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Shorter communication

Real-time monitoring of the associations between self-critical and self-punishment cognitions and nonsuicidal self-injury

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ABSTRACT

The Defective Self Model of nonsuicidal self-injury (NSSI) proposes that some people engage in NSSI to punish themselves and/or to respond to self-critical cognitions. Although there is a growing body of research to support this theory, there has been a lack of ecologically valid approaches employed to critically examine its tenets. The current study aimed to fill this gap in the literature. A sample of 64 undergraduates with a history of repetitive NSSI were recruited and completed an ecological momentary assessment (EMA) protocol. At baseline, participants completed trait measures of self-criticism and self-punishment cognitions. Over the EMA period, participants reported their experience of self-critical and self-punitive cognitions, and NSSI urge intensity three times daily. Our between-persons level findings suggest that trait and aggregated state self-punishment, but not self-critical cognitions, predict NSSI urges experienced over the EMA period. Our findings additionally provide evidence that both momentary self-critical and self-punishment cognitions are concomitantly and prospectively associated with NSSI urge intensity as measured in real-time and modeled at a within-persons level. However, after adjusting for concurrent NSSI urge intensity in prospective models, these within-persons level findings do not hold. Nevertheless, our findings provide greater support for the Defective Self Model of NSSI.

Nonsuicidal self-injury (NSSI) is defined as intentional self-injury enacted without suicidal intent (Nock, 2010). Youth and young adults are at particularly heightened risk for NSSI. Indeed, estimates suggest that upwards of 17.2% of adolescents and 13.4% of young adults have a history of NSSI (Swannell, Martin, Page, Hasking, & St John, 2014). Given that this behavior is highly prevalent and is a robust predictor of prospective suicidal behavior (Ribeiro et al., 2016), research directed at understanding short-term predictors of NSSI urges and behaviors is of high priority. Research is particularly needed to investigate both between- and within-persons short-term predictors of NSSI urges and behaviors, which would allow us to understand not only who is at risk for NSSI, but also when they are at greatest risk.

A growing body of evidence suggests that NSSI acts as a relatively effective coping strategy for aversive internal experiences. Findings suggest that engagement in NSSI not only reduces negative affect, but also might increase positive affect, facilitating both negative and positive reinforcement (Armey et al., 2011; Franklin et al., 2013; Klonsky, 2009; Nock, 2009). Despite its apparent utility for quickly ameliorating negative internal experiences, NSSI is medically dangerous, causes pain, and frequently leaves permanent physical scarring (Burke et al., 2016). Therefore, investigating why some individuals experiencing aversive internal experiences choose this behavior as opposed to other less harmful coping methods is integral to developing effective interventions.

1. Defective Self Model of NSSI

A particularly promising etiological model that may help to explain why some individuals choose to engage in self-injury as a coping method, as opposed to less harmful coping methods, is the Defective Self Model of NSSI (Hooley et al., 2010). This theory proposes that some people engage in NSSI to punish themselves and/or to respond to feelings of self-hatred or low self-worth (e.g., Hooley et al., 2010). For these individuals, pain may be perceived as deserved, and using NSSI as a

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coping method may gratify a desire for self-punishment (Hooley et al., 2010; Hooley & St. Germain, 2014; St. Germain & Hooley, 2012). Several initial lines of research including self-report and experimental designs support this hypothesis. Regarding self-report evidence, self-punishment (Swannell et al., 2008) is a common reason cited for engaging in NSSI. A recent meta-analysis suggests that there is a moderate-large effect size for the relationship between self-criticism and NSSI (Zelkowitz & Cole, 2018). Extending these findings, experimental evidence has demonstrated that self-criticism (Fox et al., 2017; Hooley et al., 2010; St. Germain & Hooley, 2012) and negative self-worth (Bastian et al., 2011) predict one's willingness to endure pain. Moreover, among participants with (Fox et al, 2017, 2019) and without (Fox et al., 2019) a history of NSSI, pain improves mood for those reporting high levels of self-criticism. Of note, longitudinal studies have been mixed regarding whether self-criticism prospectively predicts NSSI. Whereas studies have shown that among adults, self-criticism predicts NSSI over one- (Fox et al., 2018) and two-month (Perkins et al., 2020) follow-up periods, several recent studies have not found longitudinal relationships between self-criticism and NSSI among adolescents (You et al., 2017) and young adults (Daly & Willoughby, 2019) over a one-year follow-up period. Taken together, however, the overall body of evidence suggests that NSSI may represent a form of self-punishment, at least for some who engage in this behavior. Unfortunately, the large majority of studies supporting this model have examined these constructs only at the between-person level. Although useful in highlighting *who* is at risk (interindividual effects), these studies cannot speak to *when* and *under what conditions* individuals may be imminently at risk, which are considered within-person (i.e., intraindividual) effects.

To our knowledge, only one study has explored the tenets of the Defective Self Model of NSSI at the within-person level. This study employed a daily diary design in a sample with a history of NSSI (Lear et al., 2019). Daily self-punishment cognitions directly predicted daily NSSI urge intensity and engagement in NSSI behavior. Moreover, trait self-criticism had a main effect on daily self-punishment cognitions and indirectly predicted daily NSSI urge intensity (but not behavior) through the experience of daily self-punishment cognitions. Notably, trait self-criticism did not directly predict NSSI urge intensity or behavior over a two-week period (Lear et al., 2019). Although this study provides additional evidence for the Defective Self Model of NSSI, it is limited by its daily diary design, which required participants to aggregate their experience of self-punishment cognitions and NSSI urges and behavior over the course of each day. Aggregating over a day is problematic for at least two reasons. First, aggregation requires retrospective recall of short-lived thoughts, affect states, and events, which may not necessarily be accurate. Second, many of the constructs of interest in the Defective Self Model of NSSI likely fluctuate considerably within a day. Thus, aggregation over a day cannot capture these important fluctuations. Furthermore, based on the design, this study cannot evaluate whether self-criticism or self-punishment are short-term antecedents of NSSI. The current study employed an ecological momentary assessment (EMA) design to build on this literature. EMA allows for *ecological* assessment that is carried out in a participant's natural environment. It further permits the assessment of cognitive, affective, and behavioral experiences on a *momentary* basis, arguably significantly reducing the recall bias that can occur when individuals are asked to aggregate across experiences (Trull et al., 2008). Furthermore, this method of assessment permits the examination of within-person proximal antecedents of outcomes of interest (Stange, Kleiman, Mermelstein, & Trull, 2019).

2. The current study

Employing an EMA design, this study aimed to build on the literature to date to test several key components of the Defective Self Model of NSSI. First, in light of inconsistent results in prior studies (Daly & Willoughby, 2019; Fox et al., 2019; Lear et al., 2019; You et al., 2017), the present study examined between-persons differences in trait ratings of self-critical and self-punishment cognitions and the experience of NSSI urges and behavior over the 10-day EMA period. It further examined between-persons differences in aggregated state ratings of self-critical and self-punishment cognitions, which may be considered more ecologically valid trait measures (Solhan et al., 2009) of self-critical and self-punishment cognitions, and the experience of NSSI urges and behavior over the EMA period. Finally, this study explored the within-persons concurrent and prospective relations between momentary self-critical and self-punishment cognitions and NSSI urge intensity as measured in real-time. We hypothesized that both trait and aggregated state self-critical and self-punishment cognitions would be associated with the experience of NSSI urges and behavior over the EMA period, even after adjusting for recent NSSI urge and behavior histories. Regarding within-person analyses, we hypothesized that greater momentary self-critical and self-punishment cognitions would be concurrently and prospectively predictive of NSSI urge intensity over the EMA period.

3. Method

3.1. Participants

The current study sample was drawn from a larger sample of 123 undergraduates recruited from a public urban university (Burke et al., 2020). This larger sample ranged in age from 18 to 26 ($M = 19.85$, $SD = 1.75$). Inclusion criteria for the larger study required that participants possessed normal-to-corrected vision and endorsed English fluency. Participants in the current study included all participants in the NSSI + group ($n = 64$). The inclusion criterion for this group was a minimum of two lifetime NSSI acts. This criterion was determined by an initial self-report screener (Gratz, 2001); a clinician-rated interview was used to confirm group status (Nock et al., 2007). Of the NSSI + group, the average age of participants was 20 years old ($SD = 2.04$) and participants ranged in number of years in college from 1 to 5 ($M = 2.31$; $SD = 1.11$); 6 participants did not report number of years in college. The racial composition of the sample was White (70.3%), Asian (18.8%), Black (0%), Biracial (6.3%), Other (3.1%), and prefer not to answer (1.6%). Approximately 9.4% of the sample identified as Hispanic. Most of the sample (92.2%) identified as female; 71.9% identified as heterosexual, 21.9% bisexual, 1.6% homosexual, 3.1% Other, and 1.6% prefer not to answer. 31.2% ($n = 20$) reported currently receiving some form of mental health care. This study was approved by the University Institutional Review Board.

3.2. Procedure

Participants were recruited through the university online research system and through advertisements. Interested participants completed an online consent form followed by a screener using Qualtrics to determine study eligibility. Participants were compensated with course credit for completing the screener. Those eligible were invited to schedule an in-person session and subsequently complete a 10-day EMA protocol.

At the in-person session, participants completed a written consent. Then, a clinician-rated interview was administered to confirm participant self-reported screener responses for study eligibility. Participants were trained on the EMA procedures and were guided through the completion of a sample signal contingent questionnaire to ensure that they comprehended all terminology.

Beginning the day after the in-person visit, participants received links to four Qualtrics surveys via text messages each day for a period of 10 days. Participants received one daily morning questionnaire assessing sleep indices; these data were not analyzed in the current study. Participants also received three daily identical signal contingent questionnaire surveys within a self-chosen 12-h period (e.g., 10am-10pm). Alert timing for the signal contingent questionnaires was randomized,

such that participants received one alert within a morning, afternoon, and evening 4-h block. The signal contingent alerts were programmed to ensure that the alerts were not received less than 90 min apart. Participants were instructed to complete the survey as soon as possible after receiving the alert. Participants received course credit for completing the EMA study protocol. To motivate EMA compliance, participants were granted the option of an additional course credit or $15 for completion of at least 85% of the surveys within 30 min of receiving the alerts.

During the EMA training, participants were instructed that their responses would not be monitored in real-time by the study research team. During the EMA period of the study, all alerts included crisis information (i.e., numbers to the national suicide hotline and 24-h crisis intervention services). More extensive referral and crisis information was provided at the completion of each signal contingent alert. Furthermore, all participants received a written list of mental health and crisis resources.

3.3. Measures

3.3.1. Screener

The Deliberate Self Harm Inventory (DSHI; Gratz, 2001) assesses history of 17 methods of NSSI behaviors (e.g., cutting, burning). For each behavior endorsed, respondents are asked follow-up questions including free responses to frequency of behavior over the lifetime and the past one year. We modified the DSHI by adding the clause, "without intending to kill yourself" at the end of each prompt. This ensured that participants reported only nonsuicidal self-injurious behaviors within this measure. Research has supported the DSHI's test-retest reliability, and construct, discriminant, and convergent validity in a university-student sample (Fliege et al., 2006; Gratz, 2001).

Trait Self-Critical Cognitions. The Self Rating Scale (SRS; Hooley et al., 2010) is an 8-item measure that assesses self-critical beliefs on a Likert-type scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Example items include, "If others criticize me, they must be right" and "I often feel inferior to others". The SRS has good psychometric properties (Hooley et al., 2010). In the current study, the SRS internal consistency was good (alpha = 0.91).

Trait Self-Punishment Cognitions. In the current study, an additional item was added to the SRS to assess self-punishment, "I am deserving of pain and punishment."

3.3.2. Part 1: In-person assessment

Lifetime History of NSSI. The Self-Injurious Thoughts and Behaviors Interview (SITBI; Nock et al., 2007) is a structured interview that assesses the presence, frequency, and characteristics of self-injurious thoughts and behaviors. For the purpose of the current study, we employed only the subsections assessing NSSI thoughts and behaviors. In conjunction with DSHI screener responses, the SITBI was used to confirm participant eligibility. The SITBI has demonstrated strong inter-rater reliability, construct validity, and test–retest reliability (Nock et al., 2007).

3.3.3. Part 2: Ecological momentary assessment

Self-Critical and Self-Punishment Cognitions. To measure state levels of self-critical cognitions, participants were asked "Right now, to what extent are you feeling self-critical?" To measure state levels of self-punishment cognitions, participants were asked "Right now, to what extent are you feeling deserving of pain and punishment?" Participants rated each item on a Likert scale from 0 (*not at all)* to 9 (*very much*). Mean state self-critical and self-punishment cognitions were calculated by aggregating across the 30 EMA assessments.

NSSI Urge. To measure momentary NSSI urge, the EMA survey included the question, "Right now, how intense is your urge to engage in non-suicidal self-injury?" Participants rated each item on a Likert scale from 0 (*not at all)* to 9 (*very much*). We calculated a sum of reported NSSI urges (ratings of 1 and higher) experienced over the EMA period; this sum score served as the dependent variable for the regression analyses. The continuous measure of momentary NSSI urge intensity was analyzed as the dependent variable in multi-level model (MLM) analyses.

NSSI Behavior. To measure engagement in NSSI, the EMA survey included the question, "Since the last alert, have you engaged in non-suicidal self-injury?" NSSI behavior was coded dichotomously, with participants coded as positive for NSSI behavior if they engaged in NSSI over the EMA period at least once. NSSI behavior was analyzed as a dependent variable in the study for the regression analyses. We were not adequately powered to examine NSSI behavior in MLM analyses.

3.4. Analytic strategy

To examine whether baseline trait self-critical and self-punishment cognitions and their aggregated mean levels (mean computed across 30 ecological momentary assessments) were associated with number of NSSI urges experienced and engagement in NSSI over the EMA period, we employed zero-inflated Poisson regressions and binary logistic regressions in R. When predicting to number of NSSI urges over the EMA period, we covaried the number of NSSI thoughts reported over the previous one-month. When predicting to the dichotomous outcome, NSSI engagement over the EMA period, prior one-month NSSI engagement was covaried. We modeled trait self-critical and self-punishment cognitions simultaneously, and state self-critical and self-punishment cognitions simultaneously in separate models in order to ascertain self-critical and self-punishment cognitions' relative contributions to prediction at the trait and state levels.

To examine whether state levels of self-critical and self-punishment cognitions predict concomitant and prospective NSSI urge intensity, we first made a number of data- and theory-driven decisions on which signal contingent survey responses to include, as well as which MLM to employ.

3.4.1. Analytic decisions and rationale

Timing of assessments. The time between when the notification to complete the survey was received and the survey was completed ranged considerably: from 0 (i.e., surveys completed right when prompted) to 542 min ($M = 26.81$, $SD = 54.80$). We were concerned that large gaps between prompt and response could reflect a participant delaying response due to distress. When exploring time from prompt to response, we found that only 5% of responses happened more than 3 h after the prompt. Thus, we chose 3 h as the cutoff, allowing a total of 1,893 prompts.

The time between consecutive responses also ranged considerably: from 0.02 to 111.33 h. For the analyses where we were interested in only the contemporaneous associations between constructs, the time between consecutive responses only was relevant if two responses occurred very close together (i.e., referring to the same moment in time). When exploring the time between responses, we found that less than 1% of responses happened with less than 30 min in between. We excluded from all analyses the second of the pair of prompts that were within 30 min of one another, leaving a total of 1,876 prompts.

For the analyses where we were interested in prospective relationships, prompts that were too far apart also were an issue. We found that 26.9% of responses were separated by more than 12 h and excluded them from all prospective analyses, leaving 1,448 total prompts. Fig. 1 shows the flow of response selection.

Model selection. Fig. 2 shows the distribution of NSSI urge ratings by participant. Examination of NSSI urge outcome revealed there was no evidence of overdispersion in any of models (no model's overdispersion ratio exceeded 1.0; range = 0.46 to .93; Gelman & Hill, 2007). However, given the clearly skewed distribution that can be seen in this figure, it is likely that these data violate the assumptions of regression and require a model that allows for such a distribution. In these cases, there is not one ideal model, but rather several potential models that allow for different types of distributions. Thus, we report and interpret the multi-level

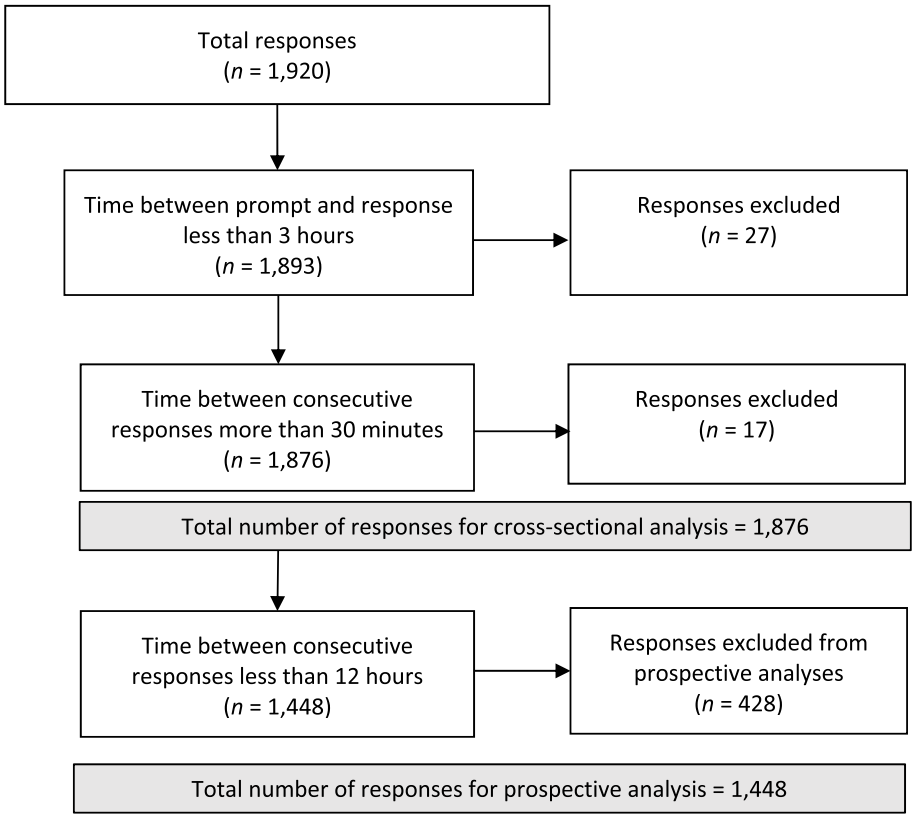

Fig. 1. Overview of responses included in momentary analyses.

Poisson model, which assumes the sample variance is equal to the mean. We chose to present the Poisson model given the finding that there was no evidence of overdispersion and given that the model assuming normal distribution exhibited a higher AIC than the Poisson models. However, given that there is ambiguity in selecting the best fitting model, we report additional models in supplementary tables. In supplementary tables, we report findings from MLMs assuming normal, negative binomial, zero-inflated Poisson, and zero-inflated negative binomial distributions.

3.5. Multi-level modeling analytic strategy

We conducted three sets of MLMs for each of the two independent variables. Observations (level 1) were nested within people (level 2). The first set explored the concurrent association between the independent variables (momentary ratings of self-criticism or self-punishment) and the dependent variable, ratings of NSSI urge from the responses to the same prompt. The second set explored the prospective association between these variables, examining momentary ratings of self-criticism and self-punishment with the outcome ratings of NSSI urge at T+1. The third set added concurrent ratings of NSSI urge as a predictor variable, which allowed us to assess the associations of ratings of self-criticism/self-punishment and NSSI urge at T+1, adjusting for the effect of NSSI urge at T. As noted above, we conducted several different models within each set, reporting the Poisson models in the results section, and the alternative models in the supplementary tables. With the exception of the zero-inflated models, all models were conducted using the *lme4* R package (Bates et al., 2015). The zero-inflated negative binomial and Poisson models were conducted using the *glmmTMB* R package (Brooks et al., 2017). All negative binomial models used the default model specification (nbinom2). All independent variables were participant-mean centered using the *EMAtools* R package (Kleiman, 2017) to allow for within-person assessment. We examine random intercept only models, considering slopes to be fixed across participants. We present Nakagawa's R^2 (Nakagawa et al., 2017) and the *AIC* for each model.

3.6. Results

3.6.1. Descriptive statistics

Participants in the current study reported a range of 2–720 NSSI lifetime acts ($M = 54.34$, $SD = 124.8$). Approximately 20.3% ($n = 13$) had a history of past month NSSI engagement and 31.7% ($n = 20$) had a history of past month NSSI urges. Over the EMA period, 14.1% ($n = 9$) of participants indicated that they engaged in NSSI, 43.8% ($n = 28$) that they experienced any non-zero NSSI urge, and the mean number of NSSI urges was 2.36 (SD = 3.79). EMA alerts took on average 2.8 min to complete. Of the alerts included within the cross-sectional MLMs, participants reported non-zero NSSI urges on 8% of alerts ($n = 150/1876$) and reported NSSI behavior on 0.8% (15/1876) of alerts over the course of the EMA period. Of the alerts included within the prospective MLMs, participants reported non-zero NSSI urges on 8.22% of alerts ($n = 119/1448$) and reported NSSI behavior on 0.9% (13/1448) of alerts.

A series of univariate zero-inflated Poisson regressions showed that neither age, race, nor sexual orientation (coded heterosexual versus non-heterosexual in order for analysis to converge) were associated with the sum of NSSI urges experienced over the EMA period (results available upon request). Neither age ($t(62) = -0.28$, $p = .783$), sexual orientation (X^2 (4, $N = 64$) = 0.71, $p = .951$), gender (X^2 (1, $N = 64$) = 0.88, $p = .346$), nor race (X^2 (4, $N = 64$) = 2.40, $p = .663$), were associated with engagement in NSSI over the EMA period. The zero-inflated Poisson regression model would not converge when assessing the association between gender and sum of NSSI urges experienced over the EMA period, likely due to the extreme homogeneity of the sample in terms of gender. Thus, we did not adjust for these demographic variables in any of our models.

Correlations between trait and aggregated state levels of self-critical and self-punishment cognitions are presented in Table 1.

Fig. 2. Histogram of NSSI urge rating, by participant.

Table 1
Means, standard deviations, and correlations with confidence intervals.

Variable	*M*	*SD*	1	2	3
1. Self-Rating Scale	28.48	11.72			
2. Self-Punishment Item	2.33	1.49	.71*** [.56, .81]		
3. SC Aggregated Mean	2.42	2.03	.42** [.19, .60]	.38** [.15, .57]	
4. SP Aggregated Mean	0.58	1.16	.29* [.05, .50]	.56*** [.36, .71]	.56*** [.36, .71]

Note. SC = self-criticism; SP = self-punishment; M = mean; SD = standard deviation. Values in square brackets indicate the 95% confidence interval for each correlation. *$p < .05$; **$p < .01$; ***$p < .001$.

3.6.2. Do trait and aggregated state levels of self-critical and self-punishment cognitions predict NSSI urges and behavior over a short-term follow-up period?

When accounting for past month NSSI urge frequency, trait self-punishment, but not trait self-criticism, was associated with the number of NSSI urges experienced over the EMA period. Similarly, aggregated (mean) state self-punishment cognitions, but not aggregated state self-critical cognitions, were associated with the number of NSSI urges experienced over the EMA period (Table 2). Neither trait nor aggregated state self-critical and self-punishment cognitions predicted NSSI behavior over the EMA period (Table 3).

3.6.3. Do within-person state levels of self-critical and self-punishment cognitions predict concomitant and prospective NSSI urge intensity?

Assessment descriptives. The larger sample from which the present sample was drawn completed a total of 3,269 signal contingent alerts, with individual participants completing an average of 88.93% of the 30 alerts over the 10-day period ($M = 26.68$; $SD = 3.49$).

Assessment timing. After assessment exclusions (see Fig. 1), included assessments were completed on average 18.79 min after participants received the alert ($SD = 28.72$ min, range = 0–179 min). Pairs of consecutive assessments (those that had < 12 h between them) had,

Table 2
Zero-Inflated Poisson Model of NSSI Urges

	Count portion			Zero-Inflated Model Coefficients		
Predictors	B (SE)	IRR	*p*	B (SE)	IRR	*p*
Intercept	1.17 (0.28)	3.22	<.000	1.54 (0.86)	4.66	0.071
Past Month NSSI Urges	0.03 (0.01)	1.03	0.028	-0.34 (0.18)	0.71	0.057
Self-Rating Scale	-0.02 (0.01)	0.98	0.180	0.03 (0.04)	1.03	0.455
Self-Punishment Item	0.30 (0.09)	1.34	0.001	-0.70 (0.33)	0.49	0.033
	Count portion			Zero-Inflated Model Coefficients		
Predictors	B (SE)	IRR	*p*	B (SE)	IRR	*p*
Intercept	1.16 (0.19)	3.21	<.001	1.76 (0.56)	5.83	0.002
Past Month NSSI Urges	0.01 (0.01)	1.01	0.426	-0.28 (0.14)	0.76	0.046
SC Aggregated Mean	0.08 (0.05)	1.08	0.124	0.02 (0.21)	1.02	0.910
SP Aggregated Mean	0.13 (0.05)	1.14	0.007	-2.94 (1.05)	0.05	0.005

Note. SC = self-criticism, SP = self-punishment; B = Beta; SE = Standard error; IRR = Incident Rate Ratio.

Table 3
Binary Logistic Regression Models of NSSI Episode Prediction

Predictors	OR	Log Odds (SE)	z-value	*p*
Intercept	0.39	-2.90 (1.18)	-2.46	0.009
Past Month NSSI (y/n)	13.10	2.75 (0.93)	2.96	0.003
Self-Rating Scale	0.94	-0.07 (0.06)	-1.21	0.228
Self-Punishment Item	2.44	0.81 (0.44)	1.85	0.064
Predictors	OR	Log Odds (SE)	z-value	*p*
Intercept	0.03	-3.55 (1.18)	-3.77	<.001
Past Month NSSI (y/n)	9.31	2.23 (0.87)	2.56	0.010
SC Aggregated Mean	1.18	0.17 (0.26)	0.66	0.510
SP Aggregated Mean	1.64	0.50 (0.38)	1.31	0.189

Note. SC = self-criticism, SP = self-punishment; SE = Standard error.

on average, 4.02 h between them (*SD* = 1.41 h, range = 0.58 h–11.14 h).

Self-criticism. In the concurrent and prospective models, self-critical cognitions were positively associated with NSSI urge intensity (Table 4). There were no significant associations between self-criticism and NSSI urge intensity in the prospective model adjusting for NSSI urge intensity at T1. Interestingly, NSSI urge intensity at T1 was not associated with NSSI urges at T2.

Self-punishment. In the concurrent and prospective models, ratings of self-punishment cognitions were positively associated with NSSI urge intensity (Table 5). When adjusting for NSSI urge intensity at T1, self-punishment cognitions were not significantly associated with prospective NSSI urge intensity.

4. Discussion

The Defective Self Model of NSSI holds that individuals may engage in NSSI as a means to punish themselves and/or to respond to self-critical feelings (Hooley et al., 2010; Nock, 2010). Specifically, the model posits that self-critical and self-punitive cognitions are related to core beliefs that the self is flawed (e.g., increasing negative experience of the self) and the self should be punished (e.g., increasing willingness to endure pain; Hooley et al., 2010), respectively. A robust body of empirical literature supports this theory; however, no research to date has examined the tenets of this model employing an ecologically valid approach assessing 'real-time' levels of self-critical and self-punishment cognitions and their relationship with NSSI urges. Our findings partly support this model. Within-person analyses provide consistent evidence that both state self-critical and self-punishment cognitions are concomitantly associated with NSSI urge intensity as measured in real-time. Moreover, our within-person results demonstrate that self-critical and self-punishment cognitions are associated with future ratings of NSSI urge intensity (on average, 4 h later), though this effect becomes insignificant after adjusting for concurrent NSSI urge intensity. On the between-person level, our findings suggest that trait and aggregated (mean) state self-punishment, but not mean self-critical cognitions, prospectively predict NSSI urges experienced over a 10-day EMA period. Thus, results suggest that desire to self-punish, above and beyond self-criticism, may be useful in understanding NSSI urge risk.

The first aim of the study was to examine whether trait and aggregated state levels of self-critical and self-punishment cognitions predict

Table 4
Associations between ratings of self-critical cognitions and NSSI urges using Poisson models.

Predictors	*B*	CI	*p*
Concurrent Model			
Intercept	0.01	0.00–0.04	**<.001**
Self-critical cognitions	1.62	1.52–1.73	**<.001**
σ^2/τ_{00}	4.18/8.34		
Marginal R^2/AIC	.049/1343.62		
Prospective Model			
Intercept	0.01	0.00–0.06	**<.001**
Self-critical cognitions	1.08	1.01–1.15	**.022**
σ^2/τ_{00}	4.24/9.62		
Marginal R^2/AIC	.001/973.28		
Prospective Model Adjusting for NSSI Urges at T1			
Intercept	0.01	0.00–0.06	**<.001**
NSSI urge at T1	1.03	0.96–1.11	.394
Self-critical cognitions	1.07	0.99–1.14	.074
σ^2/τ_{00}	4.24/9.30		
Marginal R^2/AIC	.001/974.56		

Note: CI = Confidence Interval, IRR = Incidence Rate Ratio.

Table 5
Associations between ratings of self-punishment cognitions and NSSI urges using Poisson models.

Predictors	*B*	CI	*p*
Concurrent Model			
Intercept	0.02	0.01–0.05	**<.001**
Self-punishment cognitions	1.44	1.38–1.51	**<.001**
σ^2/τ_{00}	4.18/8.21		
Marginal R^2/AIC	.010/1392.27		
Prospective Model			
Intercept	0.01	0.00–0.05	**<.001**
Self-punishment cognitions	1.11	1.04–1.18	**.002**
σ^2/τ_{00}	4.14/9.39		
Marginal R^2/AIC	.001/1338.28		
Prospective Model Adjusting for NSSI Urges at T1			
Intercept	0.02	0.00–0.05	**<.001**
NSSI urge at T1	1.10	1.03–1.18	**.005**
Self-punishment cognitions	1.02	0.94–1.11	.589
σ^2/τ_{00}	4.14/8.56		
Marginal R^2/AIC	.001/1332.20		

Note: CI = Confidence Interval, IRR = Incidence Rate Ratio.

NSSI urges and behavior over the 10-day EMA period, after adjusting for recent history of urges and behavior, respectively. Our findings only partially supported our hypotheses. In fact, only trait self-punishment (and not trait self-criticism) predicted the presence and number of NSSI urges experienced over the EMA period, after adjusting for past month NSSI urges. Similarly, only the aggregated mean of state self-punishment cognitions, and not self-criticism, predicted the presence of NSSI urges over the EMA period, after adjusting for past month NSSI urges. When predicting to NSSI behavior, neither trait nor aggregated means of state self-critical and self-punishment cognitions contributed to prospective prediction. That self-criticism did not evidence short-term between-persons prediction is in line with Lear and Pepper's (2019) findings that trait self-criticism did not evidence a direct effect on NSSI urges over a two-week follow-up period. Our null findings in relation to behavior prediction also are in line with recent studies suggesting that self-criticism does not predict NSSI episodes over a one-year follow-up period (Daly & Willoughby, 2019; You et al., 2017). However, our findings do not align with Fox and colleagues' (2019) results suggesting that self-criticism predicts NSSI episodes over a one-month follow up period.

Our pattern of results highlight that trait and aggregated state self-punishment cognitions may be better short-term between-persons predictors of NSSI urges than self-critical cognitions. In other words, our findings suggest that individuals who report experiencing greater self-punishment cognitions overall and in the moment are more at risk than those individuals who report lower trait and state self-punishment levels, and that these relationships with NSSI risk are stronger than those observed for self-criticism. Notably, however, given the high correlations between trait self-critical and self-punishment cognitions, and state self-critical and self-punishment cognitions (see Table 1), respectively, it is possible that shared variance may suppress extant effects. Therefore, future research is necessary to replicate these findings, and if replicated, to explore the characteristics of self-punishment cognitions that make this cognitive state more predictive of NSSI urges than self-criticism. One possibility is that self-punishment cognitions may evidence greater sensitivity and specificity than self-critical cognitions in prediction, given that our operationalization of self-punishment includes both a desire for punishment *and* pain, both of which NSSI could directly gratify. Thus, self-punishment cognitions, as defined in this study, may imply a *stronger intention to enact behavior* in the service of a desire than our operationalization of self-criticism. This speculation should be examined empirically.

The second aim of this study was to examine the real-time associations between self-critical and self-punishment cognitions and NSSI urge intensity. The results of these analyses extend the findings of Lear and Pepper (2019) in several important ways. First, whereas Lear and Pepper (2019) examined daily self-punishment cognitions as a predictor of NSSI urges, our study examined momentary state levels of both self-critical and self-punishment cognitions as predictors of NSSI urges. We found evidence of direct associations between state self-criticism and concurrent as well as future NSSI urge intensity. Our results demonstrate that when an individual's state self-criticism level is higher than their own mean, they are at greater risk for experiencing near-term increases in NSSI urge intensity. These within-person findings depart from our between-person findings, which showed an insignificant relationship between self-criticism and NSSI urges. This departure underscores the necessity of examining well-established between-persons predictors within individuals in order to understand their generalizability and applicability within people. Such models are integral to the development of personalized just-in-time interventions to reduce NSSI risk.

Paralleling and extending prior research (Lear & Pepper, 2019), we found that *state* self-punishment cognitions were associated concomitantly and prospectively with NSSI urge intensity. Taking together findings from the current study and Lear and Pepper's (2019) results, on days and in moments when self-punishment cognitions are higher relative to an individual's average experience of these cognitions, their near-term risk of NSSI urge is amplified. Our results provide support for the Defective Self Model of NSSI, such that experiencing self-critical and self-punishment cognitions may weaken individuals' potentially inherent barrier to NSSI (i.e., the innate drive to avoid physical injury), and thereby, increase the likelihood of considering NSSI as a coping strategy (Hooley & Franklin, 2018).

We found that neither state self-critical nor self-punishment cognitions prospectively predicted NSSI urge intensity at the following time point when covarying concurrent NSSI urge intensity. Notably, few ecologically valid studies have found that when controlling for suicidal and nonsuicidal self-injurious urges/ideation at time T, do alternate risk factors evidence prospective prediction of suicidal and nonsuicidal self-injurious urges/ideation at T+1 (e.g., Kleiman et al., 2017). This may be attributable to several different reasons. First, it is possible that after accounting for the variance from NSSI urge intensity at T, there is little variance remaining to account for, and we may not have not been powered to detect such small effects. It is also possible that self-critical and self-punishment cognitions do not constitute risk factors for NSSI urge intensity within a 30 min to 12 h prediction window and instead may evidence prediction within either shorter or longer follow-up time frames. Finally, it is possible our results suggest that self-critical and self-punishment cognitions are conceptualized best as concomitants of NSSI urges, rather than proximal risk factors.

4.1. Strengths and limitations

This study evidenced a number of strengths. First, the real-time nature of this study permits greater insight into an individual's imminent risk for NSSI than studies that have employed alternative (i.e., retrospective) methodologies. Second, the EMA compliance rates in this study were relatively high. Third, given some indicators of a non-normal distribution of our outcome, and the lack of standardized guidance on carrying out MLM with non-normal outcomes, we supplemented our primary Poisson model analyses by running a range of MLMs that account for non-normality (see Supplementary Tables). Our findings generally converged across models, increasing our confidence in our conclusions.

However, the current study has a number of limitations that should be carefully considered. First, due to the low number of NSSI behaviors reported over the EMA period, we were not powered to examine the within-persons dynamic relations between self-critical and self-punishment cognitions and NSSI behavior. Still, studies have shown that NSSI urges predict NSSI behavior (Nock et al., 2010), and thus, are important to study themselves. Relatedly, given that we observed few instances of NSSI behavior during our study period, our results are mainly generalizable to NSSI urges that are effectively resisted. Future work should consider examining whether the present findings generalize to the prediction of urges that are not effectively resisted. Second, limitations associated with our one-item measures of several of our independent variables also must be acknowledged. Although we used one-item measures of state self-critical and self-punishment cognitions to reduce participant burden over the EMA period, the study would be strengthened by a multi-item assessment of state self-critical and self-punishment cognitions. The study also would be strengthened by a multi-item assessment of trait self-punishment cognitions. Third, this study represents an initial investigation of self-critical and self-punishment cognitions and NSSI on a momentary level. Future studies with larger samples should expand on the present findings and explore whether the fundamental nature of these relationships differs across people. Furthermore, this is a homogenous sample, comprised mainly of individuals identifying as white and female. It will be critical to examine whether findings replicate in a sample with greater gender diversity, including a larger proportion of men. Furthermore, future research should evaluate generalizability in samples with greater diversity in race, ethnicity, and age, as well as in non-college community and clinical samples.

4.2. Clinical implications

There are several important clinical implications of the current study's findings. Although both self-critical and self-punishment cognitions may be valuable treatment targets to reduce NSSI, our between-persons findings provide some evidence that individuals' self-punishment cognitions may be a more salient factor in detecting the likelihood of short-term increases in NSSI risk as compared to self-critical cognitions. Our findings suggest that clinicians may consider assessing for self-punishment cognitions broadly when evaluating self-injury risk in undergraduate women. Findings should be replicated in diverse non-college samples prior to a broader adoption of such assessment recommendations. Further, our within-persons level findings lay the groundwork for the development of just-in-time interventions to buffer against the impact of fluctuations in self-critical and self-punishment cognitive states and, in turn, examine whether such interventions may reduce NSSI risk.

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CRediT authorship contribution statement

Taylor A. Burke: Data curation, Formal analysis, Writing - original draft, contributed to the study design, data collection, analyses, and manuscript preparation. **Kathryn Fox:** Formal analysis, Writing - original draft, contributed to the study design, analyses, and manuscript preparation. **Marin Kautz:** Data curation, Writing - original draft, contributed to the data collection and manuscript preparation. **David M. Siegel:** Data curation, Writing - original draft, contributed to the data collection and manuscript preparation. **Evan Kleiman:** Writing - original draft, contributed to the analyses and manuscript preparation. **Lauren B. Alloy:** Writing - original draft, contributed to the study design and manuscript preparation.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.brat.2020.103775.

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