

Emotional Cascades and Self-Injury: Investigating Instability of Rumination and Negative Emotion

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Objective: Nonsuicidal self-injury (NSSI) is a public health concern and risk factor for suicide. The Emotional Cascade Model (ECM) proposes that NSSI partially functions as a distraction from cascades of negative affect and rumination. The purpose of this study was to examine the roles of trait rumination, and momentary instability of rumination and negative emotion, in NSSI. **Method:** Experience sampling methods were used to monitor thoughts, emotions, and behaviors in 47 individuals reporting dysregulated behaviors including NSSI. Instability indices were generated for rumination and negative emotion using the momentary assessments. **Results:** Twenty-five episodes of NSSI were reported during monitoring. Trait rumination prospectively predicted NSSI episodes, and the instability indices interacted to predict NSSI. **Conclusions:** Consistent with the ECM, the interaction between rumination instability and negative affect instability during monitoring significantly predicted NSSI, with the strongest effects occurring for sadness and rumination about past. These findings may enhance conceptualization and treatment of patients with NSSI. © 2013 Wiley Periodicals, Inc. *J. Clin. Psychol.* 00:1–15, 2013.

Keywords: self-injury; self-harm; emotional cascades; experience sampling

Nonsuicidal self-injury (NSSI), which refers to the purposeful damage of bodily tissue without suicidal intent, is a major public health burden with an incidence of approximately 4% (Klonsky, 2011), although some studies have found that it may be as high as 25% (Jacobsen & Gould, 2007; Nock, 2010). For those who engage in NSSI, the associated outcomes of this behavior may be highly damaging, including elevations in suicidal behavior (Wilkinson, Kelvin, Roberts, Dubicka, & Goodyer, 2011). In fact, NSSI may potentially be a stronger predictor of future suicide attempts than past suicide attempts (Asarnow et al., 2011). Importantly, NSSI has been found to be so prevalent, and associated with so many negative consequences, that there have been calls to create a NSSI disorder in the Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-5) that would be distinct from a diagnosis of borderline personality disorder (Shaffer & Jacobson, 2009; Selby, Bender, Gordon, Nock, & Joiner, 2012). Given the health implications and poor health outcomes of NSSI, further investigation of the pathological mechanisms involved in NSSI is needed to improve current treatments.

One of the most important contributors to NSSI, which is in need of further understanding, is the role of negative emotion. NSSI appears to be paradoxical in that it produces pain and simultaneously reduces emotion intensity. Most animals desire to avoid injury and pain, yet many people who engage in NSSI report that they do so to decrease or escape from negative emotions (Nock & Prinstein, 2004). Similarly, experimental evidence suggests that engaging in NSSI results in decreased negative emotion (Franklin et al., 2010). Various theories have been proposed to explain the seemingly paradoxical effects of NSSI and reconcile how inflicting damage on one's body can quell emotional turmoil (for a review of these theories, see Klonsky, 2007). These theories generally posit a variety of mechanisms for the onset and maintenance of NSSI including pain offset relief (Franklin et al., 2010), opioid regulation (Prossin, Love, Koeppe, Zubieta, & Silk, 2010), and distraction from negative emotion (Selby & Joiner, 2009).

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These various mechanisms are not necessarily mutually exclusive and they may contribute to NSSI behavior in different ways or be highlighted issues for some individuals.

The mechanism of distraction from negative emotion in NSSI may be clarified by a recent theory called the Emotional Cascade Model (ECM; Selby, Anestis, & Joiner, 2008). This model attempts to elucidate the link between negative emotion and dysregulated behaviors (behaviors that are difficult to control and result in subsequent harm to the individual; Selby & Joiner, 2009), including NSSI, by suggesting the occurrence of a process called an “emotional cascade.” In an emotional cascade, individuals who self-injure may experience a positive feedback loop in which the tendency to ruminate on negative emotional thoughts and feelings increases levels of negative emotion. Furthermore, the increase in negative emotion, in turn, increases levels of attention to emotional stimuli, thus resulting in more rumination. This cycle of rumination and negative emotion may cause a flood of racing negative emotional thoughts, which in turn increase levels of negative emotion in a vicious, repetitive cycle, that results in an extremely aversive state. From the perspective of ECM, NSSI then serves as a form of “distraction” that short circuits the emotional cascade process due to shifting focus away from rumination and onto the potent physical sensations associated with NSSI. These sensations may include pain (Hooley, Ho, Slater, & Lockshin, 2010; Gordon et al., 2010), visual cues such as seeing blood (Glenn & Klonsky, 2010), or release of endogenous opioids (Prossin et al., 2010). In this framework, NSSI does not seem so paradoxical—NSSI distracts people from subjectively more painful and aversive emotional cascades.

Although emotional cascades are a relatively new concept, there are various findings that support the existence of these phenomena and link them to NSSI. Empirical evidence suggests a reciprocal relationship between rumination and negative emotion over time (Moberly & Watkins, 2008). Further, rumination has been linked to NSSI in a few different studies (Hoff & Muehlenkamp, 2009; Selby et al., 2009). One recent study found that in a sample of undergraduate students, level of trait rumination not only predicted frequency of self-injury, but it also interacted with the experience of painful and provocative events in life to predict even higher levels of NSSI (Selby, Connell, & Joiner, 2010). The authors posited that this interaction may be because NSSI is a stigmatized and frightening behavior to engage in, and that experience with painful and provocative life experiences may make one more willing to try using NSSI in attempts to decrease rumination and negative emotion.

Yet, despite these findings linking rumination to NSSI, more research is needed to refine the operational definition of what an emotional cascade is, and examine how that might relate to NSSI. One important distinction that is need of further refinement is between emotional cascades and trait rumination. One of the main factors that may distinguish an emotional cascade from rumination is that an emotional cascade is likely characterized by a simultaneous interaction between negative emotion and rumination, such that as each is experienced they are both progressively increased. Based on this definition, emotional cascades may be dynamic and escalate quickly. Trait rumination, on the other hand, may be more stable and remain at a constant level, as opposed to progressively increasing as a function of negative emotion experienced. One way to conceptualize this difference is that emotional cascades are volatile, with potentially fast and intense rumination, as opposed to constant high levels of rumination. Someone with a constant, high level of rumination would not be as volatile, and thus he or she would not score as highly on an index of instability for rumination (Trull et al., 2008). Essentially, rumination in self-injury may be unstable, whereas in other disorders, such as depression, it may be more stable.

Similarly, it is also important to consider how emotional cascades are distinct from other related emotion variables. For example, emotional lability refers to the tendency of an individual to experience negative emotions in a dynamic manner that leads to extreme shifts in mood typically lasting from a few hours to a few days (Trull et al., 2008). No research has been conducted distinguishing emotional cascades from emotional lability, an important issue since they may be highly related and potentially overlapping constructs. However, one distinction between the two is that some people may experience emotional lability without simultaneously experiencing increases in cognitive activity or rumination—experiencing fluctuations in negative emotion alone.

Furthermore, one assumption of the ECM is that an emotional cascade will eventually lead to a dysregulated behavior in most cases because the behavior would distract from rumination and terminate the cascade. Yet there may be some who experience emotional lability in the absence of dysregulated behaviors, thus experiencing a mood longer periods of time. Accordingly, emotional cascades may be distinguished from emotional lability by the simultaneous presence of rumination along with fluctuations in negative emotion, and emotional cascades may be more likely to result in dysregulated behaviors than emotional lability alone. Thus, more work is needed to examine if the interaction between emotional lability, or unstable negative emotion, and unstable rumination predicts dysregulated behaviors, NSSI in particular, beyond emotional lability.

Based on the discussion distinguishing emotional cascades from other factors such as rumination or emotional lability, a clearer operational definition of an emotional cascade may be reached. Thus, an emotional cascade occurs when an individual experiences an upsetting event, and responds to that event with intense and rapid rumination. This rumination results in a progressively increasing, reciprocal cycle of negative emotion and rumination that ultimately creates a highly aversive cognitive-emotional state, elevating motivation to reduce the aversive experience. Accordingly, then, an index of instability of rumination should interact with instability of negative emotion in contributing to NSSI. The ECM would also predict that those who self-injure would self-injure prior to the point of negative emotion becoming chronically elevated (emotional intensity), because they are unlikely to tolerate a progressively increasing experience of negative emotion and rumination.

The previous notions are further supported by findings that those who self-injure desire to escape from negative emotion rather than endure it (Lynam, Miller, Miller, Bornovalova, & Lejuez, 2011; Chapman, Gratz, & Brown, 2006; Arney & Crowther, 2008), have low distress tolerance (Gratz, Rosenthal, Tull, Lejuez, & Gunderson, 2006), and frequently experience emotional instability (Anestis et al., 2009). Given these findings, instability of rumination interacting with instability of negative emotion could be an incremental predictor of NSSI beyond a simple index of average negative emotional intensity. The proposed interaction between unstable rumination and unstable negative emotion is also proposed because rumination may have functional aspects, such as leading to problem solving, so if someone is frequently problem solving throughout the day, he or she may not necessarily engage in NSSI. Furthermore, constant levels of rumination and negative emotion that last over a longer period of time may characterize depression. Thus, an interaction between high instability of negative emotion and high instability of rumination may be characteristic of emotional cascades in individuals who engage in NSSI, more so than chronic elevated levels of rumination or negative emotion.

There are two more factors to consider when examining emotional cascades in NSSI: distinct emotional contributions and content of rumination within the cascade. Regarding the first factor, Nock, Prinstein, and Sterba (2009) conducted an experience sampling study of youth and adolescents who self-injured. They found that the emotions most involved in self-injury were not “overwhelmed” or “anxious,” but rather “sad/worthless,” “anger” (at self and others), and feeling “rejected.” This finding suggests that some emotions may be more relevant to NSSI than others. More research is needed to refine the qualitative nature of emotions contributing to NSSI. Regarding the second factor, it is possible that individuals who self-injure have a variety of concerns when they are ruminating. They could be ruminating on past problematic experiences, current stressors, concerns about the future, and about their emotional states. Alternatively, they may tend to focus on one of those aspects, such as a cascade of worry and anxiety about the future. To our knowledge, distinct emotions and types of rumination in the context of NSSI have not yet been empirically studied.

The goal of the current study was to examine the role of trait rumination, instability of rumination, and instability of negative emotion in daily reports of NSSI during an experience sampling study, based on the theoretical assumptions of the ECM. From the many momentary assessments obtained, we were able to generate indices of instability (versus stability) of rumination and negative emotion, using the adjusted mean successive square difference formula (Jahng, Wood, & Trull, 2008). Such indices capture the amount of fluctuation in rumination and negative emotion that people experience on a daily basis. We expected that baseline trait

rumination (stable) would prospectively predict daily NSSI reported during monitoring, that an instability index of rumination (unstable) generated from multiple momentary assessments would predict NSSI better than baseline trait rumination, and that there would be an interaction between instability of rumination and instability of negative emotion in predicting daily NSSI. Furthermore, we examined instability of specific types of rumination focused on current situations, current emotions, and past problems and concerns about the future, as well as instability of specific negative emotions.

Method

Participants

Participants consisted of undergraduate students ($N = 20$) and individuals from the community ($N = 27$), all of whom engaged in an experience sampling study for which the participants monitored their thoughts, emotions, and behaviors for a period of 2 consecutive weeks. As a part of this assessment, data on NSSI events were also collected. The sample comprised 66% female, 19% African American, 6% Asian American, 2% Native American, and 9% Hispanic; 27% of the sample reported being from low socioeconomic status.

In order to recruit a sample with higher levels of dysregulated behaviors, the student participants were screened as a part of the undergraduate psychology mass screening procedure. In this screening, participants were asked to report the frequency with which they engaged in a variety of dysregulated behaviors in the previous 2 weeks. These behaviors included NSSI, bingeing on alcohol, bingeing on food, fighting, reckless driving, impulsive shopping, and yelling at others. Only those students reporting at least four total dysregulated behaviors (any combination) in the last 2 weeks, including NSSI, were considered eligible. When rating these behaviors, instructions clarified that these behaviors were “difficult to control” with the intention of reducing reports of nondysregulated behaviors (e.g., recreational substance use). Those meeting screening criteria were invited by email to participate in the study, and they were informed that they were eligible for the study because of their report of “unique emotional experiences” on the mass screening questions. Student participants were offered course credit for their participation in the study. In order to enhance compliance with the daily monitoring, students were offered the opportunity to receive additional course credit for completing at least 80% of the random daily assessments; all student participants completed over 80% of recordings.

Community participants were recruited through local and online advertisements and flyers in community mental health centers. Flyers listed symptoms of examples of impulsive behaviors, indicating that anyone who experiences difficulties with any of these problems was eligible to participate in the study. All community participants who came to the lab for participation in the study were also required to report at least four dysregulated behaviors over the last 2 weeks. Community participants were compensated \$50 for completing the study. In order to enhance compliance with the daily monitoring, participants were offered an additional \$50 (total = \$100) if they completed at least 80% of the random daily assessments; all community participants completed over 80% of recordings, indicating the adherence incentive was effective.

Procedure

All participants were first brought in for an initial screening session, during which they were assessed for dysregulated behaviors engaged in over the last 2 weeks and current level of suicidality. Level of suicidality was assessed with the Beck Scale for Suicidal Ideation (see below) and a clinical interview, and any participants indicating elevated levels of suicidality by endorsing suicidal intent or plans were to be provided with mental health referrals, although no participants presented with these concerns. Appropriate procedures were in place if participants indicated imminent suicide risk by endorsing suicidal intent or plans, but no participants in this study met criteria for imminent risk. If participants met criteria for inclusion into the study, they then completed structured diagnostic interviews and were trained on using a Palm Zire 31 personal digital assistant (PDA). Those who did not meet criteria for the study were thanked for their

time and debriefed. All those who participated in the experience sampling portion of the study carried the PDA for 2 practice days, followed by 2 consecutive weeks of actual monitoring. The experience sampling portion of the study was completed through the use of the PDAs. The devices were programmed such that participants completed a brief questionnaire each time the PDA randomly beeped them. Participants were prompted at random five times a day each day, and at each signal they recorded current experience of emotion, thought patterns, and behaviors (see below).

Baseline Assessment Measures

Assessment of Axis I Diagnoses: Mini International Neuropsychiatric Interview (MINI; Sheehan et al., 1998). All participants were assessed with the MINI to diagnose Axis I psychopathology. In the current study, we used a diagnosis of major depressive disorder (MDD; $N = 14$) as a covariate in all analyses, given the high comorbidity of these diagnoses with people with NSSI (Selby, Bender, Gordon, Nock, & Joiner, 2012) and the established link between rumination and depression (Nolen-Hoeksema, 1991). We also used diagnoses of posttraumatic stress disorder (PTSD; $N = 8$) as a covariate in the follow-up analysis because it involved examining rumination on the past. All clinical assessments were completed by master's-level trained clinicians. A second master's-level graduate student in clinical psychology conducted a chart review of all participant diagnostic interviews and established his own Axis I diagnoses for each participant. Interrater reliability indices indicated that all Axis I diagnoses had adequate interrater reliability (above $\kappa = .80$).

Cognitive Emotion Regulation Questionnaire (CERQ; Garnefski et al., 2001). The CERQ is a trait measure of cognitive emotion regulation processes, including rumination, which was used to assess convergent validity for the experience sampling rumination assessment. For analyses, both the rumination and catastrophizing subscales were combined into one index of rumination, consistent with previous studies and supported by strong internal consistency ($\alpha = .89$) in this sample (Selby, Anestis, & Joiner, 2008; Selby, Anestis, Bender, & Joiner, 2009).

Beck Scale for Suicide Ideation (BSS; Beck & Steer, 1993). This is a self-report measure of suicidal ideation and intent over the past week, with higher scores indicating greater suicidality and potential suicide risk. In the current study, the BSS was used as a clinical tool to determine whether an individual was an imminent risk for suicide at baseline but was not used in primary analyses.

Experience Sampling Momentary Assessments

NSSI assessment. During the baseline assessment/training session participants were provided definitions of all dysregulated behaviors that would be assessed during monitoring, and all participants were instructed to record behaviors that were "difficult to control." In the case of self-injury, participants were given the description that self-injury in this case referred to "any instance where you purposely enact physical harm to your body, without any intent to die," which is consistent with accepted definitions of NSSI (Nock, 2010). At each recording, all participants were asked to report whether or not they had engaged in any number of dysregulated behaviors since the last recording, including self-injury. If, at any signal, participants reported having engaged in NSSI, they were then asked follow-up questions regarding the amount of time (in minutes) that passed from the initiation of thoughts of self-injury to the self-injurious act, the form of their self-injury (e.g., cutting, burning, scratching, picking skin), whether they had engaged in the self-injury in order to receive attention from others (yes/no), and whether they experienced physical pain during their self-injury (yes/no).

Rumination assessment. At each signal, participants were asked questions about the content of their thoughts at that moment. Each question was prefaced, "Please rate how much you are currently thinking about the following from 1 (not at all) to 10 (very much so)." The

rumination specific questions were “a currently upsetting problem,” “the emotions that I am feeling,” “upsetting memories,” or “negative future situations.” These questions allowed us to determine if participants were concerned about the present, past, future, or a specific emotional state. These items were derived from preexisting measures for trait rumination including the CERQ (Garnefski et al., 2005) and the Response Styles Questionnaire (RSQ; Nolen-Hoeksema & Morrow, 1991) and modeled after other experience sampling studies that have examined rumination (Moberly & Watkins, 2008). In support of the reliability of this measure, the items demonstrated adequate internal consistency across recordings for all participants ($\alpha = .79$). Correlation analyses also indicated that baseline levels of trait rumination (CERQ) had a significant positive correlation with average level of rumination across the duration of monitoring ($r = .42$, $p < .001$). This moderate correlation between the baseline rumination measure and the momentary measure is consistent with the same level of association found in other studies (Moberly & Watkins, 2008), and would not necessarily be expected to be higher given the inherent flaws in self-report measures, particularly poor memory for frequency and intensity of experiences (Schwarz, 2007), in addition to the differences between trait and state rumination. Thus, the experience sampling measure of rumination used in this study appeared to have preliminary and adequate construct validity.

Emotion assessment. All participants were asked to rate their current emotional state using seven items from the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), including both positive and negative emotion (i.e., anger, fear, ashamed, excited, worried, proud, and sad), and to rate each emotion on a visual-analog scale from 1 (low) to 10 (high). For the current study, only negative emotion variables were used including angry, sad, worried, and ashamed as well as “numb,” even though it is not an emotion rated on the PANAS. The Cronbach’s alpha for the indices of negative emotion across monitoring for all participants was .73, indicating good internal consistency.

Data Analysis

First, baseline data were examined with regard to trait rumination as assessed by the CERQ and frequency of self-injury in the previous two weeks. Next, the frequency and form of NSSI reported during the experience-sampling portion of the study were examined and trait rumination was used to prospectively predict daily frequency of NSSI (i.e., number of self-injury episodes reported during each day of monitoring). These analyses were then explored with instability indices of rumination and negative emotion in predicting daily NSSI, as well as the interaction between the two instability indices, which would be predicted by the ECM. Finally, follow-up analyses examined instability of specific negative emotions (i.e., angry, sad, worried, ashamed, numb) and specific forms of rumination (i.e., current, future, past, and emotion-focused).

The Instability Indices used in the current study were chosen over standard variability indices (e.g., standard deviation) because instability takes into account temporally chained observations and accounts for the magnitude of the variable at each subsequent recording (Ebner-Priemer et al., 2009), and these indices are particularly helpful when variables are highly correlated from one signal to the next. To calculate the instability indices we used the Adjusted Successive Difference (ASD) correction to the Mean Squared Successive Difference (MSSD) equation, which is displayed below:

$$MSSD(X) = \frac{\sum_{i=2}^n (x_i - x_{i-1})^2}{n - 2}$$

This equation takes into account both the amplitude and frequency of the variable (x), which in these analyses will be levels of anger, sadness, anxiety, and rumination, where x in this equation will pertain to either the interpersonal problems or dysregulated behaviors variable, the i will pertain to each individual, and the n will pertain to the number of observations. The

ASD correction to the MSSD Emotional instability index, on the other hand, was calculated using the ASD, which takes into account the frequency and intensity of individual changes in the variable from one recording to the next while simultaneously taking into account the time interval difference between random signals (Jahng, Wood, & Trull, 2008). The ASD index is particularly used for measuring short-term, within-day successive change. The ASD equation is displayed below:

$$ASD_{i+1} = \frac{x_{i+1} - x_i}{[(t_{i+1} - t_i)/Mdn(t_{i+1} - t_i)]^\lambda}$$

In the ASD equation, momentary changes in the variable (x) are a function of the difference in x from one occasion (i) to the next, divided by the quotient of the difference in time interval (t) from one signal to the next, divided by the median (Mdn) of the time interval for all observations. Dividing the time interval by its median results in a rescaled median of 1. The median rescaling of time is then raised to the λ power, and λ refers to the serial autocorrelation between changes in x and time interval length, and it can range from 1 for high serial correlations, to zero indicating no serial correlation, to -1 for an inverse serial correlation. The current sample, the autocorrelation index (and thus λ) for rumination was .46 and negative emotion was .12, indicating adjustment was needed for positive serial correlation for both variables. The outcome of the ASD index was then used to adjust the mean successive squared difference equation (MSSD; von Neumann, Kent, Bellinson, & Hart, 1941) by replacing $(x_i - \bar{x})$ with ASD_{i-1} .

To examine daily number of NSSI events, we used generalized hierarchical linear modeling (GHLM), which is an extension of standard hierarchical linear modeling except that it is used when the distribution of the outcome variable is non-normal, and in this case the outcome (number of self-injury episodes) was a count variable. The hierarchical component in the data analyses was important because it can account for nested data (i.e., multiple data points for each person). The GHLM analyses comprised two levels: within-individual observations for each day (Level 1) and between each individual (Level 2). For these analyses the response distribution for engaging in a dysregulated behavior at any given signal was Poisson, which refers to a count outcome for an individual case ($N = 1$), and a log link function was used. These analyses included a random subject intercept, while the remaining effects were fixed.

All of our independent variables were Level 3 (between subjects) predictors and included: trait rumination, instability of rumination, and instability of negative emotion. Furthermore, all covariates in the analyses (sex, MDD, PTSD) were Level 3 predictors. These covariates were included after primary analyses to further examine the strength of the relationships between our hypothesized constructs and known demographic characteristics affiliated with either NSSI (Weierich & Nock, 2008) or rumination (Nolen-Hoeksema, Larson, & Grayson, 1999). No Level 1 predictors were used in the subsequent analyses. All analyses were either conducted with either SPSS or MPlus version 5.3 (Muthén & Muthén, 2004). The model components were tested for significance at $\alpha = .05$. For the follow-up analyses exploring type of rumination and type of emotion in predicting NSSI, we did not control for multiple comparisons because of the lack of research on these specific factors and the exploratory nature of these analyses.

Results

Preliminary Analyses

At baseline, seven of the participants (15%) reported engaging in self-injury during the 2 weeks prior to the start of the study, with an average number of 1.86 episodes reported in the past 2 weeks. Analysis of the demographic variables listed in Table 1 indicated that the significant group differences between those who self-injured during monitoring and the remainder of the sample were higher rates of MDD, $\chi^2(df = 1) = 16.21, p < .001$, PTSD, $\chi^2(df = 1) = 5.3, p < .05$, older age, $F(46, 1) = 9.95, p = .003$, and higher rates of suicidality according to the BSS, $F(46, 1) = 5.64, p = .022$. There were no significant group differences on sex or baseline trait rumination. However, using a Poisson regression to account for the count distribution of

Table 1
Group Characteristics

Variable	NSSI Group (N = 7)	Dysregulated non-NSSI Group (N = 40)	
	N (%)	N (%)	χ^2 (df = 1)
Female	4 (57.1)	27 (67.5)	–
Trauma Hx	4 (57.1)	27 (67.5)	–
PTSD	3 (42.9)	5 (12.5)	5.30, $p = .021$
MDD	6 (85.7)	8 (20.0)	16.21, $p < .001$
	Mean (SD)	Mean (SD)	$F(df)$
Age	35.00 (15.87)	22.68 (7.64)	9.95 (46, 1), $p = .003$
BSS	7.83 (10.17)	2.20 (4.5)	5.64 (46, 1), $p = .022$
Baseline rumination	26.22 (7.17)	21.66 (7.47)	–

Note. NSSI = nonsuicidal self-injury; Trauma Hx = Trauma history; PTSD = post-traumatic stress disorder; MDD = major depressive disorder; SD = standard deviation; df = degree of freedom; BSS = Beck Suicide Scale

Table 2
Means and Standard Deviations for and Intercorrelations Between Key Variables

	1	2	3	4	5	6	7	8	9
1. Total NSSI	–								
2. Rumination _{Baseline}	.27*	–							
3. Rumination _{MSSD}	.28*	.42**	–						
4. NE _{MSSD}	.26*	.44**	.76**	–					
5. BSS	.20*	.39**	.25*	.28*	–				
6. MDD	.31**	.49**	.27*	.29*	.52**	–			
7. PTSD	.09	.29*	.15	.08	.38**	.70**	–		
8. Age	.04	.18	.51**	.39**	.36**	.46**	.45**	–	
9. Female	.14	.45**	.11	.19	.20	.72**	.21	–.07	–
Mean	.32	22.28	73.41	5.84	2.91	.30 [^]	.17 [^]	24.30	.66 [^]
SD	1.62	7.54	43.67	3.57	5.70	–	–	9.77	–

Note. NSSI = nonsuicidal self-injury; NE = negative emotion; MSSD = mean squared successive difference score; BSS = Beck Suicide Scale score; MDD = presence of major depressive disorder; PTSD = presence of posttraumatic stress disorder; SD = standard deviation.

N = 47. [^]Indicates percentage classified as yes.

* $p < .05$. ** $p < 0.01$.

NSSI, trait rumination as measured by the CERQ significantly predicted number of self-injury episodes reported over the previous 2 weeks at baseline, $B = .09$, standard error (SE) = .03, $p < .01$, even after controlling for MDD. Correlations from the primary measures used in this study can be found in Table 2.

Experience Sampling Data on Self-Injury

Participants completed a total of 3,118 random assessments on their PDAs during monitoring, with a mean of 67 signals per participant, standard deviation (SD) = 9.38; range = 58 to 86. Compliance indices indicated high rates of average compliance for both students and community participants (over 90%). A total of 25 episodes of NSSI were reported during the study. Similar to the baseline assessment, seven people (15%) reported at least one instance of NSSI during monitoring, with average 3.57 episodes ($SD = 1.98$) reported during monitoring among those participants. These seven individuals were the same individuals who reported baseline self-injury.

Regarding the type of self-injuries reported, 13 reported picking at their skin, six reported scratching their skin, six reported cutting, and three reported hitting themselves on purpose. Among those episodes, participants rated 17 of the episodes as occurring after less than 1 minute of thinking about self-injuring, five were reported as thinking for between 1 and 5 minutes before self-injuring, and for three episodes the participants reported thinking about self-injuring for between 10 and 30 minutes. During 20 of the episodes (80%), participants reported feeling pain. Finally, for all 25 episodes participants indicated that the self-injury was not intended to seek attention from others.

Prospective Relationship Between Trait Rumination and Self-Injury

Using the rumination subscale of the CERQ, we examined if trait rumination predicted number of daily NSSI episodes reported during monitoring. As hypothesized, baseline rumination prospectively predicted daily number of NSSI episodes ($\gamma = .10$, $SE = .03$, $p < .01$). To further test the strength of this relationship, covariates including sex and current depression were included. Again, rumination prospectively predicted number of daily self-injury episodes ($\gamma = .80$, $SE = .40$, $p < .05$). Neither sex ($\gamma = -.35$, $SE = 1.17$, $p = .76$) nor depression ($\gamma = .20$, $SE = .63$, $p = .75$) were significant, which suggests that this finding was not simply an artifact of sex or depression.

Instability of Rumination and Daily Self-Injury

Using linear regression, trait rumination significantly predicted overall instability of rumination as measured by daily monitoring ($B = .29$, $SE = .16$, $p < .001$). Building on this finding, we then examined the relationship between instability of rumination and number of daily NSSI episodes with GHLM. As expected, we found a significant relationship between instability of rumination and daily number of self-injuries ($\gamma = .02$, $SE = .007$, $p = .01$). This finding maintained significance even after controlling for sex ($\gamma = -1.89$, $SE = .86$, $p < .05$) and current MDD ($\gamma = -.42$, $SE = .54$, $p = .44$). Notably, when included in the prediction of daily NSSI events along with instability of rumination, trait rumination was no longer a significant predictor ($\gamma = .04$, $SE = .05$, $p = .41$).

Interaction Between Instability of Rumination and Negative Emotion

When instability of rumination and instability of negative emotion were included in a GHLM model, both were significant predictors of more NSSI events occurring daily (negative emotion instability $\gamma = .91$, $SE = .21$, $p < .001$; rumination instability $\gamma = .05$, $SE = .02$, $p < .05$). Furthermore, there was also a significant relationship between instability of negative emotion and instability of rumination ($\gamma = -.007$, $SE = .002$, $p < .001$)¹. This interaction was graphed with two standard deviations above and below the mean for each variable (see Figure 1). Contrary to expectations, although high instability of rumination at high instability of negative emotion was predictive of NSSI, instability of rumination at stable levels of negative emotion was also predictive. Stable rumination with stable negative emotion was not predictive of daily NSSI. This finding suggested that further examination of the experience of discrete emotions and rumination was warranted.

¹Because those in the NSSI group reported elevated scores on the BSS, we reexamined the analyses of the study including the BSS total score for each participant as a covariate. Importantly, none of the significant major findings of the paper were changed, although the magnitude of the of the interaction between instability of negative emotion and instability of rumination on NSSI episodes decreased (from $\gamma = -.007$, $SE = .002$, $p < .001$ down to $\gamma = -.006$, $SE = .002$, $p < .01$), due to a significant association between number of NSSI episodes and BSS score ($r = .20$, $p < .05$), as would be expected.

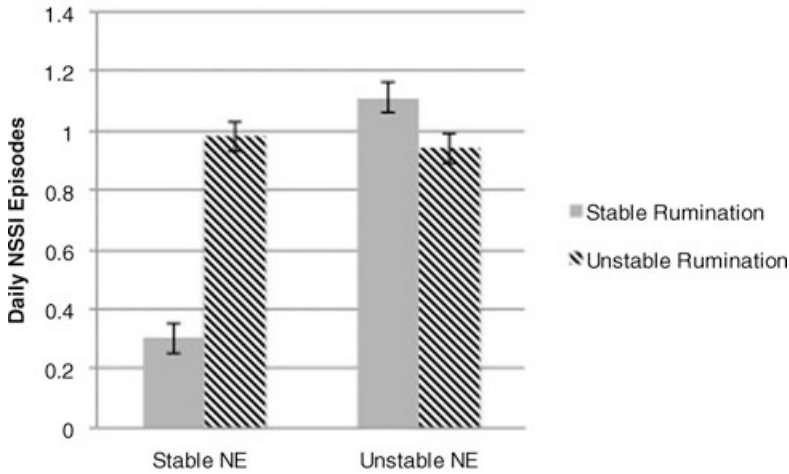


Figure 1. Interaction between Instability of Rumination and Instability of Negative Emotion. High and low levels of the MSSD indices refer to two standard deviations above and below the mean, respectively.

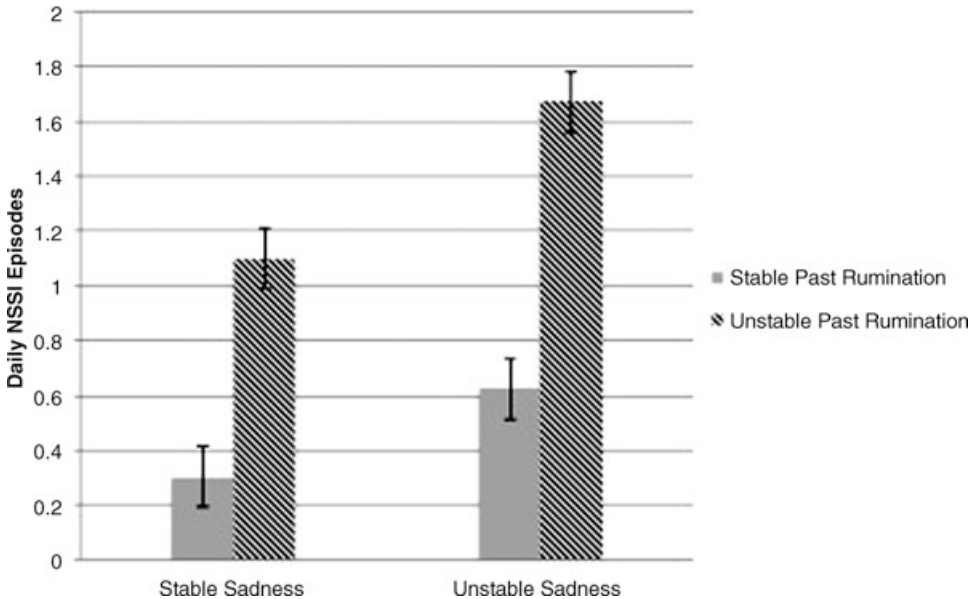


Figure 2. Interaction between Instability of Rumination on the Past and Sadness. High and low levels of the MSSD indices refer to two standard deviations above and below the mean, respectively.

Types of Rumination and Negative Emotion and Self-Injury

First, we examined a GHLM model with instability indices of the four types of rumination included simultaneously. Daily NSSI episodes were positively predicted by instability of rumination on the past ($\gamma = .39, SE = 1.29, p < .001$), but they were inversely predicted by rumination on the future ($\gamma = -.30, SE = .14, p = .033$) and by rumination on emotional states ($\gamma = -.24, SE = .10, p = .018$). Rumination on current situations was not predictive. Regarding instability of negative emotion, the only significant predictor was instability of sadness ($\gamma = 1.86, SE = .60, p = .002$). Finally, we examined if there was an interaction between instability of rumination on the past and instability of sadness, and the interaction was significant and in the expected direction of our original hypotheses ($\gamma = .32, SE = .11, p < .01$; see Figure 2). The results of this analysis held even when controlling for sex ($\gamma = -.53, SE = .82, p = .52$) and MDD ($\gamma = -.27,$

$SE = .61, p = .69$)². We also ran the analysis controlling for PTSD diagnoses, as rumination on the past may have been primarily about past traumatic events. Results indicated that the interaction remained significant, but PTSD was not a significant predictor ($\gamma = .502, SE = 1.09, p = .65$).

Discussion

Distraction from an aversive state is a promising potential partial explanation for how NSSI reduces negative emotion. According to the ECM (Selby et al., 2008), cascades of rumination and negative emotion produce an aversive state and NSSI serves to distract from these cascades, thereby reducing negative emotion. Given the novelty of this model, there have been few empirical tests examining the various components of it. The present study addressed one critical gap by employing experience-sampling methods to investigate the roles of trait rumination, instability of rumination, and instability of negative emotion in promoting daily reports of NSSI. Consistent with the ECM, rumination instability, negative emotional instability, and the interaction between them, each significantly predicted daily NSSI reports. Moreover, results specified that sadness accounted for the negative emotional effects and rumination on past events accounted for rumination effects. This supports the notion that emotional cascades may contribute to NSSI, although other critical components of the ECM, including the distraction effects of NSSI, were not tested in this study.

The findings from this study provide further support for the link between NSSI and rumination. However, unlike previous studies that focused solely on trait rumination (Hoff & Muehlenkamp, 2009; Selby et al., 2009; Selby et al., 2010), the current study examined and found important differences between, trait rumination and instability of rumination. As expected, trait rumination assessed at baseline was predictive of NSSI, even when controlling for gender and depression. However, the nature of the link between rumination and NSSI was best explained by instability of rumination. When instability of rumination was taken into account, trait rumination was no longer a significant predictor of NSSI. This finding is consistent with the ECM and supported our hypothesis that rumination associated with NSSI may be unstable, and that it may be distinct from stable rumination potentially associated with depression. It also suggests that future research needs to account for instability of rumination, rather than relying solely on measures of trait rumination.

The ECM posits that both the instability of rumination and the instability of negative emotion are important factors that result in NSSI. The present study supports the notion that fluctuating negative emotions are relevant to NSSI. This focus on *fluctuating* negative emotions, as opposed to just the stable presence of negative emotions, may be particularly important. Past experiential research with individuals with borderline personality disorder found that the nature of their emotional instability was characterized by large and rapid changes from positive to negative emotion (Ebner-Primer et al., 2007). Given that individuals with BPD have high rates of NSSI, these rapid changes may be crucial to understanding the relationship between negative emotion and NSSI. This current study expands upon this finding to suggest that unstable emotion, specifically rapid fluctuations in negative emotion, may have important clinical significance with NSSI behavior.

The current study was novel in its exploration of the interaction between stability of rumination and stability of negative emotion in predicting NSSI. ECM posits that NSSI is a result of a

²Although we used a dichotomous diagnosis of major depression as a covariate, it was possible that level of depression could be involved in the findings, given the relation between depression to rumination (Nolen-Hoeksema, 1991). In order to address this issue we generated a continuous measure of depression by summing the depression symptoms endorsed on the MINI. There was a significant correlation between this continuous measure of depression and NSSI ($r = .36, p < .01$), indicating that controlling for a continuous measure of depression was justified. When integrated into the analyses presented in the current study, the continuous measure of depression was a significant predictor of daily NSSI episodes ($\gamma = .03, SE = .01, p < .001$); however, when reexamined the primary findings of the study remained significant and the magnitudes of the main effects and interactions predicting NSSI remained essentially the same.

positive feedback loop of unstable rumination and negative emotion. Using frequent assessment points via the use of experience sampling, we could track the relationship between frequent shifts in rumination levels and changes in the experience of negative emotions to determine if there is support for this theory. The interaction between unstable rumination and unstable negative emotion was found to be predictive of NSSI. However, when the interaction was visually displayed (see Figure 1), an unexpected relationship was found. We had hypothesized that high rumination instability and high negative emotion instability would be predictive of NSSI. However, the data suggested that high rumination instability interacted with negative emotion, whether the negative emotion was stable or unstable, to predict daily NSSI.

Furthermore, stable rumination interacted with instability of negative emotion to predict daily NSSI. These findings suggest that examining instability of rumination and negative emotion in NSSI may increase our understanding of the emotional context surrounding NSSI, and that high stable indices of both together may not be that predictive of NSSI, but additional work is needed to clarify the relations between stable and unstable rumination, NSSI, and emotional cascades.

Previous studies have shown distinct emotional states and content of rumination may be relevant to consider when examining rumination preceding NSSI (Nock et al., 2009). We found that the interaction between unstable past rumination and sadness are particularly likely to produce NSSI. We also found that worry about the future was inversely related to NSSI. This study, however, was inconsistent with previous findings linking both sadness and anxiety to elevated NSSI (Klonsky, 2009), and another study that found no relationship for anxiety and sadness to be an inverse predictor of self-injury (Nock et al., 2009), suggesting further work on this area is needed. Based on this study, NSSI appears to be most related to sadness about past events and not related to worry about the future. Together, these findings have clinical utility: They can help clinicians to determine which clients may be at an increased risk for self-injury. If future research confirms that the experience of sadness is a critical precursor to self-injury, then clinicians can focus helping clients manage their sadness more effectively and/or engage in more adaptive behaviors that might reduce the frequency of sadness. In so doing, the emotional cascade can be blocked from reaching a level in which only NSSI will serve as a sufficient distraction.

Another important finding with the current study was that, contrary to the hypotheses, the interaction between the total rumination scale and the total negative emotion scale was actually an inverse predictor of NSSI frequency. When specific types of rumination and specific emotions were analyzed, the overall inverse relationship appeared to be controlled by rumination about the future and about emotion. These findings are of interest because they may highlight important differences in the focus of rumination as related to self-injury: Rumination on the past along with sadness may facilitate NSSI, while thinking about the future or contemplating emotions may actually protect from NSSI to some extent.

One possible explanation for this relationship is that thinking about the future or one's emotions may decrease the propensity toward self-injury, but on the other hand may increase other behaviors (i.e., problem solving, speaking with a friend, avoidance behaviors). These behaviors may or may not necessarily be desirable, but may be worth exploration in clinical settings as to why different emotional/cognitive states may lead to different behaviors. Furthermore, the finding that rumination on emotional states was inversely associated with NSSI may indicate that rumination involving emotional states may be inversely associated with experiential avoidance due to an enhanced ability to remain in contact with aversive emotional states, and thus rumination in such a manner may be more akin to mindful attention. However, the rumination construct is currently very broad, and more work is needed to identify adaptive and maladaptive forms of rumination and distinguish them from mindful attention; such research would further clarify the forms of rumination that may contribute to emotional cascades in NSSI.

In addition to the data viewed in light of the ECM, there are also some important alternative/complimentary theoretical perspectives to the current study. Although some findings support the ECM, other findings were less consistent, such as the finding in the main interaction that unstable rumination predicted NSSI even in the context of stable negative emotion. One possible explanation for this finding is that the findings on experiential avoidance (Chapman

et al., 2006; Lynam et al., 2011) and low distress tolerance (Gratz et al., 2006) in those who self-injure are relevant to even moderate levels of negative emotion in those who self-injure. In these views, intense/elevated negative emotion is not necessarily a motivation for self-injury, but rather the experience of negative emotion in general. In these models the negative emotion in NSSI could be similar to that felt by any healthy person, but as soon as self-injurers experience any negative emotion, they may self-injure to escape that experience, without the presence of an emotional cascade.

Another potential reason for the finding of stable elevated negative emotion predicting self-injury is that if a baseline set point of negative emotion is elevated, then one might be more vulnerable to the experience of emotional cascades. This elevated set point could be the result of smaller negative events that occurred earlier in the day, or because of things such as poor sleep or not feeling well, all of which might increase vulnerability to emotional cascades. Along these same lines, in the case of stable negative emotion with unstable rumination, some self-injurers may engage in NSSI to escape from upsetting thoughts or to “get out of their head,” as opposed to distracting from an emotional cascade *per se*.

Finally, physical factors such as diminished pain perception may reduce fear/experience of pain in self-injury (Franklin et al., 2012; Hooley et al., 2010; Selby et al., 2010), meaning that even in the context of similar acute emotional experiences as healthy controls, those who self-injure may have had an important protective barrier to NSSI behavior eroded, making NSSI a more viable option. Given the complexity of NSSI behavior, it is likely that multiple aspects of psychological and biological functioning are simultaneously involved in the behavior, and future research should synthesize multiple contributing factors in NSSI.

Furthermore, given the finding that unstable rumination predicted NSSI even in the context of stable negative emotion, and because an inverse association was found for instability of rumination about the future and NSSI, the current findings only provide partial support for the ECM in NSSI, particularly with unstable rumination about the past and unstable sadness. Additional work is needed to determine to what extent emotional cascades may play a role in NSSI, and if other forms of emotional cascades may be involved.

This study has limitations that should be addressed in future research. The sample size and number of self-injuries was relatively small, many of the instances of self-injury were somewhat minor, and self-cutting was reported by only a minority of the sample. Further research with significantly larger samples and with a greater range of severity of self-injury is necessary. Although the absolute numbers in the current study are small, it is important to note that the use of experiential sampling allowed for over 3,000 momentary assessments to be analyzed. In addition, this study supports the notion of an emotional cascade as being relevant to NSSI, as specified in the ECM. However, more research is needed on the other key component of the ECM, (i.e., that self-injury specifically serves to distract from this emotional cascade). Studying more diverse samples and clinical samples is also necessary to replicate the findings from the current study.

Another limitation with the current study is that it is difficult to determine how the “impulsive” or “dysregulated” behaviors assessed were, as such behaviors were subjectively reported. Additionally, because suicidal ideation was not assessed during the experience sampling assessments, there is no guarantee that self-injuries reported in this study occurred without the presence of suicidal ideation. Last, although the use of experience sampling allows for a more fine-tuned assessment of experiences related to self-injury, it is possible that there are other controlling variables that influence the likelihood of self-injury that were not measured in the current study.

Over the last decade there have been tremendous advances in the understanding of why people engage in NSSI. In particular, research has converged on the finding that one of the primary reasons people engage in NSSI is to reduce negative emotion. Unfortunately, other vital questions have received little empirical attention: What types of internal experiences tend to generate NSSI, and how does self-inflicting injury reduce negative emotion? The present investigation addressed these gaps in knowledge by specifying that cascading sadness and rumination on past events are particularly likely to promote NSSI. This is consistent with the predictions of the ECM, although further research is needed to support the hypothesis that distraction may partially

explain how NSSI reduces negative emotion. Although the sample of NSSI events in the present study was small, these promising preliminary findings suggest that this is a fertile line of research that warrants further examination in larger studies.

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