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BRIEF REPORT

The Emotion Regulation Function of Nonsuicidal Self-Injury: A Momentary Assessment Study in Inpatients With Borderline Personality Disorder Features

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Studies using retrospective self-report or proxies of nonsuicidal self-injury (NSSI) in the lab have shown that NSSI is often preceded by intense negative emotions and followed by a decrease in negative emotions/tension, suggesting an emotion regulation function of NSSI. To investigate this emotion regulation function of NSSI in a more ecologically valid way, we used experience sampling methods to examine the temporal relationship between NSSI behavior and emotional experiences throughout the day in 30 inpatients currently staying in psychiatric hospitals. Because NSSI is especially prevalent and severe in patients with a borderline personality disorder (BPD), we focused on patients with high levels of BPD symptomatology. Results confirmed that high levels of negative emotion prospectively predicted a higher probability of engaging in NSSI in the next time interval. However, the occurrence of NSSI itself was related to concurrent increases in negative emotion and decreases in positive emotion, and even prospectively predicted an increase in negative emotion in the consecutive time interval. These preliminary results show that on a time scale of hours, instead of resulting in emotional relief, NSSI seems to be associated with a further increase in negative emotionality, shedding light on the cyclic nature of NSSI.

General Scientific Summary

Nonsuicidal self-injury (NSSI) is often considered as serving an emotion regulation function, leading to the decrease of negative feelings. Here, we show that while NSSI is indeed preceded by elevated levels of negative emotionality, it is in fact followed by an increase, not a decrease, of negative emotion within the timespan of hours in inpatients with borderline personality disorder features, shedding light on the cyclic nature of NSSI.

Keywords: nonsuicidal self-injury, emotion regulation, experience sampling, borderline personality disorder features

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Nonsuicidal self-injury (NSSI) refers to the deliberate and direct injury of one's own body tissue without suicidal intent (Claes & Vandereycken, 2007), such as self-cutting, head banging, burning, and so forth. While NSSI has been linked to a wide range of psychopathology (Nock, Joiner, Gordon, Lloyd-Richardson, & Prinstein, 2006), it is particularly prevalent in patients with a borderline personality disorder (BPD) and BPD symptoms (e.g., Snir, Rafaeli, Gadassi, Berenson, & Downey, 2015). Moreover, studies have shown that the presence or absence of BPD symptomatology should be taken into account when examining NSSI, as NSSI is more severe (in terms of frequency, severity, and versatility in methods) in patients with compared to without BPD symptoms (Turner et al., 2015). Also within patients with BPD, the occurrence of NSSI is associated with more severe outcomes, as indicated by higher utilization of psychiatric treatments, increased likelihood of comorbid diagnoses such as a major depressive disorder, bulimia nervosa, and suicide ideation and attempts (Dulit, Fyer, Leon, Brodsky, & Frances, 1994). Therefore, it is very important to understand the mechanisms underlying this behavior in patients with BPD symptomatology.

Functions of NSSI in BPD

Theoretical accounts stipulate that NSSI serves several functions (Nock & Prinstein, 2004), such as regulating one's emotional or cognitive experiences and communicating with or influencing others, with desired outcomes reinforcing the NSSI behavior. While patients themselves typically report multiple functions of NSSI, such as tension relief, reduction of unpleasant feelings, or self-punishment, emotional relief or tension relief is by far the most frequently reported function (Kleindienst et al., 2008), underscoring the importance of the emotion regulation function of NSSI (for a literature review on functions of NSSI, see Klonsky, 2007).

The Emotion Regulation Function of NSSI

According to the functional approach to NSSI (Nock & Prinstein, 2004), NSSI is determined by its immediate antecedents and consequences. Concerning the emotion regulation function of NSSI, this means that NSSI is typically preceded by high levels of negative emotions (and low levels of positive emotions), and is subsequently followed by a decrease in negative emotions (and a possible increase in positive emotions). This notion is supported by studies in which patients were asked to retrospectively rate how they generally feel before and after NSSI behavior using questionnaires (e.g., Kleindienst et al., 2008), and by studies that used proxies of NSSI in the lab, such as the performance of a painful task (e.g., Russ et al., 1992). However, important limitations restrict the conclusions of these studies. First, these studies rely on retrospective ratings that are known to be subjected to memory biases and demand effects. Second, the use of proxies of NSSI in the lab and the fact that NSSI is instructed instead of naturally occurring may limit the external validity of these findings.

One way to overcome these limitations is afforded by experience-sampling methods (ESM), through which people report NSSI behavior and emotional experiences as they occur throughout the day (Myin-Germeys et al., 2009). The resulting data allow researchers to investigate the occurrence of actual NSSI behavior and its preceding and following emotional states in real time throughout several consecutive days, providing a real-time and more ecologically valid window on the emotion regulation function of NSSI.

Experience Sampling Studies on Emotion Regulation Function of NSSI

So far, few studies have investigated the relation between emotions and NSSI in such an ecologically valid way. An ESM study by Snir et al. (2015) examined different functions of NSSI in persons with BPD and avoidant personality disorder. As part of this study, they investigated time trends in repeatedly reported negative affect in a 20-hr time interval surrounding NSSI acts and NSSI urges in daily life, and found an increase in average negative affect before the NSSI urge (but not act) for BPD patients, that continued to increase after the reported NSSI urge, fading in a complex mix of different types of emotional changes. However, no systematic patterns of negative affect were found for time periods surrounding actual NSSI acts in both groups. A study by Armey, Crowther, and Miller (2011) used ESM to examine NSSI in college students, and found a quadratic change of negative affect and guilt specifically during a time period surrounding an NSSI act, meaning they reported an increase before, and a decrease in average negative affect and guilt after the NSSI (but no change in hostility or positive affect). Finally, in a study by Muehlenkamp et al. (2009), changes in positive affect and negative affect were examined before and after NSSI acts in patients with bulimia nervosa. Increases in negative affect and decreases in positive affect were found before NSSI acts. After the NSSI acts, only an increase in positive affect was found, partially supporting the emotion regulation hypothesis. In summary, previous studies provide some insight into the link between emotions and NSSI using real-time assessments throughout the day, but the results are mixed.

Current Study

The goal of the current study was to obtain more insight into the reciprocal relationship between NSSI and emotional states over time throughout the day, in order to evaluate the hypothesized emotion regulation function of NSSI. First, we focused on inpatients with high levels of BPD symptomatology who were currently staying in psychiatric hospitals, as NSSI is very prevalent and severe in this population. Second, we examined this relationship on a smaller time scale than previous studies. We collected more assessments per day, resulting in smaller time intervals between consecutive ratings. Third, instead of focusing on overall time trends in affect surrounding NSSI acts, we used a modeling approach that was intended to directly test the two conditions presupposed by the emotion regulation function of NSSI: (1) a predictive effect of emotional intensity on subsequent NSSI occurrence, and (2) a predictive effect of NSSI on emotional change following NSSI. Additionally, we also examined the prolonged effect of NSSI on emotional change one time interval later to examine how NSSI affects emotions at a later point in time. To this end, we analyzed data that have partly been reported elsewhere, albeit not the data on NSSI (Houben et al., 2016).

Based on the emotion regulation function account of NSSI, we expected that (a) high levels of negative emotion (and possibly low

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levels of positive emotion) will predict a higher probability to engage in NSSI. In turn, we expected that (b) the occurrence of NSSI will predict subsequent emotional relief, as reflected by a decrease in subsequent negative emotion (and possibly an increase in positive emotion), acting as a reinforcement. No hypotheses were formulated about the prolonged effect of NSSI on emotions. The current study has a limited sample size and should therefore be considered as providing preliminary evidence. However, it provides the first and direct empirical test of the emotional antecedents and consequences of NSSI acts, as well as of a prolonged effect of NSSI on emotional states, as they occur throughout the day in inpatients with BPD features.

Method

Participants

Participants were 34 inpatients, who were currently residing in psychiatric hospitals and receiving treatment in BPD specialized units (74% were recruited at the University Psychiatric Center, KU Leuven—Campus Kortenberg, Belgium, and 26% at the psychiatric hospital in Duffel, Belgium). Four participants were excluded based on poor compliance with the experience sampling protocol (<25% compliance in terms of responded beeps), resulting in a final sample of 30 participants. Note that inpatient treatment is typically organized by pathology in Belgium. As such, patients with BPD-related symptomatology are typically treated in specialized BPD units. Patients are admitted to these units, after being referred by mental health practitioners, and after the psychiatrist in charge of the unit conducted an intake, in which the presence of BPD symptomatology and the absence of acute problems that require different treatment approaches are assessed.

The mean age of the sample was 29.03 years (SE = 1.60), and the majority (87%) were female. Most participants were currently taking psychotropic medication (93%), with antidepressants being taken by most patients (73%), followed by atypical antipsychotics (50%), and typical antipsychotics (37%) and benzodiazepine (37%).

Procedure

After providing informed consent, participants first completed a batch of self-report questionnaires, and next received instructions on how to complete questions on a Tungsten E palmtop. Then, they carried the palmtop with them for the next 8 days in the hospital, and were prompted 10 times a day (generally between 8.30 a.m. and 9.30 p.m.; this period was divided into 10 equal intervals, and a questionnaire was programmed randomly within each interval) to complete a short questionnaire on the palmtop. The ESM design resulted in a mean time interval of 1.33 hours (SE = 0.01; 80% of time intervals are between 0.58 and 2.08 hr) between consecutive assessments. Patients did not receive payment to ensure voluntary participation. Ethical approval for this study was obtained from the KU Leuven medical ethics committees (s54563 and ML8517/ML5967).

Measures

Assessment of *DSM–IV* Personality Disorders (ADP-IV) BPD Scale. The BPD Scale of the ADP-IV (Schotte et al., 1998) was used to obtain a dimensional and categorical assessment of BPD based on the diagnostic criteria according to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM–IV–TR*) (which are identical to those of the *DSM–5*). This self-report scale consists of 10 trait items scored on a 7-point scale. For scores higher than 4, an additional distress rating is requested (ranging from 1 to 3). A total of at least five items that are scored at least 5 on the trait scale and at least 2 on the distress scale is considered indicative of a BPD diagnosis. The dimensional score is obtained by summing the individual trait items. The scale is shown to have acceptable concordance with the Structured Clinical Interview for *DSM–IV* Axis II borderline personality disorder section (Schotte et al., 2004). Internal consistency was acceptable in our sample (α = .67).

Psychiatric Diagnostic Screening Questionnaire—Major Depressive Disorder Scale (PDSQ-MDD Scale). The PDSQ is a Self-Administered Questionnaire that is shown to be a reliable and valid measure to assess symptoms of several *DSM–IV* Axis I disorders in psychiatric patients (Zimmerman, & Mattia, 1999). The PDSQ-MDD Scale consists of 21 items that cover the *DSM–IV* MDD diagnostic criteria, scored 1 (*present*) or 0 (*absent).* The subscale score represents the number of MDD symptoms endorsed, with 9 or more considered indicative of a possible MDD diagnosis.

The Self-Injury Questionnaire. This questionnaire assesses the occurrence of different types of NSSI, such as scratching, bruising, cutting, burning, and biting oneself (Claes, & Vandereycken, 2007). For each type, it asks participants to indicate the location of the self-injury on the body, the frequency, the typical experience of pain, typical antecedents and consequences, and the functionality. This questionnaire has been shown to be reliable and valid in assessing NSSI in psychiatric inpatients (e.g., with eating disorders; Claes & Vandereycken, 2007).

ESM items. At each measurement occasion of the ESM part, participants rated to what degree they were currently experiencing each of six different emotions (anger, depressed, anxiety, stressed, happy, relaxed) using a slider scale ranging from 0 (*not at all*) to 100 (*very much*). Negative and positive emotion ratings were averaged to form average negative emotion (NE) and average positive emotion (PE), respectively. Reliability estimates (following Nezlek, 2012) showed fair-to-excellent reliability for NE (estimate = .58 at the level of the measurement occasion; estimate = .98 at the person level) and for PE (estimate = .72 at the level of the measurement occasion; estimate = .97 at the person level).[1] Additionally, participants were asked to indicate whether or not they engaged in NSSI (yes/no) since the last beep. On average, patients completed 53.40 ESM assessments (SE = 2.77, range = 19–76), resulting in an average compliance rate of 65.80% (SE = 3.52), which is fair for inpatients with BPD symptomatology.

Results

Participant Characteristics

All patients scored high on BPD symptomatology (M = 56.83, SE = 1.42), and fulfilled criteria for a clinical diagnosis of BPD, according to the ADP-IV-BPD Scale (Schotte, De Doncker,

[1] Analyses on separate emotions, instead of composite NE and PE, resulted in similar conclusions.

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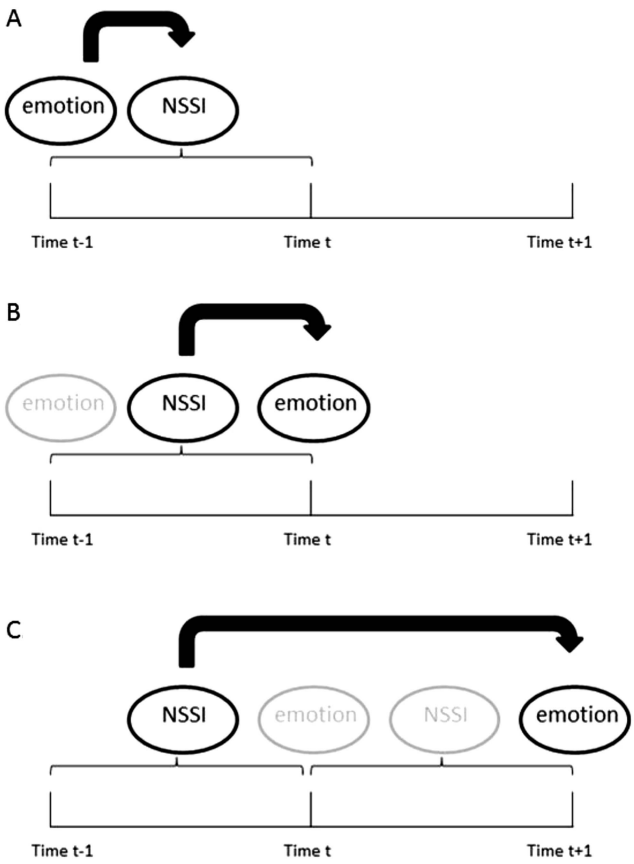

Figure 1. Graphical illustration of the models used in which (A) the predictive effect of emotion on consecutive nonsuicidal self-injury (NSSI) acts was estimated, (B) the predictive effect of NSSI on consecutive emotion was estimated, correcting for emotional intensity at the previous time point, and (C) the predictive effect of NSSI on emotion was estimated at the next time interval, taking into account the occurrence of another NSSI act and the emotion at the previous time point.

Vankerckhoven, Vertommen, & Cosyns, 1998). Moreover, participants scored high on major depressive disorder symptoms (endorsing on average 13.57 out of possible 21 symptoms; *SE* = 0.84), with 80% scoring above the cut-off of 9 symptoms, considered indicative of a major depression disorder diagnosis according to the PDSQ-MDD Scale (Zimmerman & Mattia, 1999). Patients also reported frequent NSSI behavior: 81% of patients reported engaging in NSSI at least at one point in their lives, and 63% reported recent NSSI behavior (in the last week or month), of which 59% reported two or more different methods of NSSI within this time frame, as assessed with the Self-Injury Questionnaire (Claes & Vandereycken, 2007).

Descriptive Statistics

During the ESM part of the study, average reported emotional intensity was 36.90 (*SE* = 3.87) for NE and 28.79 (*SE* = 2.99) for PE, with possible scores ranging between 0 and 100. Moreover, on average, patients reported NSSI acts on 5.6% of all sampled time points, with large variability between persons (*SD* = 10.19, range = 54). This number is largely comparable to frequencies of NSSI reported in the ESM studies by Snir et al. (2015) and Armey et al. (2011).

Relation Between NSSI and Emotions

We applied multilevel regression modeling (Nezlek, 2012) to deal with the nested structure of the data (repeated measurements over time nested within persons). Separately for NE and PE, the moment-to-moment relations between emotions and the occurrence of NSSI were modeled at Level 1 of the models, allowing for random intercepts and slopes.

First, to examine the effect of the intensity of NE/PE on the occurrence of NSSI, we modeled the predictive effect of NE or PE at time $t - 1$ (person-mean centered, to disentangle within-person from between-persons effects; Wang & Maxwell, 2015) on the probability that someone would engage in NSSI during the following time interval, as reported at time *t*, using two-level logistic regression models (see Figure 1A for a graphical representation of the model). Results are shown in Table 1 and indicate that high levels of NE predicted a higher probability of engaging in NSSI in the next time interval. No predictive effects were found for PE.

Next, to examine the effect of NSSI on NE/PE, we modeled the predictive effect of NSSI in the previous time interval (between time $t - 1$ and time *t*, as reported at time *t*) on current NE, respectively. PE at time *t* using two-level linear regression models, also adding NE, respectively. PE at time $t - 1$ as a covariate (person-mean centered). By doing so, we modeled the effect of NSSI on change in NE (or PE) over time (see Figure 1B). The results showed that the occurrence of NSSI in a certain time interval predicted an increase in NE and a decrease in PE in the same time interval (see Table 2).

Table 1
Results From Two-Level Logistic Regression Models Examining the Predictive Effect of Average Negative or Positive Emotion for the Probability of Engaging in NSSI in the Next Time Interval

		Intercept γ_{00}					Predictor slope γ_{10}				
Predicted event	Predictor	Coefficient	*SE*	*t* ratio	*df*	*p*	Coefficient	*SE*	*t* ratio	*df*	*p*
NSSI between $t - 1$ and t	Negative emotion at $t - 1$	−3.48	.28	−12.45	29	<.001	.03	.01	3.01	29	.005
NSSI between $t - 1$ and t	Positive emotion at $t - 1$	−3.43	.28	−12.38	29	<.001	−.01	.01	−1.34	29	.191

Note. The predictor slopes (e.g., negative emotion slope on the first line, and positive emotion slope on the second line) are the effects of interest, and represent the effect of negative emotion and positive emotion, respectively, on the probability to engage in NSSI in the next time interval (see Figure 1A). NSSI = nonsuicidal self-injury.

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Table 2
Results From Two-Level Linear Regression Models in Which Average Negative or Positive Emotion is Predicted by the Occurrence of NSSI in the Previous Time Interval and the Same Emotion at the Previous Time Point

	Intercept γ_{00}				NSSI between $t-1$ and t, slope γ_{10}				Same emotion at $t-1$, slope γ_{20}			
Predicted emotion at t	Coefficient	*SE*	*T* (*df*)	*p*	Coefficient	*SE*	*T* (*df*)	*p*	Coefficient	*SE*	*T* (*df*)	*p*
Negative emotion	36.87	4.05	9.10 (29)	<.001	6.08	2.11	2.88 (29)	.007	.42	.04	9.51 (29)	<.001
Positive emotion	29.59	3.19	9.27 (29)	<.001	−5.82	2.03	−2.87 (29)	.008	.36	.05	7.16 (29)	<.001

Note. The nonsuicidal self-injury (NSSI) between $t-1$ and t slope is the effect of interest, and represents the effect of NSSI on change in negative emotion or positive emotion in the same time interval (see Figure 1B).

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The previous analyses examined how the occurrence of NSSI in a time interval is related to emotional change within that interval. Based on such analyses, one cannot exclude the possibility that the NSSI may have occurred after rather than before the emotional change. A more stringent test would involve examining how the occurrence of NSSI during one time interval is followed by emotional change in a following interval. To this end, we examined the prolonged effect of NSSI on NE and PE, measured at a later moment in time. More specifically, we modeled the predictive effect of NSSI between time $t-1$ and time t, on NE (or PE) at the end of the next time interval (at time $t+1$), controlling for NE (or PE) at time t (group-mean centered), and a dummy variable coding for the occurrence of NSSI during time interval t and $t+1$ as covariates (see Figure 1C). This enables us to investigate the predictive effect of NSSI on the change in NE and PE in the next time interval, while taking into account whether or not another NSSI act occurred. The results showed a prolonged positive effect of NSSI on NE in the next time interval (see Table 3). This was the case after correcting for NE at the previous time point and the possible occurrence of another NSSI act, meaning that NSSI predicted an increase in NE in the next time interval, even if no additional NSSI act was reported in that time interval. No effects were found for PE. However, seen the limited sample size, results have to be interpreted with caution.[2,3]

Discussion

The current study investigated the emotion regulation function of NSSI in inpatients with BPD features by examining the temporal relationship between NSSI and emotions using real-time assessments throughout the day, while patients resided in a psychiatric hospital. In line with the first condition of the emotion-regulation function account of NSSI, we found that high levels of NE predicted a higher probability of subsequent NSSI. Regarding the second condition, however, no indication was found for emotional relief after NSSI. Instead results showed that NSSI was related to an increase in NE, and a decrease in PE in the same interval, and a further increase in NE one time interval later. Therefore, at least on a time scale of hours, and based on the current sample, we found that NSSI was followed by an invigoration of, rather than relief from, negative emotion.

Based on our design, we cannot exclude the possibility that on a very short time scale in terms of seconds or minutes, some initial emotional relief (for example, early changes in physiological arousal and stress) may occur, that cannot be captured with the time scale used in our study. Therefore, we do not consider the current results to be incompatible with previous lab studies and studies using self-report. Instead they suggest that on a more intermediate time scale (in term of minutes to hours), NSSI does not result in emotional relief. While replication is needed, our findings provide more insight into the potential cyclic nature of NSSI, in which NSSI eventually leads to increased negative emotion, in turn again increasing the probability of engaging in NSSI in following time points.

The absence of emotional relief on the longer time scale raises questions about why people repeatedly engage in NSSI. Speculatively, consequences of NSSI that immediately follow the behavior might be stronger reinforcers than the unpleasant longer-term consequences of NSSI. So although patients might become aware of the aversive effects of NSSI after the NSSI acts (e.g., they realize NSSI does not work, that they have disappointed others), patients still repeatedly engage in NSSI to obtain the desired short-term effect of NSSI. This explanation is in line with a study by Haines, Williams, Brain, and Wilson (1995) in which they showed a decrease in physiological arousal immediately after NSSI imagery in lab studies. Another possible explanation is the occurrence of habituation (Tanner, Hasking, & Martin, 2015). People could engage in NSSI because they hope to obtain the beneficial effects of NSSI they used to obtain in the past. However, because of habituation or desensitization processes, the body does not respond in the desired way anymore. A third possibility is that although patients report engaging in NSSI for emotion-regulation reasons, the actual reason is a different one (e.g., feeling generation, or social reinforcement functions such as attention generation). Future studies should bring more insight into the processes underlying the persistent engagement in NSSI behavior by, for example, using physiological measurements in combination with event contingent designs (i.e., they fill in ESM questions after a prespecified event, such as NSSI), or using very small time intervals between repeated assessments. Moreover, information about the chronicity of the NSSI behavior in patients could inform us about possible habituation effects.

Although the findings are preliminary, they have some clinical implications. Given that many patients report using NSSI to relieve negative affect, the finding that NSSI on the contrary might deteriorate mood in the longer run could be addressed during psychoe-

[2] If analyses were repeated, including only the 18 patients who engaged at least once in NSSI behavior during the study, conclusions were the same. However, these results are based on models with robust standard errors, which are less appropriate for data sets including 18 or fewer participants or Level 2 units.

[3] Data were collected at two different hospitals. Note that overall, all reported effects were highly similar in each of the two subsamples.

Table 3
Results From Two-Level Linear Regression Models in Which Average Negative or Positive Emotion is Predicted by the Same Emotion at the Previous Time Point and by the Occurrence of NSSI in One and Two Time Intervals Back

Predicted emotion at $t + 1$	Intercept γ_{00}				Same emotion at t, slope γ_{10}				NSSI between $t - 1$ and t, slope γ_{20}				NSSI between t and $t + 1$, slope γ_{30}			
	Coefficient	*SE*	*T* (*df*)	*p*	Coefficient	*SE*	*T* (*df*)	*p*	Coefficient	*SE*	*T* (*df*)	*p*	Coefficient	*SE*	*T* (*df*)	*p*
Negative emotion	36.61	4.04	9.06 (29)	<.001	.42	.05	9.22 (29)	<.001	6.45	2.16	2.99 (29)	.006	5.07	2.01	2.53 (29)	.017
Positive emotion	29.56	3.19	9.28 (29)	<.001	.36	.05	7.20 (29)	<.001	.21	2.36	.09 (29)	.930	−5.94	1.96	−3.03 (29)	.005

Note. The nonsuicidal self-injury (NSSI) between $t - 1$ and t slope is the effect of interest, and represents the effect of NSSI on change in negative emotion or positive emotion in the following time interval (see Figure 1C).

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ducation, and can be used to motivate patients to seek for and use alternative (less damaging) ways to regulate emotions and tension.

Several limitations can be noted. First, our sample of 30 inpatients was relatively small and consisted predominantly of women. Therefore, this study shows preliminary results that should be interpreted with caution. Replication is needed with larger sample sizes and samples including more males. Second, the patients completed the study while receiving residential treatment in a psychiatric hospital. Although this setting may also involve intense emotional events and triggers, triggers encountered inside a hospital and in their own personal environment are unlikely to be the same. Moreover, the distinct learning history with significant others in the own personal environment would influence the timing and potential mechanisms associated with NSSI. Therefore, generalizability of the results to outpatients should be studied. Third, comorbidity was not systematically assessed, so we do not know whether and how comorbid disorders could have influenced our findings.

To conclude, we showed that in inpatients with BPD features, high levels of negative emotion predict a higher probability for patients to engage in subsequent NSSI acts. In turn, NSSI itself was related to further increases, rather than decreases in negative emotion after the NSSI act. These preliminary findings suggest that, irrespective of what happens on a smaller timescale, in the longer run, NSSI seems to result in an invigoration of, rather than relief from, negative feelings.

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