate different dimensions of emotional experience as well as valence of the emotion. For example, the item “I tend to get very emotional very easily” conflates emotional reactivity (the likelihood of experiencing an emotion) with the intensity of the response, and also does not distinguish between negative and positive emotional experiences. Indeed, most items on the scale ask people to report on emotions in general, thereby conflating negative and positive emotion. This is particularly problematic in the context of NSSI-related research, as recent evidence indicates that negative and positive affect are both associated with self-injury, and that positive affect may be protective against NSSI even when negative affect is high (Bresin, 2014; Burke, McArthur, Daryanani, Abramson, & Alloy, 2018; Cohen et al., 2015; Hasking et al., 2018).

The recently developed Emotional Reactivity Intensity and Perseveration Scale (ERIPS; Ripper, Boyes, Clarke, & Hasking, 2018) attempts to address these limitations of the Emotional Reactivity Scale. The ERIPS was adapted from the widely used Positive and Negative Affect

Schedule (PANAS; Watson, Clark, & Tellegen, 1988) to conceptually distinguish between, and independently assess, dimensions of emotional reactivity (the likelihood of experiencing an emotional response), intensity (the strength of the response), and perseveration (the duration of the response) in the context of both positive and negative emotion. These dimensions accounted for unique variance in trait negative and positive affect and were differentially associated with symptoms of depression, anxiety and stress (Boyes, Carmody, Clarke, & Hasking, 2017; Ripper et al., 2018). While negative and positive affect (as assessed by the PANAS), and fluctuations in these, have been associated with self-injury (e.g. Arbuthnott, Lewis, & Bailey, 2015; Selby, Franklin, Carson-Wong, & Rizvi, 2013), the reactivity, intensity, and perseveration dimensions of emotional experience captured by the ERIPS have not yet been used in the context of NSSI-related research.

In summary, the primary self-report measure used to investigate dispositional differences in emotional experience in the context of NSSI is unable to differentiate between negative and positive emotional experiences, and conflates specific aspects of emotional experience (reactivity, intensity, and perseveration). Additionally, experimental studies in the field of NSSI have typically been limited to investigations of negative emotion, overlooking potential differences in responses to positively-valenced stimuli, and have not investigated NSSI-related differences in the extent to which emotions may persist over time.

The current study addressed these limitations by investigating NSSI-related differences in positive and negative emotional reactivity, intensity, and perseveration using the ERIPS. We also investigated state emotional responses to negatively-valenced (sad) and positively-valenced (amusing) movie clips. Movie clips are a well-validated method of inducing both negative and positive emotions in laboratory conditions and can be used to measure both the intensity and duration of an emotional response (Gross & Levenson, 1995). Furthermore, as films are dynamic and multi-sensory, they have greater ecological validity than the static images used in previous studies (Glenn et al., 2011; Tatnell et al., 2018). Assessing induced emotional responses in real time should also theoretically limit the effect of recall biases. Specifically, we aimed to answer two

research questions. First, do individuals with and without a history of NSSI differ in their dispositional experience of both negative and positive emotion (in terms of emotional reactivity, intensity and perseveration)? Second, do individuals with and without a history of NSSI differ in their responses to negative and positive emotion inductions conducted under controlled laboratory conditions? With regard to dispositional emotional experience, we hypothesized that individuals with a history of NSSI would report more negative emotional reactivity, intensity, and perseveration, and less positive reactivity, intensity, and perseveration, than individuals with no history of self-injury. With regard to state emotional experience, we hypothesized that when compared to individuals with no history of self-injury, individuals with a history of NSSI would have reactions to the sad movie clip that were more intense and of longer duration, and reactions to the amusing movie clip that were less intense and of shorter duration.

Method

Participants

Participants were 214 undergraduate students at a large Australian university ($M_{\text{age}} = 21.33$ years, $SD = 5.49$, 73.8% female, 35.5% reported a history of NSSI). Consistent with the national demographic of university students, the majority of participants were born in Australia (68.2%), studying full-time (91.6%), and living at home with family (67.3%). Sample size was determined using G*Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007) and the study was powered to identify medium between groups effects (no history/lifetime history of NSSI) on the ERIPS subscales.

Materials

Sociodemographic details: We collected information on participant age and gender, living arrangements, mode of study (*full-time/part-time*), and any diagnosis of a mental illness (*no/yes*). Participants indicating a mental illness diagnosis were also asked report their diagnosis.

Inventory of Statements About Self-injury (ISAS; Klonsky & Olino, 2008): The ISAS was used to assess history of self-injury. A definition of NSSI was provided and participants were asked whether they had ever engaged in self-injury. Participants with a history of self-injury also provided information on the primary method, frequency, and functions of their self-injury. The ISAS is widely-used and well-validated, and has demonstrated excellent test-retest reliability in samples of young adults ($r = 0.85$; Klonsky & Olino, 2008).

Emotion Reactivity Intensity and Perseveration Scale (ERIPS; Ripper et al., 2018): The ERIPS was used to assess individual differences in dispositional emotional reactivity, intensity, and perseveration. The ERIPS uses the 20 adjectives of the PANAS (Watson et al., 1988), however, the instructions and response options have been adapted. To assess reactivity, participants were asked, “When exposed to a situation that would make the ‘average’ person experience this feeling, how likely is it that you will experience this particular feeling?” (1: *not at all likely*; 5: *extremely likely*). To assess intensity, participants were asked, “When you are experiencing a situation that does make you feel this way, how intense is the feeling compared to how other people feel?” (1: *not at all intense*; 5: *extremely intense*). To assess perseveration, participants were asked, “When you are experiencing a situation that does make you feel this way, how long is this feeling likely to persist?” (1: *not at all persistent*; 5: *extremely persistent*). Relevant items are summated to generate indices of positive reactivity, intensity, and perseveration, and negative reactivity, intensity, and perseveration. The ERIPS subscales are independently associated with trait negative and positive affect (Ripper et al., 2018). Internal consistencies in the current sample ranged between $\alpha = 0.87$ (positive perseveration) and $\alpha = 0.91$ (negative reactivity).

Emotion induction: Two validated movie clips were used to induce a negatively-valenced (sadness) and positively-valenced (amusement) emotional response (Kaloerinos, Greenaway, & Denson, 2015). The sad movie clip was the scene of Mufasa’s death from the *Lion King* (126s). The amusing movie clip was the scene of Dory speaking whale in *Finding Nemo* (105s). Emotional responses to the movie clips were assessed at seven time-points using visual analogue scales.

Participants rated their level of sadness/amusement (0: *not at all*; 100: *extremely*) immediately before watching the movie clips (to measure baseline levels of these emotions), immediately after watching the movie-clips (to measure the intensity of the emotional response evoked), and then at one-minute intervals for a total of five minutes (to measure perseveration of the emotional response evoked).

Procedure

Ethical approval was granted by the Human Research Ethics Committee at Curtin University (RDHS-109-16). The study was advertised on the university's online research participant pool and students were awarded course credit for participation in the study. After providing informed consent, participants completed the demographic questionnaire, ISAS, and the ERIPS, before watching the movie clips and completing the associated sadness and amusement ratings. The order of presentation of the movie clips was randomised across participants. After completing the study, participants were provided with a package of useful resources, including fact-sheets about self-injury and information about local mental health resources. A related validation paper has used this dataset to test whether ERIPS subscales are associated with reactivity, intensity, and perseveration of real-time emotional responses to the movie clips (Boyes, Clarke, & Hasking, 2019).

Analysis plan

All analyses were conducted in SPSS version 25. Rates of missing data were low (<2% on all variables) and data were missing completely at random, [$\chi^2(1302) = 1333.37, p = 0.264$]. Missing data were imputed using expectation maximisation. NSSI-related differences in dispositional experience of negative and positive emotion (as measured by the ERIPS) were assessed using a series of MANOVAs and MANCOVAs, with appropriate univariate post-hoc tests. NSSI-related differences in state emotional responses to the two movie clips were assessed in separate generalised linear mixed models (GLMMs). Both GLMMs included participant as a random factor.

Time (sadness/amusement ratings taken immediately pre, immediately post, and at one minute intervals for five minutes after viewing the clip), history of NSSI, and the interaction between time and history of NSSI were included as fixed factors. Data are publically accessible (osf.io/6q9e8/).

Results

Sample characteristics

Of the sample, 76 individuals (35.5%) reported having engaged in self-injury, with a mean age of onset of 14.84 years ($SD = 3.60$). The majority of these individuals ($n = 34$, 46.6%) indicated that cutting was their primary method of self-injury. Swallowing dangerous substances had the lowest lifetime frequency ($M = 0.51$, $SD = 1.37$) and severe scratching ($M = 44.35$, $SD = 268.92$) had the highest lifetime frequency. Lifetime frequency of cutting ranged between zero and 500 ($M = 27.22$, $SD = 71.69$; Supplementary Table 1). Of individuals who reported any history of self-injury, 36 (47.4%) had self-injured at least once in the past 12 months.

Sixty participants (28%) had received a mental illness diagnosis, the majority of whom reported either a diagnosis of depression, anxiety, or co-morbid depression and anxiety ($n = 55$, 91.7%). Individuals with a history of NSSI did not differ from those without a history of NSSI in terms of age, $F(1,212) = 2.00$, $p = 0.159$, or gender, $\chi^2(2) = 1.84$, $p = 0.399$; however, age and gender were significantly associated with ERIPS subscales (Table 1). Additionally, participants with a history of NSSI were significantly more likely to have received a mental illness diagnosis ($n = 39$, 51%) than those with no history of NSSI ($n = 21$, 15%), $\chi^2(1) = 31.65$, $p < 0.001$. Mental illness diagnosis was also significantly associated with dispositional emotion (Table 1). Given these associations, where significant NSSI-related differences in emotional experience were observed, we checked whether these remained significant after adjusting for age, gender, and mental illness.

[Insert Table 1 approximately here]

NSSI-related differences in dispositional emotional reactivity, intensity, and perseverance

Descriptive statistics (both unadjusted and adjusted), disaggregated by history of NSSI, are summarised in Table 2. In terms of negative dispositional emotion, there was a significant multivariate effect of history of NSSI, $\lambda(3,210) = 0.95, p = 0.010$, partial $\eta^2 = 0.05$. Univariate analyses indicated that individuals with a history of NSSI reported more negative emotional reactivity, $F(1,212) = 10.08, p = 0.002$, partial $\eta^2 = 0.05$, intensity, $F(1,212) = 7.50, p = 0.007$, partial $\eta^2 = 0.03$, and perseverance, $F(1,212) = 9.27, p = 0.003$, partial $\eta^2 = 0.04$, than participants with no history of self-injury. However, these effects were negated after adjusting for age, gender, and mental illness diagnosis: negative emotional reactivity, $F(1,209) = 1.43, p = 0.233$, partial $\eta^2 = 0.01$, intensity, $F(1,209) = 0.57, p = 0.450$, partial $\eta^2 = 0.00$, and perseverance, $F(1,209) = 1.50, p = 0.222$, partial $\eta^2 = 0.01$.

In terms of positive dispositional emotion, there was a significant multivariate effect of history of NSSI, $\lambda(3,210) = 0.96, p = 0.042$, partial $\eta^2 = 0.04$, and follow-up univariate analyses indicated that individuals with a history of NSSI reported less positive emotional reactivity, $F(1,212) = 3.97, p = 0.048$, partial $\eta^2 = 0.02$, intensity, $F(1,212) = 8.13, p = 0.005$, partial $\eta^2 = 0.04$, and perseverance, $F(1,212) = 5.55, p = 0.019$, partial $\eta^2 = 0.03$. After adjusting for age, gender, and mental illness diagnosis, the NSSI-related differences in positive emotional reactivity, $F(1,209) = 4.35, p = 0.038$, partial $\eta^2 = 0.02$, and intensity, $F(1,209) = 7.34, p = 0.007$, partial $\eta^2 = 0.03$, remained significant. The NSSI-related difference in positive perseverance was approaching significance, $F(1,209) = 3.19, p = 0.076$, partial $\eta^2 = 0.02$ ¹.

[Insert Table 2 approximately here]

¹ Although the study was only powered to investigate differences in ERIPS scores across two groups (i.e. participants with no history/lifetime history of NSSI), at the request of reviewers we did also explore differences between individuals with no history of NSSI, individuals with a history of NSSI but no recent self-injury (past 12 months), and individuals who had recently self-injured. For negative affect, there were significant differences on all ERIPS subscales; however, group differences were only observed when comparing individuals with no history of NSSI and those who had recently self-injured. Consistent with the main analyses these effects were negated after adjustment (see Supplementary Table 2 and page 4 of Supplementary Materials). For positive affect, the multivariate effect of NSSI history was not significant before or after adjustment, although we were underpowered for this analysis (observed power ~ 0.69 ; descriptive statistics for the three group are presented in Supplementary Table 2 for illustrative purposes).

NSSI-related differences in state emotional responses to the movie clips

Negative emotion: Consistent with the aims of the emotion induction, there was a significant main effect of time on sadness ratings, $F(6,1484) = 68.16, p < 0.001$. Irrespective of NSSI history, participants reported a significant spike in sadness ratings immediately after viewing the movie clip, followed by significant incremental decreases in sadness ratings over the next five assessments (all $p < 0.001$, Supplementary Table 3). There was no main effect of NSSI history on sadness ratings, $F(1,1484) = 0.61, p = 0.435$; however there was a significant interaction between NSSI history and time, $F(6,1484) = 2.45, p = 0.023$. Starting from a significantly higher baseline sadness rating, $t(1484) = 2.45, p = 0.014$, individuals with a history of NSSI responded less intensely to the negatively-valenced movie clip than individuals without a history of NSSI. Individuals with a history of NSSI also demonstrated a flatter gradient in their responses over the course of the five post-viewing assessments (Figure 1a and Supplementary Table 4). The effect of time, $F(6, 1480) = 68.16, p < 0.001$, and the interaction between time and NSSI history, $F(6, 1480) = 2.45, p = 0.023$, remained significant after adjusting for age, gender, and mental illness diagnosis.

Positive emotion: Consistent with the aims of the emotion induction, there was a significant main effect of time on amusement ratings, $F(6,1484) = 53.64, p < 0.001$. Irrespective of NSSI history, participants reported a significant spike in amusement ratings immediately after viewing the movie clip, followed by significant incremental decreases in amusement ratings over the next four assessments (all $p < 0.001$, Supplementary Table 3). The change in amusement ratings between the assessments 4 and 5 minutes after viewing the movie clip was not significant ($p = 0.889$). There was also a significant main effect of NSSI history, $F(1,1484) = 6.81, p = 0.009$. Individuals with a history of NSSI reported significantly lower amusement ratings at all assessment points (Figure 1b and Supplementary Table 5). The interaction between time and history of NSS was not significant, $F(6,1484) = 1.57, p = 0.152$. The effects of time, $F(6,1484) = 53.64, p < 0.001$, and NSSI history,

$F(1,1484) = 8.64, p = 0.003$, remained significant after adjusting for age, gender, and mental illness diagnosis².

[Insert Figure 1 approximately here]

Discussion

NSSI is a prevalent and complex behaviour associated with negative outcomes including increased risk of future suicidal thoughts and behaviour (Kiekens et al., 2018). The current study aimed to extend understanding of the role of emotional experience in NSSI. Specifically, we investigated whether individuals with and without a history of NSSI differed in their dispositional experience of both negative and positive emotion (emotional reactivity, intensity, and perseveration), and whether individuals with and without a history of NSSI differed in their state responses to negatively-valenced and positively-valenced movie clips.

In terms of negative emotional experience, as predicted, relative to individuals with no history of self-injury, individuals with a history of NSSI reported more reactivity, intensity, and perseveration of dispositional negative emotionality. However, these effects were negated after adjusting for age, gender, and mental illness. Similar findings have been reported by Jacobson, Hill, Pettit, and Grozeva (2015), who observed that in a large university student sample, the association between emotional reactivity and NSSI was not significant after controlling for symptoms of depression. Taken together, these findings are consistent with the possibility that co-occurring

² At the request of reviewers we also explored differences between emotional responses to the movie clips among individuals with no history of NSSI, individuals with a history of NSSI but no recent self-injury (past 12 months), and individuals who had recently self-injured. Although not reaching significance [$F(12, 1477) = 1.53, p = 0.147$], for sadness ratings it appears the association between NSSI and perseveration may be driven by individuals with a recent history of self-injury group (Supplementary Figure 1 and page 8 of Supplementary Materials). For amusement ratings, the main effect of NSSI history [$F(2, 1477) = 5.30, p = 0.005$] and the NSSI group*time interaction [$F(12, 1477) = 1.95, p = 0.025$] were significant. Individuals with no history of NSSI reported more amusement overall than individuals with a lifetime history and those who had self-injured recently. Individuals with no history of NSSI also demonstrated a flatter gradient in their responses over the course of the five post-viewing assessments (Supplementary Figure 2 and page 8 of Supplementary Materials).

symptoms of mental illness may account for the links between dispositional emotional reactivity and NSSI reported in previous studies (Claes et al., 2014; Glenn et al., 2011; Smith et al., 2017), or that individuals who self-injure may be prone to a recall bias that influences responses to dispositional measures of emotional experience (Hasking et al., 2018). Regardless, these findings suggest that if we are to understand the role of emotion in NSSI, we need to disentangle which aspects of emotional experience are unique to NSSI and which are shared with mental illness more generally.

With regard to state negative emotion, NSSI-related differences in responses to the sad movie clip were observed over time. Unexpectedly, individuals with a history of NSSI responded less, not more, intensely to the movie clip than individuals with no history of self-injury. Exploratory analyses indicated that this association is may be being driven by individuals who have self-injured in the past 12 months. Although this is inconsistent with theoretical perspectives emphasising the role of emotional intensity in the onset and maintenance of NSSI (e.g. Chapman et al., 2006; Selby & Joiner, 2009), this finding is not without precedent. Studies using both daily diary (Bresin, 2014) and experimental (Tatnell et al., 2018) approaches have reported individuals with a history of NSSI, relative to those without, respond less intensely to emotional stimuli. However, although individuals with a history of NSSI responded less intensely to the negatively-valenced movie, they did demonstrate perseveration of this negative emotion over time. Specifically, individuals with a history of NSSI demonstrated a flatter gradient in their reduction of sadness ratings over time. Moreover, individuals with no history of NSSI were still reporting a significant reduction in sadness at the final assessment, whereas for individuals with a history of self-injury, ratings had plateaued by the final assessment, with no further reduction in sadness reported. Importantly, these NSSI-related differences in emotional responding remained significant after adjusting for age, gender, and mental illness.

Arguably, it may be the case that rather than experiencing negative emotions particularly intensely, individuals who self-injure may experience less intense, but more persistent negative

affect. This would be consistent with a depressive profile in which people may experience flat affect over time, and could account for the subjective experience of feeling more negative emotion. From a clinical perspective, interventions that address slow emotional recovery from negative experiences may be helpful in the context of NSSI. Additionally, although speculative, consistent with theoretical accounts of NSSI (e.g. Emotional Cascade Model; Selby & Joiner, 2009), repeated persistent negative emotional states, generated by internal or external stimuli, could accumulate over time to result in a more intense subjective experience that is perceived as overwhelming (Hughes et al., in press; Slabbert, Hasking, & Boyes, 2018). Although each individual experience may not be overly intense, the accumulation of negative emotions over time, and the slower return to a non-negative emotional state, may increase the likelihood of using NSSI to alleviate intense or unwanted negative emotion. If this is the case, developing strategies to recognise the incremental elevation of negative emotion, and engage in emotion regulation strategies early in the cascade, could prove fruitful in reducing risk of NSSI. These hypotheses should be tested in future research.

In terms of positive emotional experience, as hypothesized, relative to individuals with no history of self-injury, participants with a history of NSSI reported less reactivity, intensity, and perseveration of dispositional positive emotionality. Additionally, for reactivity and intensity, these NSSI-related differences in positive emotionality remained significant after adjusting for age, gender, and mental illness. With regard to state positive emotion, relative to individuals with no history of self-injury, individuals with a history of NSSI reported less amusement at all assessments pre and post viewing the movie clip. This group difference remained significant after adjusting for age, gender, and mental illness diagnosis. Exploratory analyses indicated that individuals with a lifetime history of NSSI, as well as those who had self-injured within the past 12 months, reported less amusement than individuals with no history of NSSI.

These findings are consistent with recent research demonstrating that in comparison with individuals with no history of NSSI, individuals who self-injure report dampened positive affect (Bresin, 2014; Santangelo et al., 2017), less rumination on positive emotions (Burke et al., 2018),

and less positive affect in daily life (Bresin, 2014). The current NSSI-related differences in both dispositional and state positive emotional experience appear independent of mental illness and add to the burgeoning literature suggesting that positive affect may be protective against NSSI (e.g. Burke et al., 2018; Cohen et al., 2015; Hasking et al., 2018). Although clearly still speculative, from a clinical perspective, interventions boosting positive emotional experiences may be a beneficial adjunct to NSSI treatment. For example, interventions designed to promote the “savouring” of positive emotional experiences (e.g. strategies to enhance and maintain positive emotional experiences; Bryant, 1989) have demonstrated efficacy in addressing symptoms of depression and anxiety (Quoidbach, Berry, Hansenne, & Mikolajczak, 2010; C. Taylor, Lyubomirsky, & Stein, 2016) and could be tested in the context of NSSI.

However, our findings need to be considered in the light of several limitations. First, although NSSI-related differences in response to the movie clips were observed, and these may be more ecologically valid than static images, questions regarding how laboratory-based emotion inductions translate to real-life experience remain. Specifically, NSSI-related differences in emotional experience may be more salient in the context of personally-relevant emotional stimuli (Plener, Bubalo, Fladung, Ludolph, & Lulé, 2012). Additionally, it may be the case that sadness and amusement inductions are not optimal for assessing potential NSSI-related differences in emotional responding, and that inducing more high-arousal negative states (e.g. stress, anxiety) may be better options. This should be tested in future research. Alternatively, it could be that emotional instability, rather than emotional intensity, characterises the emotional experience of people who self-injure (Santangelo et al., 2017). These are important questions to address in future research, and designs that can assess dynamic processes, such as ecological momentary assessment, may be particularly useful in disentangling these possibilities. Second, although we did assess state emotion in responses to the movie clips, assessments were limited to self-reported ratings of sadness and amusement on visual analogue scales. Self-reported ratings are limited by a respondent’s subjective awareness of their emotional experiences (P. Davis & Schwartz, 1987) and future research should

examine NSSI-related differences in responses over time to laboratory-based emotion-inductions using psychophysiological measures. Finally, the sample was limited to undergraduate students and of the individuals with a history of self-injury many had not self-injured in that past 12 months, limiting the generalisability of the findings. Future research should attempt to replicate these findings in clinical samples and among individuals who have engaged in self-injury more recently.

Bearing these limitations in mind, our findings demonstrate the utility of considering different dimensions of emotional experience in the theoretical and clinical understanding of NSSI, and future research should investigate whether individual differences in emotional reactivity, intensity, and perseveration contribute to the development and maintenance of NSSI. Results also underscore the need to consider NSSI-related differences in both positive and negative emotional experiences, as well as the need to disentangle which aspects of dispositional and state emotional experience are unique to NSSI and which are shared with mental illness more generally. While recent years have seen a growth in the number of EMA studies (e.g. Bresin, 2014; Hughes et al., in press; Santangelo et al., 2017), which allow assessment of the relationship between emotion and NSSI in shorter time frames, future work in this area, explicitly disentangling associations between both negative and positive emotional reactivity, intensity, and perseveration and NSSI, may be particularly useful in furthering our understanding of the role of emotional experience in self-injury.

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Table 1. Associations between mental illness diagnosis, age, gender, and ERIPS subscales

	1. Mental Illness	2. Age	3. Gender	4. Negative reactivity	5. Negative intensity	6. Negative perseveration	7. Positive reactivity	8. Positive intensity	9. Positive perseveration
1	--	-0.04	0.07	0.33***	0.33***	0.31***	-0.03	-0.06	-0.11
2		--	-0.07	-0.24***	-0.16*	-0.16*	-0.09	0.03	0.11
3			--	0.20**	0.02	0.06	0.12	-0.13*	-0.08
4				--	0.73***	0.67***	.28***	-0.02	-0.12
5					--	0.81***	0.11	0.29***	0.09
6						--	-0.01	0.14*	.15*
7							--	0.57***	0.49***
8								--	0.76***
9									--

Note: Point biserial correlations are reported when binary variables are included. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$.

Table 2. Dispositional emotional reactivity, intensity, and perseveration scores disaggregated by history of NSSI

	<i>Unadjusted Means and Standard Deviations</i>			<i>Adjusted Means and Standard Deviations</i>		
	No history of NSSI	History of NSSI	Cohen's D	No history of NSSI	History of NSSI	Cohen's D
	(<i>n</i> = 138)	(<i>n</i> = 76)		(<i>n</i> = 138)	(<i>n</i> = 76)	
<i>Negative Emotion</i>						
Negative reactivity	30.00 (8.42)	33.79 (8.25)**	0.45	30.84 (7.98)	32.27 (8.18)	0.18
Negative intensity	29.21 (7.55)	32.21 (7.88)**	0.39	29.97 (7.54)	30.83 (7.73)	0.11
Negative perseveration	28.10 (7.43)	31.33 (7.41)**	0.44	28.77 (7.37)	30.12 (7.54)	0.18
<i>Positive Emotion</i>						
Positive reactivity	34.10 (5.87)	32.33 (6.82)*	0.28	34.18 (6.39)	32.18 (6.54)*	0.31
Positive intensity	30.85 (6.58)	28.07 (7.27)**	0.40	30.88 (7.04)	28.01 (7.21)**	0.41
Positive perseveration	29.28 (6.00)	27.20 (6.50)*	0.33	29.15 (6.37)	27.43 (6.53)	0.27

Note: Adjusted means and standard deviations control for age, gender, and mental illness diagnosis (* $p < 0.05$ ** $p < 0.01$).

Figure 1: Mean sadness and amusement ratings (and 95% confidence intervals) over time, disaggregated by history of NSSI.

Figure 1a

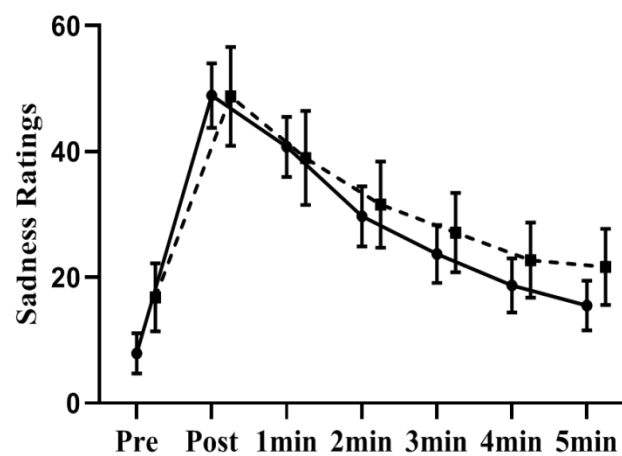
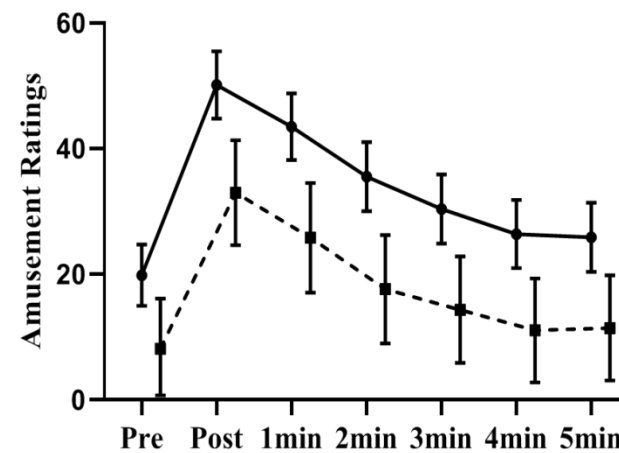


Figure 1b



—●— No history of NSSI
- - ■ - - History of NSSI

Supplementary Materials

Supplementary Table 1. Lifetime frequency of self-injurious behaviours in the sample

	Minimum	Maximum	Mean (SD)	Median
Cutting	0	500	27.22 (71.69)	5.00
Biting	0	20	3.28 (5.38)	0.00
Burning	0	10	1.12	0.00
Skin carving	0	75	3.08 (10.87)	0.00
Pinching	0	50	8.68 (11.81)	5.00
Hair pulling	0	2000	43.51 (274.10)	0.00
Severe scratching	0	2000	44.35 (268.92)	4.00
Self-battery	0	100	13.15 (19.19)	8.50
Wound interference	0	1000	23.43 (139.92)	0.00
Skin rubbing	0	30	2.80 (6.12)	0.00
Needle pricking	0	15	0.84 (2.76)	0.00
Swallowing substances	0	6	0.51 (1.37)	0.00

Supplementary Table 2. Dispositional emotional reactivity, intensity, and perseveration scores disaggregated by no history of NSSI, lifetime history of NSSI, and recent self-injury (past 12 months)

	<i>Unadjusted Means and Standard Errors</i>			<i>Adjusted Means and Standard Errors</i>		
	No history of NSSI	History of NSSI	Recent	No history of NSSI	History of NSSI	Recent
	(<i>n</i> = 138)	(<i>n</i> = 40)	(<i>n</i> = 36)	(<i>n</i> = 138)	(<i>n</i> = 40)	(<i>n</i> = 36)
<i>Negative Emotion</i>						
Negative reactivity	30.00 (0.71)	33.18 (1.32)	34.47 (1.40)	30.83 (0.68)	31.61 (1.26)	33.01 (1.33)
Negative intensity	29.21 (0.65)	31.40 (1.21)	33.11 (1.28)	29.97 (0.64)	30.05 (1.19)	31.71 (1.26)
Negative perseveration	28.10 (0.63)	30.00 (1.17)	32.81 (1.23)	28.76 (0.62)	28.81 (1.16)	31.60 (1.22)
<i>Positive Emotion</i>						
Positive reactivity	34.10 (0.53)	32.90 (0.98)	31.69 (1.04)	34.19 (0.54)	32.71 (1.01)	31.59 (1.06)
Positive intensity	30.85 (0.58)	27.53 (1.08)	28.67 (1.14)	30.88 (0.60)	27.50 (1.11)	28.58 (1.17)
Positive perseveration	29.28 (0.53)	26.95 (0.98)	27.47 (1.03)	29.15 (0.54)	27.21 (1.01)	27.68 (1.06)

For negative emotion, there was a significant multivariate effect of NSSI history [$\lambda(6, 418) = 0.93, p = 0.025$], and univariate tests indicated significant main effects of NSSI history on negative reactivity [$F(2, 213) = 5.25, p = 0.006$], intensity [$F(2, 213) = 4.22, p = 0.016$], and perseveration [$F(2, 213) = 6.036, p = 0.003$]. Pairwise comparisons (Bonferroni adjustment for multiple comparisons) indicated that for all subscales the difference between individuals with no history of self-injury and those who had self-injured within the past 12 months were significant (Mean Differences = 3.90 – 4.70, p 's = 0.002 – 0.021). However, differences between individuals with no history of self-injury and those with a lifetime history of NSSI (Mean Differences = 1.90 – 3.18, p 's = 0.107 – 0.462), and individuals with a lifetime history of NSSI and those who had self-injured within the past 12 months (Mean Differences = 1.30 – 2.81, p 's = 0.300 – 1.00) were not significant.

After adjusting for age, gender, and mental illness, there were no significant multivariate effect of NSSI history [$\lambda(6, 412) = 0.97, p = 0.498$]. There were also no univariate effects of NSSI history on negative reactivity [$F(2, 208) = 1.03, p = 0.361$], intensity [$F(2, 208) = 0.78, p = 0.462$], or perseveration [$F(2, 208) = 2.21, p = 0.112$]. Pairwise comparisons confirmed that there were no differences between any of the NSSI history groups on negative reactivity, intensity, or perseveration. (Mean Differences = 0.05 – 2.84, p 's = 0.134 – 1.00).

For positive emotion, the multivariate effect of NSSI history was not significant before [$\lambda(6, 420) = 0.95, p = 0.088$] or after [$\lambda(6, 412) = 0.95, p = 0.110$] adjustment. However, we were under powered for these analyses (Unadjusted: observed power = 0.69; Adjusted: observed power = 0.66) and follow-up univariate analyses pairwise comparisons are not reported.

Supplementary Table 3. Sadness and amusement ratings over time in the full sample

	Sadness Ratings			Amusement Ratings		
	Mean (95% CI)	Contrast (previous rating)	<i>p</i>	Mean (95% CI)	Contrast (previous rating)	<i>p</i>
Pre	12.38 (9.74 – 15.02)	--	--	13.98 (10.85 – 17.11)	--	--
Post	48.84 (44.67 – 53.01)	36.46	< 0.001	41.55 (37.77 – 45.32)	27.57	< 0.001
1 min	39.87 (2.01 – 35.93)	-8.97	< 0.001	34.64 (30.94 – 38.34)	-6.91	< 0.001
2 min	30.64 (26.84 – 34.45)	-9.23	< 0.001	26.56 (22.92 – 30.21)	-8.07	< 0.001
3 min	25.42 (21.87 – 28.98)	-5.22	< 0.001	22.35 (18.78 – 25.92)	-4.21	< 0.001
4 min	20.73 (17.42 – 24.05)	-4.69	< 0.001	18.73 (15.32 – 22.13)	-3.62	< 0.001
5 min	18.60 (15.34 – 21.87)	-2.13	< 0.001	18.66 (15.17 – 22.14)	-0.07	0.889

Note: Significant *p* values are bolded.

Supplementary Table 4. Sadness ratings over time disaggregated by history of NSSI

	No history of NSSI			History of NSSI			Between groups comparison
	Mean (95% CI)	Contrast (previous rating)	<i>p</i>	Mean (95% CI)	Contrast (previous rating)	<i>p</i>	
Pre	7.94 (4.74 – 11.14)	--	--	16.82 (11.43 – 22.21)			0.014
Post	48.91 (43.76 – 54.05)	40.96	< 0.001	48.77 (40.94 – 56.60)	31.95	< 0.001	0.979
1 min	40.76 (35.98 – 45.54)	-8.15	< 0.001	38.98 (31.50 – 46.46)	-9.79	< 0.001	0.721
2 min	29.72 (24.95 – 34.49)	-11.04	< 0.001	31.57 (24.73 – 38.41)	-7.41	< 0.001	0.686
3 min	23.72 (19.11 – 28.33)	-5.99	< 0.001	27.12 (20.83 – 33.42)	-4.45	< 0.001	0.429
4 min	18.72 (14.45 – 23.00)	-5.00	< 0.001	22.74 (16.78 – 28.70)	-4.38	< 0.001	0.323
5 min	15.54 (11.60 – 19.49)	-3.18	< 0.001	21.66 (15.63 – 27.70)	-1.08	0.173	0.125

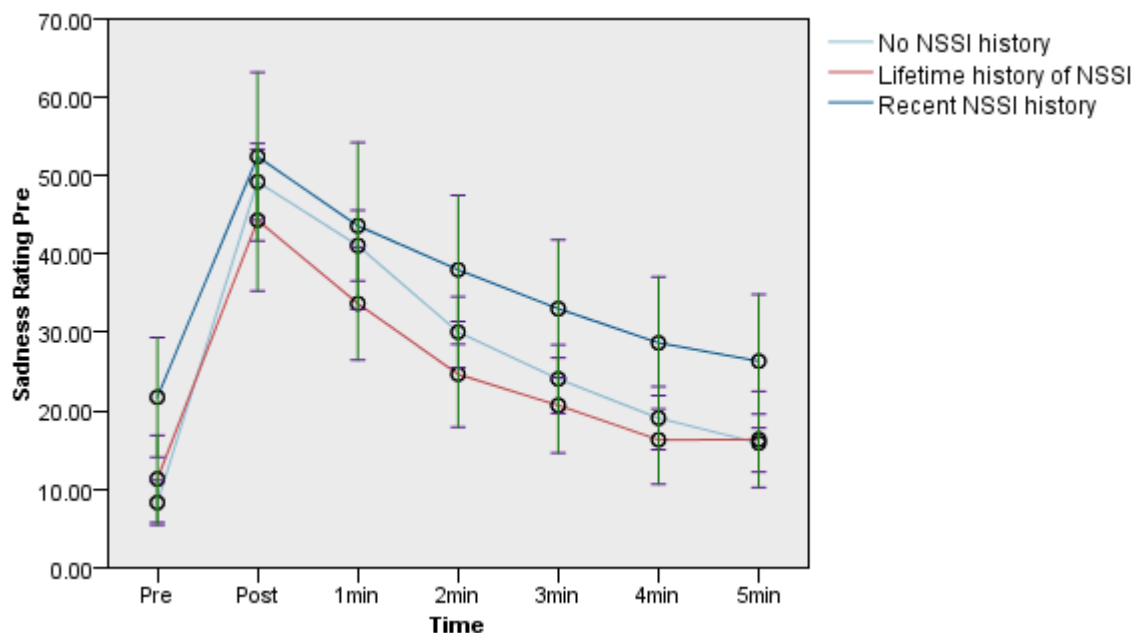
Note: Significant *p* values are bolded

Supplementary Table 5. Amusement ratings over time disaggregated by history of NSSI

	No history of NSSI			History of NSSI			Between groups comparison (<i>p</i>)
	Mean (95% CI)	Contrast with previous rating	<i>p</i>	Mean (95% CI)	Contrast with previous rating	<i>p</i>	
Pre	19.84 (14.97 – 24.72)	--	--	8.11 (0.12 – 16.11)	--	--	< 0.001
Post	50.13 (44.80 – 55.45)	30.28	< 0.001	32.97 (24.60 – 41.34)	24.86	< 0.001	< 0.001
1 min	43.47 (38.16 – 48.77)	-6.66	< 0.001	25.81 (17.08 – 34.53)	-7.16	< 0.001	< 0.001
2 min	35.52 (30.01 – 41.02)	-7.95	< 0.001	17.61 (8.99 – 26.23)	-8.20	< 0.001	< 0.001
3 min	30.37 (24.88 – 35.85)	-5.15	< 0.001	14.34 (5.87 – 22.80)	-3.28	< 0.001	< 0.001
4 min	26.40 (20.96 – 31.83)	-3.97	< 0.001	11.06 (2.77 – 19.34)	-3.23	< 0.001	< 0.001
5 min	25.87 (20.38 – 31.36)	-0.52	0.489	11.44 (3.07 – 19.82)	0.38	0.567	< 0.001

Note: Significant *p* values are bolded

At the request of reviewers we also explored differences between emotional responses to the movie clips among individuals with no history of NSSI, individuals with a lifetime history of NSSI but who had not self-injury within the past 12 months), and individuals who had self-injured within the past 12 months. Although the interaction between NSSI history and time did not reach significance [$F(12, 1477) = 1.53, p = 0.147$], for sadness ratings it appears the association between NSSI and perseveration may be driven by individuals who have self-injured within the past 12 months (Supplementary Figure 1).



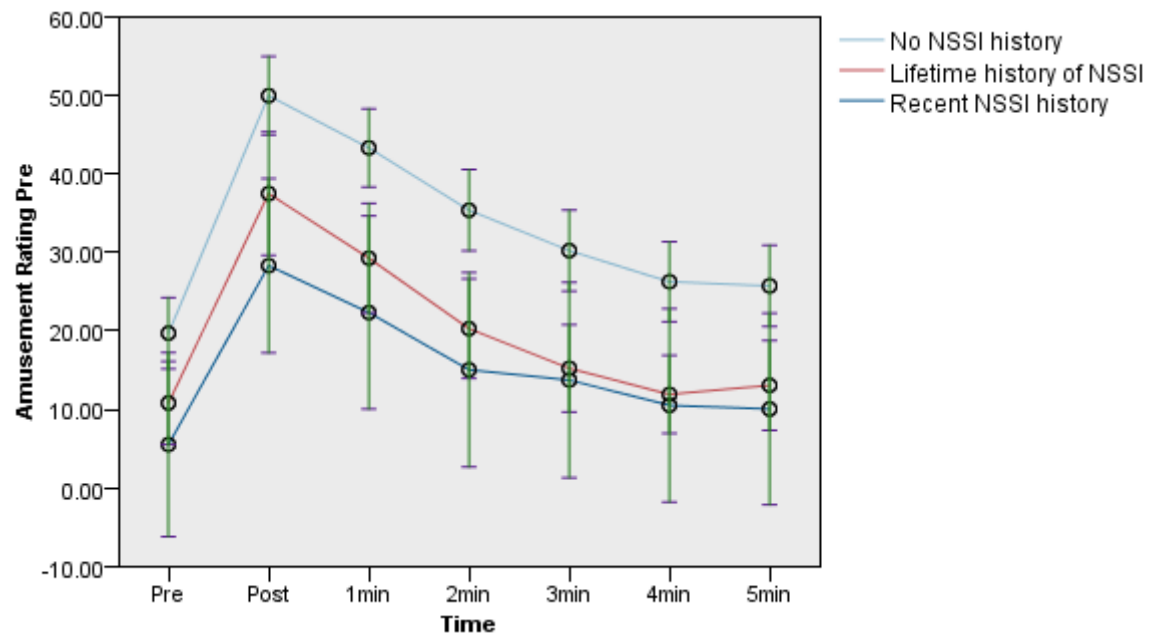
Supplementary Figure 1: Sadness scores over time disaggregated by no NSSI history, lifetime history of NSSI, and recent self-injury

For amusement ratings, the main effect of NSSI history [$F(2, 1477) = 5.30, p = 0.005$] and the NSSI history*time interaction [$F(12, 1477) = 1.95, p = 0.025$] were significant.

Individuals with no history of self-injury reported more amusement overall than individuals

with a lifetime history of NSSI and those who had self-injured within the past 12 months.

Individuals with no history of NSSI also demonstrated a flatter gradient in their responses over the course of the five post-viewing assessments (Supplementary Figure 2).



Supplementary Figure 1: Amusement scores over time disaggregated by no NSSI history, lifetime history of NSSI, and recent self-injury