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Micro-sequences of anger and shame and non-suicidal self-injury in youth: an ecological momentary assessment study

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Objective: Non-suicidal self-injury (NSSI) is a significant mental health concern with the highest prevalence among adolescents. NSSI has been conceptualized as one of the maladaptive strategies to cope with challenging affect or a form of self-punishment. Although characterizing moment-to-moment associations between shame and NSSI in individuals' real-world environment and partitioning between- and within-person effects is critical for mobile and timely interventions, most studies examined habitual experiences of negative affective states and focused on adults. **Method:** In this study, we focused on in vivo anger at self and others and shame and NSSI among 158 adolescents 3 weeks following their psychiatric hospitalizations using ecological momentary assessment (EMA) technology. **Results:** We found that greater between-person levels of anger at self and others were linked to a higher number of subsequent NSSI occurrences within a day. These findings remained primarily unchanged when we statistically adjusted for participants' age, sex assigned at birth, the number of current psychiatric diagnoses, EMA response rates, and youth lifetime history of SI. Within-person increases in NSSI were linked to increased anger at self over and beyond between-person average levels of NSSI. **Conclusions:** These findings highlight the potential regulatory role of NSSI to decrease negative affective states and point to the clinical utility of assessing and early mobile interventions targeting challenging affect in youth. **Keywords:** Adolescent non-suicidal self-injury; ecological momentary assessment; in vivo negative affect; anger; shame.

Introduction

Non-suicidal self-injury (NSSI) is a significant mental health concern, particularly among adolescents. The meta-analytically derived lifetime prevalence of NSSI in non-clinical samples appears to be the highest among adolescents (17.2%), followed by young adults (13.4%) and adults (5.5%), with similar rates for females and males (Lim et al., 2019; Swannell, Martin, Page, Hasking, & St John, 2014). In psychiatrically hospitalized adolescents, the rates surge to 50%–80% (Plener et al., 2016; Zetterqvist, 2015). NSSI is a serious and unique risk factor for future suicidal behavior as it increases suicidal desire and desensitizes individuals to physical pain, thus increasing their capacity to act on suicidal desire (Hooley, Fox, & Boccagno, 2020; Klonsky, Victor, & Saffer, 2014; Nock, Joiner, Gordon, Lloyd-Richardson, & Prinstein, 2006; Ribeiro et al., 2016). Indeed, the majority (70%) of adolescents who engage in NSSI also report a lifetime history of at least one suicide attempt (Nock et al., 2006). As having a long history of NSSI is among NSSI characteristics most strongly associated with suicidal behavior, delivering timely interventions could decrease suicide risk among adolescents.

The functions of NSSI are multifaceted and can be broadly categorized as intrapersonal (i.e., to escape or avoid challenging affective states or to punish self) and interpersonal or social (e.g., expressing distress) for both adolescents and adults (Klonsky & Glenn, 2009; Nock & Prinstein, 2004). In line with the emotion–regulation model of NSSI, intrapersonal functions of NSSI seem to be the most common in adolescents (63%–78%), whereas interpersonal functions are less common (33%–56%) (Klonsky, 2007; Taylor et al., 2018). NSSI frequently co-occurs with difficulties in affect regulation and high-emotional reactivity in youth (Gratz & Roemer, 2008; Klonsky, 2007; Nock, Wedig, Holmberg, & Hooley, 2008). Findings from a recent meta-analysis show that NSSI thoughts and occurrences are often preceded by an increase in negative affect, supporting the hypothesized function of NSSI as a maladaptive emotion regulation strategy (Kuehn et al., 2022). Anger is among the challenging emotions with particular relevance to NSSI, as it is an activating emotion that often prompts one to resolve emotional discomfort with active behaviors that are not always acceptable or possible in one's circumstances (Williams, 2017). As such, anger has been identified as a powerful emotional antecedent by the largest proportion of female participants who engaged in NSSI (Chapman & Dixon-Gordon, 2007). Inward expression of anger specifically was linked to greater NSSI among adolescents (Cipriano, Cella, & Cotrufo, 2020). Inward expression of anger is also consistent with markedly elevated self-criticism and

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self-hatred among adolescents with NSSI (Glassman, Weierich, Hooley, Deliberto, & Nock, 2007; Glenn, Michel, Franklin, Hooley, & Nock, 2014; Nock, Prinstein, & Sterba, 2009). Both holding angry feelings in and acting out of anger (e.g., losing one's temper) mediated the link between experiencing parental rejection and engaging in NSSI in adolescents, highlighting the potential role of experiencing and acting on challenging affect in NSSI occurrences (Cipriano et al., 2020).

Although a growing body of research describes the role of primary challenging emotions, including those described earlier in NSSI, the role of secondary emotional states that may arise in response to primary emotions or other cognitive–affective processes and NSSI is less characterized. Experiencing challenging emotions, such as sadness or anger, or having difficulties with regulating them may produce secondary self-referential emotions, including shame, which may further impact NSSI occurrence (Linehan, 1993). Shame may also arise in response to various circumstances or self-referential cognitions, as it involves regretting a perceived embarrassment or transgression and seeing oneself as defective (Tangney, Stuewig, & Mashek, 2007). Not surprisingly, higher habitual levels of shame and shame proneness were linked to NSSI in college students (Hack & Martin, 2018; VanDerhei, Rojahn, Stuewig, & McKnight, 2014; Wielgus, Hammond, Fox, Hudson, & Mezulis, 2019). Similarly, in an online undergraduate daily diary study, feeling dissatisfied with self and ashamed was linked to NSSI (Victor & Klonsky, 2014). Women who engaged in NSSI in a community-based study reported higher levels of habitual shame aversion and shame proneness and a reduction in state shame following pain administration in a laboratory, suggesting that individuals may use physical pain as a maladaptive strategy to decrease shame (Schoenleber, Berenbaum, & Motl, 2014). As prior research on shame and NSSI mainly focused on adults, the potential relations of shame in NSSI in youth who experience greater levels of psychopathology remain uncharacterized.

Although anger at self and shame are both self-referential emotional states that may arise in response to similar circumstances (e.g., regrettable behavior or traits), they appear to have distinct phenomenology and aims (Silva, 2022). Similarly to anger at others, anger at self is experienced as an activating or emboldening experience fueled by a desire to challenge and confront (Ellsworth & Tong, 2006; Silva, 2022). Shame is often described as a disempowering negative sense of self and experience of deflation and may trigger avoidance behavior (Gilbert, Pehl, & Allan, 1994; Silva, 2022). These subtle but important distinctions between anger at self and shame warrant examining their relationships with NSSI in youth separately.

Studies that assess affect multiple times throughout the day using ecological momentary assessment (EMA) technology are particularly well suited to examine the proximal role of affect in NSSI, as they provide in vivo, real-time affect for better precision and real-world meaning (Rodríguez-Blanco, Carballo, & Baca-García, 2018). Studies using EMA found that adolescents and young adults recruited from the community were more likely to engage in NSSI when they experienced anger themselves or others (Nock et al., 2009). The levels of anger at self and shame peaked at NSSI occurrence (Armey, Crowther, & Miller, 2011; Muehlenkamp et al., 2009), and engaging in NSSI was followed by a decrease in anger (Kranzler et al., 2018). Together, these findings suggest that experiencing challenging emotions, including anger at self and others and shame, is linked to NSSI occurrence in youth. However, the proximal potentially reciprocal relationships of anger at self and others and shame with NSSI throughout the day in youth immediately following a psychiatric hospitalization remains uncharacterized. Marked by fluctuations in negative affect, the post-discharge period is a time of increased risk for suicide, but it is also sensitive to timely mental health interventions in youth (Armey, Brick, Schatten, Nugent, & Miller, 2018; Chung et al., 2017; Fontanella et al., 2020). Fluctuations in negative affect and NSSI immediately post-discharge in youth are remarkably understudied and there is a need for fine-grained descriptions of the relationships between anger and NSSI at proximal time-scale (Rodríguez-Blanco et al., 2018).

To fill these gaps, we examined in vivo proximal feelings of anger at self and others and shame with NSSI occurrences in a sample of psychiatrically hospitalized adolescents. Specifically, we asked the youth to report their levels of current affect, including anger at self and anger at others, shame, and self-injurious thoughts and behaviors via a phone app five times daily for 3 weeks following their discharge from the psychiatric unit. Based on prior findings of higher anger and shame among NSSI youth (Nock et al., 2009), we hypothesized that increased anger at self and others and shame would be linked to greater NSSI occurrences on that day. We also hypothesized that engaging in NSSI would lead to a subsequent decrease in those emotions, supporting the emotion regulation function of the NSSI (Armey et al., 2011; Kranzler et al., 2018; Nock et al., 2009).

Method

Participants

Participants were 158 adolescents recruited from the inpatient unit of a private nonprofit teaching child psychiatric hospital located in the northeast as part of a large study of the interplay between affect, social context, and self-harm. Youths aged 13–18 who were hospitalized for suicidal thoughts or behaviors in the past month, fluent in English to complete study procedures, and comfortable using smartphone technology for

EMA assessments were included in that study. Exclusion criteria were current psychotic symptoms, pervasive developmental disorder, or substance use interfering with participation. Participants' average age was 15.18 years old (*SD* = 1.35). More than half of the participants (107; 67.7%) were assigned female sex at birth. Participants identified with the following races/ethnicities: 2 (1.3%) Asian, 14 (8.9%) Black or African American, 2 (1.3%) Native or Alaska Native, 104 (65.8%) White, and 24 (15.2%) identified with more than one race. The majority of participants (80.4%) identified as Not Hispanic or Latino. This sample's racial/ethnic demographics approximate those reported by the U.S. Census Bureau for (anonymized state) (anonymized ref). Regarding gender identity, most youth identified as female (*n* = 96, 60.8%), followed by male (*n* = 51, 32.3%). The rest responded that they identified in some other way (*n* = 6, 3.8%), were unsure whether they were transgender (*n* = 1, 0.6%), or did not know what the question was asking (*n* = 1, 0.6%), and 3 individuals did not provide an answer. In terms of teens' sexual orientation, 68 (43.0%) identified as straight, 10 (6.3%) – as gay or lesbian, 37 (23.4%) as bisexual, 13 (8.2% were unsure), 18 (11.4%) identified with none of the above, and 12 (7.6%) did not provide an answer.

Procedure

Following the informed consent/assent, participating families filled out the basic demographic questionnaires and symptom measures. Adolescents' shame and NSSI were assessed via a phone app five times daily for 3 weeks, starting the day after their discharge from the hospital. All the procedures were approved by the hospital's Institutional Review Board (IRB #633181; Biomarkers, social, and affective predictors of suicidal thoughts and behaviors in adolescents).

EMA Safety Protocol: During the informed assent/consent procedure, participants were informed that their EMA responses would not be available to researchers in real-time and that this would not be a way to get help if they felt unsafe. We tailored the EMA protocol to each participant to display the contact information of their mental health provider(s). We encouraged them to contact their provider if they endorsed NSSI or suicidality. Participants were also informed that they would need to call the research staff if they had concerns about the study or discuss them at the follow-up visit. To ensure comprehension of the lack of real-time data monitoring, participants completed a true/false questionnaire. This was reinforced again when participants were trained on how to use the app.

Measures

EMA of shame and anger at self and others and NSSI. Participants received EMA notifications via a mobile app (Ilumivu's mEMA) five times a day at semi-random intervals throughout the day for 3 weeks. Schedules were tailored to each participant's schedules and generally included before and after school assessment windows. The earliest survey was completed at 7:57 AM and the latest was at 11:36 PM. The average time when most surveys were completed was 5:21 PM. No notifications were sent when participants were at school. The average time difference between completed responses within each day across our participants was 39.55 min (*SD* = 49.84). Participants were instructed to complete a brief questionnaire assessing current affect and self-harm behaviors since the last survey. Youth experiences of shame were assessed using the PANAS-X format (Watson et al., 1988). Adolescents were asked to rate how they were feeling 'right now' (e.g., anger at self) on a 5-point Likert scale from 1 (very slightly or not at all) to 5 (extremely). Youth were also asked to indicate whether or not they have engaged in NSSI since their last survey (i.e., 'Since you last completed a questionnaire, have you done anything to hurt your body on purpose, but without the intent to kill yourself?'). Therefore, each EMA window focused on assessing NSSI occurrences before the assessment. An emergency safety protocol used in prior studies was used in the event that individuals endorsed a strong desire to engage in self-harm or suicidal behavior at any time during EMA (Armey et al., 2018; Schatten et al., 2020).

Current psychiatric diagnoses and history of Self-injurious thoughts and behaviors. Current psychiatric diagnoses were assessed via a semi-structured diagnostic interview KSADS–PL by clinicians and trained research assistants and audiotaped for inter-rater reliability (Kaufman et al., 2016). Self-Injurious Thoughts and Behaviors Interview (SITBI) was used to gather data about past and recent suicidal and non-suicidal thoughts and behaviors (Nock, Holmberg, Photos, & Michel, 2007). All the interviewers, including postdoctoral fellows, faculty, and research assistants, underwent formal interview training and ongoing clinical supervision, including regular interrater reliability meetings. Didactics was provided for the KSADS and SITBI, followed by a set of training interviews, with interviewers completing scoring of interviews that they then went over with the experienced clinical trainer (who had personally completed hundreds of interviews and had extensive experience in training). Once interviewers demonstrated sufficient (≥0.90) interrater reliability with the training set, they next observed one to three clinical interviews conducted by an experienced interviewer before beginning to implement the interviews themselves.

Analytic approach. Out of 188 participants who completed the baseline measures of the main study, 172 (91.5%) adolescents completed EMA procedures. Reasons for not providing EMA responses were as follows: not returning to follow-up (8), losing their device (2), withdrawing from the study after baseline (2), and unknown (4). We lost 14 participants who only had one NSSI-related response within a given day by creating a lead variable for the outcome (NSSI occurrences) to examine NSSI occurrences during the assessment windows subsequent to reported affect. Of note, there were no significant differences between participants in our final sample (*n* = 158) and participants who completed baseline procedures but not EMA (*n* = 16) and those we lost when creating a lead NSSI variable (*n* = 14) in the number of current mental health diagnoses, age, sex assigned at birth, gender identity diversity status (yes/no), or sexual orientation diversity stats (yes/no) (all *p*s. > .05). An iterative model testing approach via a series of GLMM for binomial outcomes was used to examine the association of differences in EMA-reported shame and NSSI. In line with the open-science initiative, our analyses were conducted via open-source software using lme4, lmerTest, jtools, ggplot2, psych, plyr, dpyr, jtools, tidyr, and knitr packages (RStudio Team, 2020) We used SPSS (v24) for descriptive analyses of demographic and clinical variables. Time was coded as a continuous value representing days since the start of the EMA period and time of day based on the timestamp recorded for each EMA survey. To examine the effects of current affect (anger at self and others, shame) on subsequent NSSI occurrences, we created a lead variable for NSSI (time + 1) occurrences within the same day. We used a modeling approach that distinguishes between within and between-person effects of time-varying predictors, as described in prior research (Bolger & Laurenceau, 2013; Vogel, Ram, Conroy, Pincus, & Gerstorf, 2017). Specifically, affect was split into trait affect, a sample mean-centered between-person component, and state affect, a person-centered within-person component. To separate out trait affect component (between-person effect of shame), we first created person-centered (intraindividual) means for affect and then sample-centered these means. To isolate the state affect component (within-

person effect of shame), we subtracted intraindividual affect means from raw affect scores (Bolger & Laurenceau, 2013; Vogel et al., 2017). To capture potential bouts of negative affect and NSSI, we examined the effects of trait and state NSSI on subsequent affect during the same assessment window, as the question assessing shame was phrased to capture affective states at the moment of assessment. In contrast, NSSI occurrences that preceded the survey were assessed by each EMA survey.

We used an iterative model testing approach using a series of GLMM to examine the association of within and between-person differences in EMA-reported anger at self, anger at others, and shame and subsequent NSSI. First, we estimated a null model (intercept-only model with no predictors) to calculate the intraclass correlation (ICC) and determine the amount of variability in EMA-reported NSSI over the course of the EMA period. Then, in Model 1, we tested for time trends across the EMA sampling window by adding a fixed effect for our time variable. Then, we tested the links between- and within-person effects of anger at self, anger at others, and shame and NSSI (Model 2 a, b, c). We then tested the robustness of the significant associations between affect and NSSI via Model 3 (a, b), which included relevant participant demographic and clinical characteristics [i.e., age, sex assigned at birth, the number of psychiatric diagnoses, lifetime history of suicidal ideation (SI) and EMA response rate]. We examined the effects of state and trait NSSI on subsequent affect (Model 4 a, b, c) to probe whether negative affective states follow NSSI. As before, we conducted sensitivity tests to examine whether the findings were maintained when we statistically adjusted to the relevant participant demographic and clinical characteristics (i.e., age, sex assigned at birth, number of psychiatric diagnoses, and EMA response rate (Model 5 a, b, c)).

Results

Clinical characteristics

The number of concurrent diagnoses ranged from 0 to 7 and the median number of current diagnoses in our sample was 2. The prevalence of current diagnoses was as follows: 86.1% met the criteria for a depressive disorder, 58.9% – an anxiety disorder, 15.2% – Attention Deficit and Hyperactivity Disorder, 8.9% – a substance use disorder, 7.6% – a conduct disorder, 5.7% – obsessive–compulsive disorder, 5.7% – eating disorder, and 2.5% – bipolar disorder. The average number of times engaging in NSSI in the past 6 months was 11.51 (*SD* = 24.55); in the past month – 4.28 (*SD* = 15.50). The average participant rating of the likelihood of engaging in NSSI in the future at baseline was 1.43 out of 4 (*SD* = 1.38).

EMA responses

Participants completed between 1 and 105 assessments, comprising a total of 6,800 assessments. The average number of NSSI and current affect responses per person was 43 (41%), 60 (38%) participants responded to at least half of the total observations of shame and NSSI, and 71 (45%) of participants provided at least one response each day (Figure 1). Across all the participants and assessment days, the middle 50% of EMA responses occurred after school hours (after 3:00 PM). This is likely due to most assessment windows being set for before school (morning) or after school hours to prevent any potential disturbances from receiving notifications in class.

NSSI

In our sample, 40 (23.3%) participants reported NSSI at least once during the 3-week EMA period. We used an iterative model testing approach using a series of GLMM to examine the association of within and between-person differences in EMA-reported shame and NSSI. Results from the initial null model indicated that 64% of the variability in NSSI was due to between-person differences (ICC = 0.64). Results

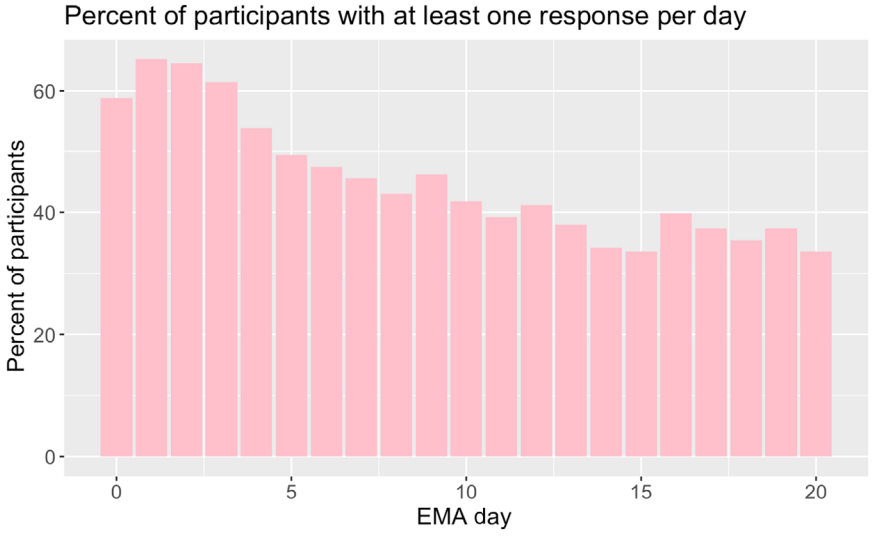

Figure 1 Percentage of participants who responded to at least one notification each day throughout the assessment window. EMA Day 0 = Day of psychiatric discharge

for Model 1 indicated no significant effect of time on NSSI, such that the frequency of NSSI occurrences did not change significantly over the sampling window (β = .02, p = .57).

Between- and within-person effects of negative affective states on subsequent NSSI

Affective ratings of anger at self, anger at others, and shame ranged from 1 to 5 and the average levels of affect were 1.57 (*SD* = 1.04) for anger at self, 1.48 (SD = 0.97) for anger at others, and 1.42 (*SD* = 0.89) for shame. Results for Model 2a (Table 1) indicated a significant effect of between (trait), but not within-person (state) effects of feeling anger directed at self on NSSI occurrences during the subsequent EMA window (Figure 2A). Results for Model 2b (Table 1) indicated a significant effect of between, but not within-person effects of feeling anger directed others on NSSI occurrences during the subsequent EMA window (Figure 2B). Results for Model 2c (Table 1) indicated no significant effects of between or within-person effects of shame on NSSI occurrences during the subsequent EMA window (Figure 2C). Significant findings were maintained when we statistically adjusted for the youth's demographics, including age, sex assigned at birth, the number of current psychiatric diagnoses and lifetime history of SI, and teens' EMA response rates (Table 2; Model 3a and b). The only participant characteristic significantly linked to NSSI occurrences was sex, with females reporting more frequent NSSI. These results suggest that experiencing greater anger at self and others, but not shame compared with the other individuals in our sample, was linked to subsequent NSSI.

Between- and within-person effects of engaging in NSSI on subsequent affective states

Results for Model 4a (Table 3) indicated significant effects of between- and within-person effects of NSSI occurrences on feeling anger directed at self during the subsequent EMA window (Figure 3). There was a significant between-person, but not within-person effect of NSSI occurrences on subsequent feelings of anger at others (Model 4b, Table 3). Similarly, between, but not within-person increases in NSSI occurrences led to increased feelings of shame (Model 4c, Table 3). Significant findings were maintained for the effects of NSSI on subsequent anger at self and shame, but not anger at others when we statistically adjusted for the youth's demographics, including age, sex assigned at birth, the number of current psychiatric diagnosis, EMA response rates, and youth lifetime history of SI (Model 5a and c, Table 4). These results suggest that increases in NSSI compared with both adolescents' own typical levels of NSSI and the group average levels of NSSI were associated with increased anger in the next sampling window directed at self. In contrast, greater levels of NSSI compared with the other individuals, but not self, were linked to subsequent feelings of anger at others and shame.

Discussion

We examined in vivo moment-to-moment feelings of anger at self and others and shame and NSSI occurrences in a sample of recently psychiatrically hospitalized adolescents. Specifically, we asked youth to report their levels of affect and NSSI occurrences via a phone app five times daily for 3 weeks after discharge from the psychiatric unit. We found that higher levels of between-person or trait anger at self and others, but not shame, were both associated with greater subsequent NSSI occurrences. Between-person increases in NSSI occurrences led to higher feelings of shame. We also found that within-person increases in NSSI occurrences were lined to subsequent increases in feelings of anger at self over and beyond average NSSI levels. These findings were at least partially independent of the participant's age, sex assigned at birth, how many responses they provided to the phone app surveys over the assessment period, or whether they had a current psychiatric diagnosis or a lifetime history of SI.

The findings focused on in vivo anger in relation to NSSI are consistent with prior research in community youth suggesting that greater feeling angry at

Table 1 Associations between trait and state in vivo affect and subsequent NSSI (N = 158)

Fixed effects (estimate, *SE*)	Anger at self (2a)	Anger at others (2b)	Shame (2c)
Intercept	−8.05 (1.27)	−8.08 (1.27)**	−8.66 (1.31)**
Time	0.03 (0.03)	0.03 (0.03)	0.03 (0.03)
Trait affect	1.21 (0.57)*	1.22 (0.57)*	0.64 (0.57)
State affect	0.16 (0.17)	−0.05 (0.19)	0.19 (0.20)
Random effects			
Intercept variance (*SD*)	15.22 (3.90)	15.33 (3.91)	21.79 (4.67)
Model fit			
R^2 fixed	.03	.03	.01
R^2 total	.83	.83	.87
AIC	406.6	407.4	409.2
BIC	437.7	438.6	440.4

*$p \leq .05$; **$p \leq .01$.

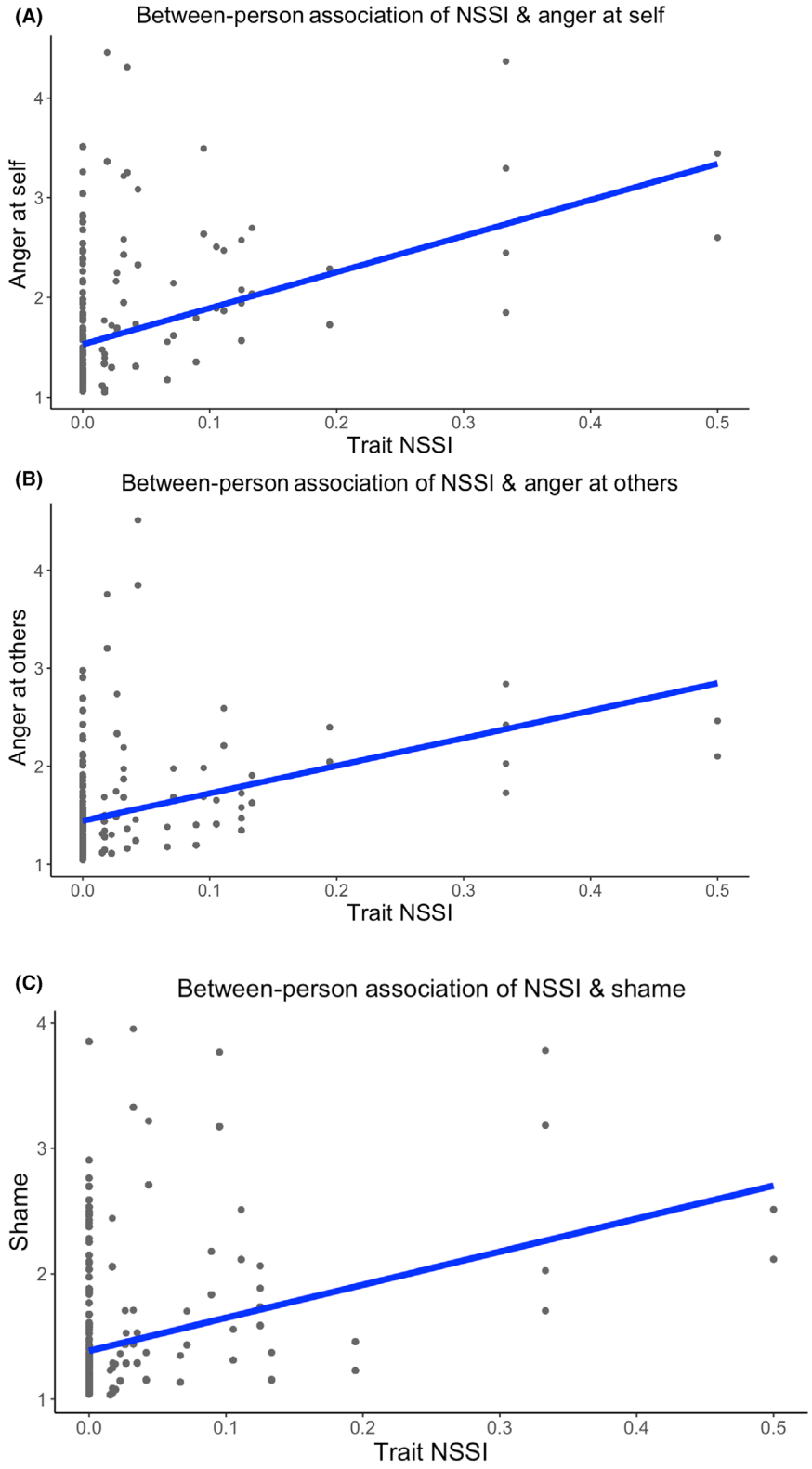

Figure 2 Predicted between-person or trait-level association between NSSI and anger at self (A), anger at others (B), and shame (C) over a 3-week EMA sampling window following adolescents' discharge from the psychiatric hospitalization. The blue line represents an average slope of an association between trait NSSI and affect

self and others was linked to greater NSSI occurrences (Armey et al., 2011; Nock et al., 2009; Tang et al., 2013). Our findings extend prior research to examining between- and within-person levels of anger at self and others ecologically assessed in youth following psychiatric hospitalization. The findings suggest that youth who experience overall greater levels of anger at self and others compared with the other individuals, but not compared with their own typical levels of these emotions, may be

Table 2 Tests of robustness for the associations between trait and state in vivo affect and subsequent NSSI (N = 142)

Fixed effects (estimate, *SE*)	Anger at self (3a) (at Model 3a)	Anger at others (3b)
Intercept	−6.60 (34.19)	−6.67 (21.13)
Time	0.19 (0.18)	0.20 (0.18)
Trait affect	1.04 (0.47)*	0.66 (0.30)*
State affect	0.14 (0.17)	0.02 (0.14)
Age	−0.31 (0.33)	−0.31 (0.33)
Sex assigned at birth	−1.94 (0.97)*	−1.94 (0.97)*
Current psychiatric diagnoses	−0.07 (0.36)	−0.07 (0.36)
EMA response rate	−0.09 (0.35)	−0.09 (0.35)
Lifetime SI history	3.40 (143.41)	3.30 (88.60)
Random effects		
Intercept variance (*SD*)	4.72 (2.17)	4.72 (2.17)
Model fit		
R^2 fixed	.56	.54
R^2 total	.82	.81
AIC	375.93	376.55
BIC	437.40	438.03

*$p \leq .05$.

Table 3 Associations between trait and state NSSI and subsequent affect (N = 158)

Fixed effects (estimate, *SE*)	Anger at self (4a)	Anger at others (4b)	Shame (4c)
Intercept	0.40 (0.04)**	0.33 (0.04)**	0.31 (0.04)**
Time	0.00 (0.0)	0.01 (0.00)*	0.00 (0.00)
Trait NSSI	1.66 (0.58)**	1.18 (0.57)*	1.37 (0.61)*
State NSSI	0.28 (0.10)*	0.16 (0.11)	0.17 (0.12)
Random effects			
Intercept variance (*SD*)	0.11 (0.34)	0.09 (0.30)	0.12 (0.35)
Model fit			
R^2 fixed	.01	.01	<.01
R^2 total	.19	.19	.18
AIC	10,174.1	9,942.5	9,583.7
BIC	10,205.4	9,973.8	9,552.4

*$p \leq .05$; **$p \leq .01$.

linked to greater subsequent NSSI occurrences. Moreover, greater average levels of NSSI were linked to subsequent higher levels of anger at self and others. Intriguingly, increases in NSSI compared with the one's own typical levels of NSSI were associated with anger at self over and above between-person average levels of NSSI. A similar proximal increase in negative affect (composite scores of feeling angry, anxious, depressed, and stressed) instead of emotional relief following NSSI was observed among young adults in the inpatient unit (Houben et al., 2017). Given that one of the main purposes of NSSI reported by youth is intrapersonal negative reinforcement or coping with challenging affective states, our findings suggest that any respite from those affective states does not last long (Nock et al., 2009). Engaging in NSSI itself seems to be followed by a relatively quick return to those challenging emotions.

Although prior research suggests that increased habitual levels of shame and shame proneness are associated with night NSSI frequency among young adults, feelings of shame did not lead to an increase in subsequent NSSI occurrences in youth in our sample (Hack & Martin, 2018; VanDerhei et al., 2014; Victor & Klonsky, 2014; Wielgus et al., 2019). However, engaging in self-injury led to increased feelings of shame, suggesting that in adolescence with high-symptom acuity, feelings of shame might not be the primary emotional drivers of engaging in NSSI. Increased shame following NSSI could add to difficulties coping with other challenging emotional states and exacerbate mental health symptoms. (Gilbert et al., 1994; Silva, 2022).

Although shame and anger at self often co-occur, in our sample, increased anger at self and others, but not shame, was linked to higher NSSI. These differences could arise from subtle differences between the emotional constructs of shame and anger at self. Anger at self can be mislabeled as shame or guilt but is a distinct emotion with separate phenomenology and functions (Silva, 2022). Shame is thought to involve a sense of deflation and lack of capability, whereas anger at self may bring out feelings of emboldening for actions (Gilbert et al., 1994; Silva, 2022). Thus, anger at self could be more potent in precipitating actions, including NSSI, than shame.

The study's strengths are in using EMA technology to assess in-the-moment feelings of anger at self and others and shame in adolescents' real-world environment, using the analytic approach that allows examining between- and within-person effects of affect, and being the first to our knowledge to examine the bidirectional moment-to-moment links between affect and NSSI in adolescents following an inpatient psychiatric hospitalization. In addition, our analytic approach of partitioning between-person and within-person effects may be especially relevant for the potential personalization of just-in-time adaptive interventions based on an individual's report of NSSI occurrences or their own subsequent negative affect state. Just-in-time adaptive interventions are designed to monitor and evaluate dynamic data to identify the optimal timing and the type of support the user might require in each context. For example, an app may prompt a user to engage in coping strategies following the answers they provide to an assessment that may suggest they are struggling with increased anger at self compared to their own baseline and are in settings in which they are more likely to engage in NSSI (e.g., alone) (Hardeman, Houghton, Lane, Jones, & Naughton, 2019).

Several limitations provide directions for future research. First, the study's design precluded us from drawing any conclusions about temporal sequences

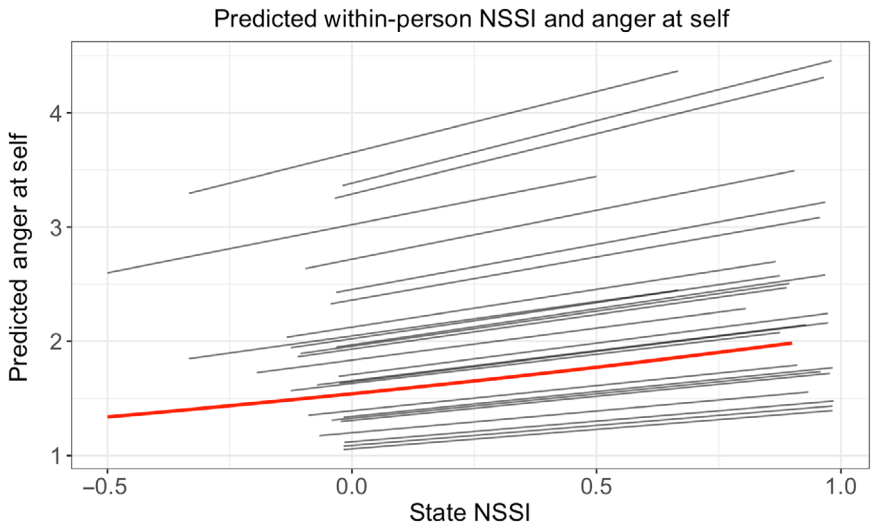

Figure 3 Predicted within-person or state-level association of NSSI (centered) and subsequent anger at self over a 3-week EMA sampling window following adolescents' discharge from the psychiatric hospitalization using interpolated missing values. The red line represents an average slope of an association between state NSSI and subsequent feelings of anger at self

Table 4 Tests of robustness for the associations between trait and state NSSI and subsequent affect ($N = 142$)

Fixed effects (estimate, *SE*)	Anger at self (5a)	Anger at others (5b)	Shame (5c)
Intercept	0.55 (0.08)**	−0.04 (0.34)	0.31 (0.04)**
Time	0.02 (0.01)	0.02 (0.02)	0.02 (0.02)
Trait NSSI	0.07 (0.03)**	0.05 (0.03)	0.06 (0.03)*
State NSSI	0.03 (0.01)**	0.02 (0.01)	0.02 (0.01)
Age	−0.02 (0.03)	0.03 (0.02)	−0.01 (0.03)
Sex assigned at birth	−0.01 (0.08)	0.01 (0.07)	−0.00 (0.08)
Current psychiatric diagnoses	0.01 (0.03)	0.03 (0.03)	0.05 (0.03)
EMA response rate	−0.25 (0.14)**	−0.07 (0.03)	−0.08 (0.03)*
Lifetime SI history	−0.02 (0.04)	0.01 (0.03)	−0.04 (0.04)
Random effects			
Intercept variance (*SD*)	0.11 (0.33)	0.09 (0.29)	0.11 (0.33)
Model Fit			
R^2 fixed	.01	.01	.02
R^2 total	.19	.15	.19
AIC	9,152.4	8,922.8	8,591.0
BIC	9,213.8	8,984.2	8,652.5

*$p \leq .05$; **$p \leq .01$.

beyond a single day or causality. Next, we did not assess the bidirectional associations of affect and severity or type of NSSI; future research that examines whether anger at self, others, or shame is associated with these or other characteristics of NSSI is warranted. Another limitation is a large proportion of missing EMA shame and NSSI ratings, though typically reported EMA response rates via a phone app range from 18% to 87% for adolescents (Dennis, Scott, Funk, & Nicholson, 2015; Garcia et al., 2014; Kenny, Dooley, & Fitzgerald, 2016). Future studies using incentives to encourage higher response rates might achieve a higher temporal resolution of affect–NSSI cycles during the day. As NSSI occurrences are relatively infrequent, we asked participants to indicate if there were any occurrences 'since the last notification.' It is possible that participants may not have remembered when they received the last notification. Thus, future research specifying when the previous notification occurred during each assessment is warranted. Last, we did not examine whether having a specific mental health diagnosis further affected the link between affect and NSSI. Future research could focus on whether specific mental health conditions (e.g., borderline personality disorder, depression) could exacerbate the associations between anger and/or shame and NSSI. We also did not assess self-criticism, which has been shown to have both trait-and state-level effects on NSSI in youth (Ammerman & Brown, 2018; Hooley & St. Germain, 2014; Nagy, Shanahan, & Baer, 2021). Future research on moment-to-moment relationships between negative affective states, self-criticism, and NSSI in youth is warranted.

Overall, in line with prior research, our findings provide preliminary evidence that greater anger at self or others leads to increased NSSI occurrences, highlighting the clinical utility of assessing anger in adolescents. Engaging in NSSI, in turn, appears to fuel increased anger at self and others, creating self-feeding micro cycles. The findings could inform future research that focuses on adapting or developing mobile just-in-time adaptive interventions aimed at reducing NSSI risk in youth by assessing and targeting the intensity of anger in adolescents' daily lives.

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Data availability statement

We present secondary analyses from a larger study examining the interplay of affect and social context with self-harm among psychiatrically hospitalized youth. We described how we arrived at our final sample size, all the data exclusions and manipulations, and all measures in this study in the previous sections. This study design, hypotheses, or analyses were not preregistered. Analysis code and output are included with the submission. Data are available upon reasonable request. Researchers working in academic or clinical settings at nonprofit educational organizations can provide specific research questions and hypotheses and a data safety plan and request data from senior authors.

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Key points

- We examined in vivo anger at self and others and shame and NSSI among 158 adolescents during 3 weeks following their psychiatric hospitalizations.
- Greater between-person levels of anger at self and others were linked to higher subsequent NSSI occurrences within a day.
- Within-person increases in NSSI were linked to subsequently increased anger at self over and beyond between-person average levels of NSSI.
- Findings point to the clinical utility of assessing and just-in-time adaptive mobile interventions targeting challenging affect in youth.

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