



Shorter communication

Emotional states preceding and following acts of non-suicidal self-injury in bulimia nervosa patients[☆]Jennifer J. Muehlenkamp^{a,*}, Scott G. Engel^{b,c}, Andrea Wadeson^b, Ross D. Crosby^{b,c}, Stephen A. Wonderlich^{b,c}, Heather Simonich^b, James E. Mitchell^{b,c}^a Department of Psychology, University of North Dakota, 319 Harvard Street, Stop 8380, Grand Forks, ND 58202, USA^b Neuropsychiatric Research Institute, Fargo, ND, USA^c Department of Clinical Neuroscience, University of North Dakota, Grand Forks, ND, USA

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ABSTRACT

Bulimia nervosa and non-suicidal self-injury (NSSI) co-occur at high rates, and both have been conceptualized as maladaptive emotion regulation strategies. Treatments focusing on emotion regulation have been designed for both problem behaviors, yet, there exists very little research examining the temporal emotional states surrounding acts of NSSI. Using ecological momentary assessment (EMA) methodology, the current study examined the temporal association between positive and negative emotional states prior to and consequent to acts of NSSI within a subset of bulimia nervosa patients. Results indicate significant increases in negative affect, and decreases in positive affect, prior to an NSSI act. Post-NSSI, positive affect significantly increased while negative affect remained unchanged. The findings offer partial support for an emotion regulation paradigm to understanding NSSI within bulimic populations and implications for treatment are discussed.

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Non-suicidal self-injury (NSSI; the deliberate damage of one's body tissue without suicidal intent, Muehlenkamp, 2005) is a troubling behavior that many clinicians are encountering, yet struggle to understand (White Kress, 2003; Zila & Kiselica, 2001). Prevalence rates among non-clinical samples of adolescents and young adults range from 4% (Klonsky & Muehlenkamp, 2007) to 38% (Lloyd-Richardson, Perrine, & Dierker, 2007; Whitlock, Eckenrode, & Silverman, 2006), whereas prevalence rates among inpatient adolescents have been reported at 30–68% (Makikyro et al., 2004; Nixon, Cloutier, & Aggarwal, 2002). Of particular interest are findings that rates of NSSI tend to be quite high among a subset of persons with select psychiatric disorders including borderline personality disorder (Zanarini, Frankenburg, Ridolfi, Jager-Hyman, Hennen, & Gunderson, 2006), and eating disorders; especially bulimia nervosa (BN; Anderson, Carter, & McIntosh, 2002; Claes, Vandereycken, & Vertommen, 2001; Favaro & Santonastaso, 1999; Wonderlich, Myers, Norton, & Crosby, 2002).

An increasing amount of empirical research has focused on examining the relationship between NSSI and eating disorders

(ED), as some have suggested that they share similar etiological and maintenance factors (see Svirko & Hawton, 2007 for a review). One possible explanation for the high co-occurrence between EDs and NSSI may be that both sets of behaviors function as emotion regulation strategies. Negative affect models of EDs suggest that the management of negative emotional experiences is an important predictor in the etiology and maintenance of the ED, particularly in those with BN (Agras & Telch, 1998; Kjelsås, Borsting, & Gudde, 2004; Smyth, Wonderlich, & Heron, 2007; Telch & Agras, 1996; Waters, Hill, & Waller, 2001). Heatherton and Baumeister (1991) put forth an explanatory model of BN based purely on the idea that the BN symptoms serve as a way for the individual to escape from aversive self-awareness or negative affective states.

Similarly, NSSI is also conceptualized as an experiential avoidance (Chapman, Gratz, & Brown, 2006), or affect regulation mechanism (Nock & Prinstein, 2004); with a growing body of literature documenting that the most common reason individuals give for engaging in NSSI is to escape from, or alleviate, an aversive emotional state (Brown, Comtois, & Linehan, 2002; Kamphuis, Ruyling, & Reijntjes, 2007; Klonsky, 2007; Laye-Gindhu & Schonert-Reichl, 2005; Rodham, Hawton, & Evans, 2004). As a result of the convergence across studies, most of the existing treatment methods designed to target NSSI are based on the emotion regulation hypothesis (Gratz, 2007; Klonsky & Muehlenkamp, 2007; Linehan, 1993; Nock, Teper, & Hollander, 2007). However, there

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remains very little empirical data examining temporal events and affective states surrounding an act of NSSI, as much of the research relies upon retrospective self-reported function, or motivation, underlying the NSSI acts.

To fully understand the affective antecedents and consequences of NSSI acts and further validate the emotion regulation hypothesis and treatment approaches, real-time data on both positive and negative affect states before and after acts of NSSI is needed. In addition, none of the existing research to date has looked at the real-time emotion regulation effects of NSSI within persons with an ED diagnosis despite the fact that both behaviors tend to co-occur and be conceptualized from emotional avoidance theories. Given the importance of emotion regulation in understanding and treating both NSSI and ED behaviors, the purpose of the current study was to examine, prospectively, the real-time emotional state prior to and following acts of NSSI using ecological momentary assessment (EMA) methods within a subset of the BN sample reported on by Smyth et al. (2007). It was hypothesized that participants would report significantly increasing negative affect and decreasing positive affect prior to an act of NSSI. It was also hypothesized that negative affect would show a significant decrease following the act, and positive affect would show a significant increase.

Method

Participants

One hundred thirty one female participants who met DSM-IV criteria for bulimia nervosa (BN) took part in this study. Participants were recruited from the community and local campuses. The participants were selected from a sample of 154 women who appeared to meet study entry criteria based on a phone screening process. Ph.D. level assessors trained in administering the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I/P; described below) then screened potentially eligible women in face-to-face assessments to determine if they met inclusion criteria (i.e., SCID-I/P based DSM-IV criteria for BN) and exclusion criteria (e.g., excluded males, younger than age 18, current psychotic disorder, pregnant, or unable to read). Eleven participants failed to meet inclusion criteria based on this more thorough assessment, leaving 143 participants who began the EMA portion of the study. Ten participants either dropped out or provided incomplete EMA data, resulting in 133 individuals who completed the EMA protocol. Finally, two of these individuals provided incomplete information on questionnaires used in the current study and were, therefore, excluded from analyses, resulting in a sample of 131 participants.

Measures

Structured Clinical Interview for DSM-IV Axis I Disorders, Patient Edition – Eating Disorder Module (First, Spitzer, Gibbon, & Williams, 1995). The SCID-I/P eating disorder module was used as a screening device to determine whether a potential participant met DSM-IV criteria for BN and could be included in the study. The SCID-I/P has been shown to be a reliable and valid instrument (Beck, Steer, & Garbin, 1988). In the current study, the kappa coefficient for interrater reliability of BN diagnoses (based on 25 randomly selected cases) was 1.00.

Eating Disorder Examination (EDE; Fairburn & Cooper, 1993). The EDE investigator-administered interview assesses current (past four weeks) eating disorder symptoms and was used to provide a current estimate of the severity of ED pathology among participants. The EDE contains four subscales (restraint, eating concern, shape concern, and weight concern) which purport to measure the core psychopathology of eating disorders, and a valid total score.

Subscale scores range from “0” (low pathology) to “6” (high pathology). The EDE has been shown to have excellent validity and reliability (Fairburn & Cooper, 1993). Intraclass correlation coefficients (based on 25 randomly selected cases from our sample) ranged from 0.65 on the restraint subscale to greater than 0.98 on weight concern, shape concern, and eating concerns.

Diagnostic interview for borderlines – revised (DIB-R; Zanarini, Frankenburg, & Vujanovic, 2002). The DIB-R is a semi-structured interview that assesses core features associated with borderline personality disorder. Subscales on the DIB-R are: affect, cognition, impulse action patterns, and interpersonal relationships. Research has shown that the DIB-R has excellent psychometric properties (Zanarini, Gunderson, Frankenburg, & Chauncey, 1989). Intraclass correlation coefficients (based on 25 randomly selected cases from our sample) ranged from 0.75 (cognition) to 1.0 (interpersonal) for DIB-R scales and were 0.98 for the total score.

EMA assessments

Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988). To select items to assess momentary affect, we chose a subset of positive and negative affect items from the PANAS. The items were selected primarily by high factor loadings. The 13 positive affect items were: happy, alert, proud, cheerful, enthusiastic, confident, concentrating, energetic, calm, strong, determined, attentive, and relaxed. The 11 negative affect items were: afraid, lonely, irritable, ashamed, disgusted, nervous, dissatisfied with self, jittery, sad, distressed, and angry with self. Consistent with convention, PANAS scores were divided into positive affect and negative affect by generation of a mean score to the relevant items. Positive affect scores ranged from 13 to 65 and negative affect scores ranged from 11 to 55. This measure has been found to have good reliability with alpha coefficients of 0.85 for negative and 0.87 for positive affect (Watson et al., 1988). Coefficient alphas in the current study were 0.92 for negative affect and 0.91 for positive affect.

Self-injurious Behavior Checklist. Items from several scales of eating disorder and self-destructive behavior (e.g., Rossotto, Yager, & Rorty, 1998; Vanderlinden & Vanderycken, 1997) were used to create a 19-item checklist of momentary behaviors. The checklist included eating-related items (e.g., “I binge ate,” “I vomited”), impulsive behaviors (e.g., “I drove dangerously or recklessly”, “I engaged in risky and unprotected sex”), and self-injurious behavior items. Only the self-injurious behavior items (“I cut myself”, “I scratched myself”, “I burned myself”, “I hit myself”, and “I banged my head”) were used in this analysis. Participants were asked to indicate whether or not they had engaged in a behavior. Frequency of self-injurious acts per each NSSI episode was not assessed.

Procedure

Eligible individuals attended an informational meeting where they received more detailed information regarding the study, completed the consent process, and were checked for medical stability by way of a serum electrolyte screening. Next, participants were scheduled for two assessment visits that lasted approximately 4 h (total). These assessment visits were conducted by a Ph.D. level psychologist who administered several structured interviews assessing the domains of eating disorder symptoms, comorbid psychopathology, and personality. Much of these data were not used in the present study.

After the first assessment visit, participants were trained on the use of the palmtop computers. At that time they also met with the Principal Investigator of the study who reminded them of the goals of the study as well as what to expect during the data collection period. Participants completed two practice days of data collection,

after which they returned for the second assessment visit and their practice data were reviewed (these data were not used in analyses). Although EMA data show little sign of reactivity to eating disorder-related assessments (Stein & Corte, 2003), these practice data were employed to reduce concerns about immediate reactivity and to ensure that participants understood what was expected of them in the protocol. At that time, participants were given feedback regarding adherence to the protocol based on their practice data, and there was discussion concerning strategies with participants who needed to improve adherence rates. Participants then began the EMA assessment portion of the study in which they completed two weeks of EMA recordings. During that time, they also completed a packet of self-report questionnaires. Participants typically met with the research assistant four times over these two weeks to download their EMA data and receive feedback regarding compliance. Women who agreed to participate in the study received \$200 (for the two weeks of EMA) and were given an additional \$50 bonus for compliance rates of 85% or more of the daily recordings.

The current EMA protocol implemented three types of self-report methods: signal-contingent, event-contingent, and interval-contingent recordings (Wheeler & Reis, 1991). Signal-contingent recordings require individuals to respond to the palmtop computer in response to a signal. In the present study, participants were signaled at six semi-random times throughout the day. Participants reported their mood, stressors, BN symptoms, and self-injurious behaviors during these recordings. Event-contingent recordings are based on the occurrence of a pre-identified event. In the current study, participants were asked to complete these ratings after any of 19 behaviors occurred (these behaviors were printed on a laminated card that was carried on the palmtop computer to help participants remember if a behavior was associated with an event-contingent recording). Behaviors included the previously mentioned eating disorder behaviors, self-injurious behaviors, other self-damaging behaviors. Finally, interval-contingent recordings were collected before the participant went to sleep each night and were primarily used to summarize the experiences of the day (although these data are not used in this report).

Results

Description of sample

The 131 participants included in this sample were predominantly single/never married (64.9%), primarily Caucasian (96.9%), and full-time students (51.1%). Participants were relatively young ($M = 25.3$ years; $SD = 7.6$) and were generally of average weight (body mass index = 23.8; $SD = 5.25$). Of the 131 participants, 19 (14.5%) reported at least one act of NSSI during the study time period. A total of 55 episodes of NSSI were recorded across these 19 participants and used for the current study analyses.

Comparison of NSSI group vs. non-NSSI group

We first compared the NSSI group ($n = 19$) with the non-NSSI group ($n = 112$) on descriptive information. The two groups did not differ in age, $t(129) = 0.12$; $p = 0.90$, body mass index, $t(129) = -1.66$; $p = 0.11$, marital status, $\chi^2(5) = 4.63$; $p = 0.46$, or primary role, $\chi^2(5) = 2.03$; $p = 0.85$. Although the groups statistically significantly differed on percentage of non-Caucasians, $\chi^2(3) = 12.26$; $p = 0.01$, these differences were small and likely not very meaningful; there were only two non-Caucasian individuals in each group.

We further compared groups on eating disorder and personality measures (see Table 1). These comparisons revealed that the NSSI group reported more binge eating, $t(129) = -3.93$, $p < 0.01$, and vomiting, $t(129) = -3.64$, $p < 0.01$, but did not score higher on

Table 1
Comparison of NSSI and Non-NSSI groups.

	NSSI group	Non-NSSI group	t Value	Significance	Partial Eta squared
	Mean (SD)	Mean (SD)			
EMA					
Binge	14.47 (8.02)	7.71 (6.74)	3.93	0.001	0.11
Vomit	18.68 (13.92)	9.84 (8.94)	2.67	0.01	0.09
Laxative	1.42 (3.72)	1.21 (4.14)	0.23	0.83	0.00
EDE					
Restraint	3.43 (1.32)	3.07 (1.60)	0.94	0.35	0.01
Eating concern	2.72 (1.35)	2.19 (1.37)	1.56	0.12	0.02
Shape concern	3.96 (1.34)	3.78 (1.33)	0.54	0.59	0.00
Weight concern	4.18 (1.32)	4.02 (1.38)	0.49	0.63	0.00
Global	3.57 (1.04)	3.27 (1.14)	1.11	0.27	0.01
DIB-R					
Affect	1.42 (0.61)	1.47 (0.64)	0.33	0.74	0.00
Cognition	1.16 (0.96)	0.71 (0.80)	1.91	0.03	0.04
Impulse action	2.00 (1.16)	1.46 (1.23)	1.85	0.08	0.02
Interpersonal relationships	1.84 (1.07)	1.18 (1.34)	2.41	0.02	0.03
Total	6.42 (2.95)	4.83 (3.15)	2.15	0.04	0.03

a measure of general eating pathology, as measured by the global score of the EDE, $t(129) = -1.11$, $p = 0.27$. Finally, the NSSI group scored higher on borderline pathology (as measured by the DIB-R lifetime score), $t(129) = -2.05$, $p < 0.05$.

Statistical analysis

Modeling affect around the NSSI behaviors was accomplished with a two-level hierarchical linear model (HLM; Raudenbush & Bryk, 2002) using SPSS version 16.0.1 (SPSS Inc., 2008). Level 1 observations were represented by momentary reports of affect (both linear and quadratic functions were included to assess both linear and non-linear components of affect) and Level 2 observations were represented by individual participants. Models were run separately for affect prior to and following NSSI acts. The model employed random effects for both intercept and slope, using an AR1 serial autocorrelation correction (Schwartz & Stone, 1998).

Within-participant analysis of affect prior to NSSI behavior

Negative affect significantly increased prior to NSSI acts, *linear estimate* = 0.883, $t(212) = 2.94$, $p < 0.01$; *non-linear estimate* = 0.034, $t(212) = 1.80$, $p = 0.074$. As expected, positive affect significantly decreased over time prior to NSSI behaviors, *linear estimate* = -0.915, $t(212) = -2.95$, $p < 0.01$; *non-linear estimate* = -0.063, $t(212) = -3.20$, $p < 0.01$. See Fig. 1.

Within-participant analysis of affect consequent to NSSI behavior

For negative affect following NSSI behaviors, neither the linear (*estimate* = 0.034, $t(237) = 0.129$, $p = 0.897$), nor the non-linear (*estimate* = -0.003, $t(237) = -0.233$; $p = 0.816$) component reached significance. Positive affect, however, increased significantly following NSSI behaviors with significant linear (*estimate* = 0.573, $t(237) = 2.19$; $p < 0.03$) and non-linear (*estimate* = -0.031, $t(237) = -2.37$; $p < 0.02$) components. See Fig. 1.

Discussion

Results from the current study partially confirm hypotheses that NSSI serves a real-time emotion regulating function within persons diagnosed with bulimia nervosa (BN). Findings that negative affect increased and positive affect decreased preceding an act of NSSI is

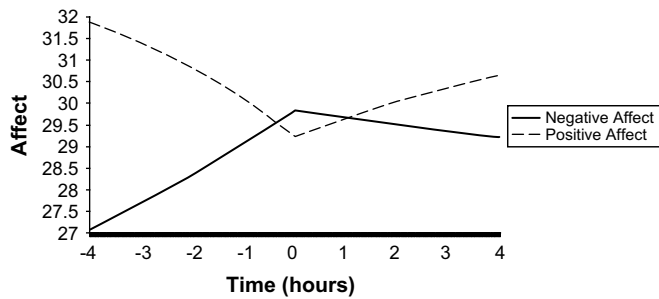


Fig. 1. NSSI and affect.

consistent with previous self-report data indicating NSSI is used to manage aversive emotional states (Kemperman, Russ, & Shearin, 1997; Laye-Gindhu & Schonert-Reichl, 2005; Nock & Prinstein, 2004; Osuch, Noll, & Putnam, 1999). The result that positive affect increased following an act of NSSI is congruent with reports that NSSI can be used to create more positive emotional states (Bennum & Phil, 1983; Klonsky, 2007; Michel, Valach, & Waeber, 1994; Nock & Prinstein, 2004) and expands current understandings of the emotional consequences of NSSI.

Few studies have examined the role of positive affect in NSSI, and our findings indicate that positive affect is an important variable to consider. The fact that positive affect was observed to significantly increase following an act of NSSI, but negative affect did not decrease, suggests that the perceived alleviation of negative affect may result from several mechanisms. The current results would suggest that the relief from negative emotional tension frequently reported by individuals may be caused by the experience of an increase in positive emotions which mitigates the distress experienced by negative affect; thus, resulting in the feeling of relief/release. It may also be that the subjective improvement in negative affect post-NSSI is caused by biological reactions to the injury inflicted resulting from the endogenous opioid system (Russ, 1992; Winchel & Stanley, 1991), which can produce subjective experiences of positive affect. This hypothesis would support prior findings that the reduction of negative emotional states following NSSI is short lived (Favazza & Conterio, 1989; Kamphuis et al., 2007; Kemperman et al., 1997). The pattern of emotional responding to NSSI in this sample appears to suggest that NSSI does serve emotion regulatory functions, and the new findings related to positive affect highlight the need for treatments of NSSI to consider both positively and negatively valenced emotional experiences.

Our results are also informative to understanding potential mechanisms underlying the high comorbidity between eating disordered behaviors and NSSI (Claes et al., 2001; Svirko & Hawton, 2007). The pattern of findings for NSSI within this sample, although not directly compared, is similar to findings from Smyth et al.'s (2007) study of the emotional antecedents and consequences of binge/purge episodes. This convergence suggests that NSSI serves an emotion regulation function similar to that served by BN symptoms, and this shared function may help to explain the high prevalence of NSSI among persons with a BN diagnosis. The current results are also consistent with anecdotal reports that eating disorder symptoms and NSSI are often interchanged, or replace each other, such that when one behavior is under control, the other re-appears (Lader, personal communication June, 2008; Strong, 1998; Vega, 2007). This interchangeability represents a repeating cycle of dysfunctional coping that appears to be perpetuated by emotional dysregulation. These observed and anecdotal patterns suggest that treatments for both BN and NSSI should probably address emotional coping and distress tolerance

prior to other mechanisms in an effort to prevent behavioral replacement.

Also of clinical importance are our findings that the BN + NSSI group scored significantly higher on the severity of their BN behaviors as well as borderline personality disorder pathology than persons with BN and no NSSI. These findings are consistent with previous studies of NSSI within BN populations (Claes et al., 2001; Claes, Vandereycken, & Vertommen, 2003; Favaro & Santonastaso, 1999), and underscore the hypothesis that the BN + NSSI group represents persons with a more severe clinical presentation (Myers et al., 2006; Newton, Freeman, & Munro, 1993; Whitlock, Muehlenkamp, & Eckenrode, in press). It may also be that persons with BN + NSSI require a different, or more intensive, treatment approach than standard BN treatments to better address the underlying mechanisms influencing the co-occurrence of NSSI and BN behaviors. Another possibility is that the NSSI is an indicator of growing decompensation such that the NSSI is needed to further regulate emotions because the BN symptoms are no longer as effective. Unfortunately, we were unable to determine whether BN symptoms preceded the first ever act of NSSI or vice versa. This is an avenue ripe for future investigation.

While the current results offer new and important data for understanding the complexity of NSSI in BN persons, there are some limitations that need mention. First, the sample was small. Of the original 133 participants enrolled in the BN study, only 19 persons reported an act of NSSI. These 19 persons resulted in a total of 55 NSSI acts that could be used for analyses, which is adequate, but still somewhat limited in scope. It will be important for future studies to include larger samples of individuals reporting NSSI, and to obtain data on a larger number of NSSI acts to ensure that our findings are replicated. It is possible that our lack of findings for a significant improvement in negative affect post-NSSI is due to the low sample size. The sample is further limited to understanding the emotional pattern of NSSI within persons diagnosed with BN, which represents a large, but specific subgroup of persons with self-injury. NSSI is also common to persons with anorexia nervosa as well as eating disorder-NOS so these groups need to be studied along with non-eating disorder groups. Although a primary strength of this study is the use of EMA data, there are limitations to using this methodology. While the data are suggestive of temporal processes of mood and NSSI acts, the data are still correlational and rely upon accurate reporting by participants. The temporal time frame was also limited to a relatively short time period, thus future studies should examine the relationship between mood and NSSI in extended time periods. Finally, it is unclear whether self-monitoring of affective states and NSSI/BN acts influenced the occurrence of such behaviors although prior EMA studies have shown there is little reactivity (Stein & Corte, 2003).

In conclusion, this study represents the first known real-time assessment of emotional states before and after an act of NSSI within an eating disorder population. Results support the emotion regulation function of NSSI and suggest that the presence of NSSI may signal increased psychopathology among individuals diagnosed with BN. The findings have important treatment implications, suggesting that clinicians treating persons with a BN diagnosis who also have a history of, or current, NSSI may want to focus specifically on emotional psychoeducation and adaptive methods for distress tolerance to help decrease reliance on both sets of behavior (e.g., Fairburn, Cooper, & Shafran, 2003; Gratz, 2007; Muehlenkamp, 2006; Wonderlich, Mitchell, Peterson, & Crow, 2001). Furthermore, our results highlight the need to consider the role of positive affect as an antecedent and consequence to NSSI. Additional research is needed to fully understand the shared dynamics underlying NSSI and eating disordered behaviors so that clinicians who encounter these co-occurring maladaptive behaviors have guidance for their treatment approaches.

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