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Self-Critical and Self-Punishment Cognitions Differentiate Those With and Without a History of Nonsuicidal Self-Injury: An Ecological Momentary Assessment Study

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The aim of this study was to examine trait, state, and temporal instability measures of self-critical and self-punishment cognitions to evaluate their respective roles in nonsuicidal self-injury (NSSI). Participants were university students with a history of NSSI (n = 64) and those with no history of NSSI (n = 59). At baseline, participants completed measures assessing history of NSSI behavior, as well as trait measures of self-criticism and self-punishment. After completion of baseline procedures, participants subsequently participated in a 10-day ecological momentary assessment protocol in which self-critical and self-punishment cognitions were assessed in real time three times daily. Employing bivariate and multivariate frameworks, our results demonstrate that both trait and state levels of self-critical and self-punishment cognitions robustly differentiate between young adults with and without a lifetime history of NSSI. The present results also confirm that the temporal instability of these cognitive states also meaningfully differentiate between groups, such that those who exhibit greater fluctuations in these cognitive states are more likely to have a history of NSSI. The current findings suggest that trait, state, and temporal instability of negative self-focused cognitions may be vulnerability factors for engagement in NSSI.

Keywords: nonsuicidal self-injury; self-criticism; self-punishment; ecological momentary assessment

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NONSUICIDAL SELF-INJURY (NSSI) IS defined as intentional self-injury enacted without suicidal intent

(Nock, 2010) and includes self-cutting and burning behaviors. The onset of NSSI occurs typically in early- to mid-adolescence (Ammerman et al., 2018), with a pooled prevalence estimate of 17.2% among adolescents and 13.4% among young adults (Swannell et al., 2014). Individuals with a history of NSSI are at risk for continued engagement; indeed, a history of NSSI is one of the strongest predictors of future NSSI (weighted $OR = 5.95$; Fox et al., 2015). Furthermore, a history of NSSI is associated with psychological distress, and is a strong prospective predictor of suicidal behavior, as well as other negative mental health outcomes (Hamza et al., 2012; Mars et al., 2014). Therefore, a growing body of research has focused on elucidating the underlying mechanisms for NSSI's onset and maintenance. Incorporating and extending such empirical work, numerous theories have emerged to aid in guiding future research on the etiology of NSSI.

A particularly promising such theory, the Benefits and Barriers Model of NSSI (Hooley & Franklin, 2018), holds that "(a) NSSI has the potential to provide a range of benefits for nearly everyone but that (b) most people do not access the benefits that result from NSSI because certain physiological, psychological, and social barriers disincline them from doing so." A central *barrier* highlighted by this model is a positive view of the self, which is hypothesized to protect individuals from selecting NSSI as a regulatory behavior. Ample research supports this notion. People who engage in NSSI demonstrate lower levels of self-worth than individuals who do not engage in NSSI across several domains, including self-disgust (Smith et al., 2015), body image (e.g., Muehlenkamp & Brausch, 2012), self-hate (Ammerman & Brown, 2018), self-dissatisfaction (Victor & Klonsky, 2014), self-esteem (Forrester et al., 2017), and self-criticism (e.g., Baetens et al., 2015; Burke et al., 2015; Glassman et al., 2007; Hooley et al., 2010). In a thorough review of the relationship between NSSI and low self-worth, Forrester and colleagues found that individuals who engage in NSSI tend to report low self-esteem, and note that this effect is even stronger when considering hostile forms of self-evaluation, including self-criticism, self-disgust, and self-hatred. Moreover, experimental research has provided evidence that self-criticism is positively correlated with mood improvement during a pain induction task (Fox et al., 2019), and that a brief intervention aimed at reducing self-critical cognitions reduces willingness to enact self-directed pain (Hooley & St. Germain, 2014).

A central, and arguably complementary *benefit* highlighted by the Benefits and Barriers Model of NSSI is that "NSSI gratifies self-punishment desires" such that enacting NSSI provides cognitive reinforcement to those who possess the desire to self-punish (Hooley & Franklin, 2018). In addition to theory supporting this model (i.e., Defective Self Model of NSSI; Hooley et al., 2010), empirical evidence suggests that self-punishment is a commonly endorsed function of NSSI (Taylor et al., 2017). Recent evidence has also suggested that within-person increases in self-punishment cognitions predict increases in NSSI thoughts and behaviors among self-injurers (e.g., Lear et al., 2019). Further supporting this hypothesized benefit of NSSI, experimental evidence suggests that individuals who report engaging in NSSI as a form of self-punishment experience greater emotional reinforcement from a laboratory pain task than those who endorse alternative functions of NSSI (Hamza et al., 2014).

Despite growing evidence supporting the role of self-criticism and self-punishment cognitions in the onset and maintenance of NSSI, several questions remain. First, the vast majority of the literature on the relationship between self-critical and self-punishment cognitions and NSSI has relied mainly on trait measures that can fall prey to recall bias and do not capture fluctuations in these cognitions over time. No studies to our knowledge have examined both trait and ecologically valid state (real-time) measures of self-critical and self-punishment cognitions to attain a more fine-grained understanding of their respective roles in differentiating those with and without a history of NSSI. Second, prior research has suggested that affective instability may be uniquely associated with NSSI, suggesting that NSSI may be used as a means to stabilize aversive affective states (Vansteelandt et al., 2017). A growing body of empirical and ecologically valid evidence supports the relevance of affective instability in NSSI (Bresin, 2014; Santangelo et al., 2017; Selby et al., 2013), which is in line with evidence suggesting that trait measures of emotional dysregulation are predictive of NSSI (McKenzie & Gross, 2014; Robinson et al., 2019). However, no studies have examined the instability of self-critical and self-punitive cognitive states to determine whether instability of these cognitions also is meaningful in differentiating those with and without a history of NSSI. If instability in these cognitive states is associated with a history of NSSI, results would provide preliminary evidence that dysregulation in aversive cognitive states, in addition to emotional states, may be associated with NSSI risk.

In order to fill these gaps in the literature, the current study employed an ecological momentary assessment (EMA) design to attain state ratings of

self-critical and self-punishment cognitions. This methodology allows for the attainment of more ecologically valid trait ratings and permits the estimation of within-individual variation (Trull et al., 2008). The current study aimed to examine and determine the contribution of trait and state ratings of self-critical and self-punishment cognitions in differentiating young adults with and without a history of NSSI. We endeavored to examine these aims in a bivariate framework, as well as a multivariate framework to estimate individuals' within- and between-factor levels on the variables of interest, adjusting for measurement error. A secondary aim of this study was to examine whether within-person temporal instability in these cognitive states also may contribute to group classification. Finally, an exploratory aim of the current study was to examine the relative strength of associations between state versus trait self-critical and self-punishment cognitions and group classification.

We hypothesized that trait and state self-critical and self-punishment cognitions would be strongly associated with a history of NSSI. We additionally hypothesized that within-person temporal instability in these cognitive states would be associated with group membership, such that greater fluctuations in self-critical and self-punishment cognitions would differentiate those with and without a history of NSSI.

Method

PARTICIPANTS

The current study included 123 young adults, ages 18–26 (M = 19.85, SD = 1.75) from a diverse university setting. During recruitment, participants were selected for two groups: participants with a lifetime history of NSSI (i.e., a minimum of two prior acts; n = 64) and participants with no history of NSSI (i.e., no prior acts; n = 59). Group status was selected based on an initial self-report questionnaire (Gratz, 2001) and confirmed by a clinician-rated interview (Nock et al., 2007). Inclusion criteria also were a lack of impaired vision and fluency in English. Participants were not excluded based on demographic characteristics. The majority of the full sample identified as female (87.8%). The full sample was racially diverse with 62.6% White, 15.4% Asian, 9.0% Black, 5.7% biracial, 8.1% other race, and 0.8% indicated that they preferred not to answer. Additionally, 10.6% of the sample identified their ethnicity as Hispanic. A variety of sexual orientations were represented, with the majority of participants identifying as heterosexual (74.8%), 17.1% as bisexual, 1.6% as homosexual, and 6.6% as other or prefer not to answer. This study was approved by the university Institutional Review Board.

PROCEDURE

University students were recruited to participate through the online research system, Sona Systems, and through posters and class announcements. All participants completed an electronic consent form and an initial self-report questionnaire, the Deliberate Self-Harm Inventory (DSHI; Gratz, 2001). The DSHI was used to assess initial eligibility per the inclusion criteria. Participants also reported on trait levels of self-criticism and self-punishment cognitions in the online screener. Participants were compensated for completing the screener with course credit. Those who were eligible for either group were invited subsequently to complete an in-person session as well as a 10-day EMA protocol following the in-person session.

Part 1

Participants completed a written consent at the baseline in-person visit. To confirm their eligibility for each study group and to ascertain lifetime NSSI history, the clinician-rated Self-Injurious Thoughts and Behaviors Interview (SITBI; Nock et al., 2007) was administered.

Part 2

Participants were trained on the EMA procedures and, with assistance from the research team, completed a sample signal-contingent EMA questionnaire to ensure that they understood all questions and response options. Starting 1 day after the baseline in-person visit, participants received links to four online surveys via preprogrammed text messages (using Google Boomerang services) each day for the 10-day observation period. The surveys were administered via Qualtrics. One of the four daily surveys served as a sleep diary, assessing *only* participants' prior night's sleep; these data were not analyzed in the current study. The other three daily surveys were identical 25-item signal-contingent questionnaires that were distributed within a self-chosen 12-hour period (e.g., 10 a.m.–10 p.m.). We allowed participants to choose this 12-hour block given that university student schedules are highly variable, and we endeavored to send alerts at times when the participants would be most likely to be available. Per the randomization protocol, the participants received one alert in the morning, afternoon, and evening 4-hour block.

Participants were asked to complete the signal-contingent alerts as close to when they received them as possible and the minimum length of time between the alerts was programed to be 90 minutes. For participants in this sample, the signal-contingent questionnaires took an average of 2.8

minutes to complete. Participants were compensated for completing the EMA study protocol with course credit. To motivate protocol compliance, if participants completed at least 85% of the surveys within 30 minutes of receiving the alerts over the course of the 10-day EMA period, then they were offered an additional course credit or $15.

We designed the study to maximize data without overburdening participants, particularly because incentives were minimal (mainly course credit). We were particularly concerned that too many alerts would lead to a low compliance rate, posing the threat of significant missing data. Therefore, we asked participants to complete a total of four surveys per day (three of which were signal contingent). The signal-contingent surveys were randomized given that prior evidence suggests that the assessed constructs fluctuate throughout the course of the day (Trull & Ebner-Priemer, 2020).

Participants were informed that their responses were not monitored by the research team during the study. To ensure participant safety during the EMA period of the study, participants were provided with numbers to the national suicide hotline and 24-hour crisis intervention services in the city in which this study took place at the top of each page throughout the online questionnaires. Additionally, comprehensive referral and crisis information were provided at the completion of each signal-contingent alert. All participants were provided with verbal and written information about the purpose of the study and potential benefits that could emerge from study findings as part of our debriefing process. Regardless of EMA responses, all participants additionally were provided with a written list of mental health and crisis resources at this time.

MEASURES

Screener

The DSHI (Gratz, 2001) assesses the frequency and duration of 17 types of NSSI behaviors the participant may have engaged in, such as cutting, carving, burning, biting, and head banging. The DSHI assesses which types of NSSI behavior the participant has engaged in with the prompt, "Have you ever intentionally (i.e., on purpose) _____?" For each NSSI behavior endorsed, the measure inquires about the age at onset, frequency, recency, length of engagement in years, and whether hospitalization or medical treatment was required as a result of the behavior. Prior evidence has supported the psychometrics of the DSHI in a university-student sample, including the internal consistency, test–retest reliability, and construct, discriminant, and convergent validity of the measure (Fliege et al., 2006; Gratz, 2001). The DSHI was used during the screener to initially assess the presence or absence of a lifetime history of NSSI behavior, which was a key inclusion criterion for being invited to the in-person assessment.

Part 1: In-Person Assessment

Lifetime history of NSSI. The SITBI (Nock et al., 2007) is a structured interview that assesses current and past history of self-injurious thoughts and behaviors (SITBs), with additional questions to measure the frequency and characteristics of endorsed experiences. The SITBI assesses age of onset and frequency of NSSI, suicidal ideation, suicide plans, suicide gestures, and suicide attempts across several time frames, including in the prior month. Strong evidence supports the psychometric properties of this interview, which has been used in various clinical and nonclinical settings, including interrater reliability, construct validity, and test–retest reliability (Nock et al., 2007). The reliability of the SITBI was determined by agreement between joint ratings in 20% of the interviews. These calculations found 100% agreement between the raters when assessing NSSI history in the current study. Eligibility in each of the two respective study groups was initially determined with the screener DSHI questionnaire and confirmed with the SITBI.

Trait self-critical cognitions. Self-critical beliefs were assessed with the Self-Rating Scale (SRS; Hooley et al., 2010). This measure includes eight items, including "If others criticize me, they must be right" and "I often feel inferior to others." Items were assessed on a Likert-type scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). High scores on the SRS indicate greater levels of self-critical cognitions. Prior research has demonstrated good psychometric properties for the SRS (Glassman et al., 2007; Hooley et al., 2010). Previously it also has been found to successfully distinguish between self-injurers and healthy controls (Hooley et al., 2010). Internal consistency of total scores on the SRS was $\alpha = .93$. In the current analyses, trait level of self-critical cognitions was included as an independent variable.

Trait self-punishment cognitions. In the current study, one item was added to the SRS to measure self-punishment cognitions: "I am deserving of pain and punishment." Like all items on the validated SRS, this item was assessed on a Likert-type scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). This item was administered as part of the SRS, although it is examined separately. In the current analyses, trait level of self-punishment cognitions was included as an independent variable.

Part 2: Ecological Momentary Assessment

State self-critical and self-punishment cognitions. Three times per day, the EMA survey asked participants to report state levels of self-critical and self-punishment cognitions with one item each. These items included "Right now, to what extent are you feeling self-critical?" and "Right now, to what extent are you feeling deserving of pain and punishment?" Each item was rated on a Likert scale from 0 (*not at all*) to 9 (*very much*). Higher scores indicated greater levels of state self-critical and self-punishment cognitions at the present moment. In the current study, we calculated aggregate state scores by taking the average of all self-critical and self-punishment cognition scores across all signal-contingent assessments.

ANALYTIC STRATEGY

To examine differences in trait self-critical and self-punishment cognitions between groups, we first employed invariance testing to examine whether the trait self-criticism measure (SRS; validated original eight-item measure) was comparable across comparison groups. For factorial invariance estimation analyses, the SRS items were treated as ordered categorical, given that the responses were integer values on a Likert scale; a weighted least squares estimator was utilized. To examine differences in state self-critical and self-punishment cognitions between groups free from measurement error, we used multilevel confirmatory factor analysis on the state self-critical and self-punishment cognition items to attain factor scores that partition both within and between participant variance. For multilevel factor analyses, self-critical and self-punishment cognition items were treated as continuous, and a maximum likelihood estimator with robust standard errors was employed. Of note, we also examined differences in trait and state self-critical and self-punishment cognitions between groups utilizing the raw scores of both the trait and aggregated mean self-critical and self-punishment cognition scores.

Invariance Testing

First, we examined the extent to which the SRS scale was comparable across our comparison groups. To do so, we examined the factorial invariance of a single-factor SRS model across participants who reported engaging in NSSI (NSSI+) and those who did not (NSSI–). We examined three levels of measurement invariance, where each level is established sequentially (Meredith, 1993). Each level requires placing equality constraints on model parameters across groups, and examining changes in model fit as a result of equality constraints. Configural invariance is established when the latent SRS model shows the same patterns of indicator loadings across groups. To examine configural invariance, we evaluated the fit of a single-factor confirmatory factor analysis (CFA) model in both the NSSI+ and NSSI– groups. Metric invariance requires that indicator loadings be identical across groups. Strong invariance requires that indicator intercepts be identical across groups. Metric and strong invariance are examined in a single step, wherein factor loadings, as well as indicator thresholds, are simultaneously constrained to equality across groups, and model fit is compared with that of the configural model. Once factorial invariance was achieved, we parameterized a single-factor SRS model across the entire sample and saved the factor scores from this model to use in subsequent regression analyses.

Multilevel Modeling

We utilized multilevel CFA (MCFA; Heck & Thomas, 2015; Mehta & Neale, 2005; Sadikaj et al., 2019) for the concurrent examination of multiple indicators within a multilevel framework. This approach permits the partitioning of observed variables into latent between- and within-person portions. Further, it takes into account the nature of the nested (repeated observations per person across the 10 days of the study), multivariate (multiple ratings of self-criticism and self-punishment daily), and time-structured (individual observations are ordered in time) nature of the current data. Following the strategy outlined by Sadikaj et al., we parameterized separate single-factor self-criticism and self-punishment models comprising individuals' three self-criticism and self-punishment ratings per day at both the within- and between-person levels. The within-person factors account for the shared variance among daily self-criticism and self-punishment ratings (i.e., day-level differences in self-criticism and self-punishment); the between-person factors account for the individual differences among mean criticism and punishment scores (i.e., individual-level differences in self-criticism and self-punishment).

Evaluation of model fit for MCFA models must be done in a level-specific manner, because evaluating the fit of the entire model can obscure localized areas of misfit at either the within- and between-person levels (Ryu & West, 2009). To evaluate model fit at the between-person level, the within-person level was saturated (i.e., identified with 0 *df*; all correlations among indicators at the between-person level are estimated). To evaluate model fit at the within-person level, the between-person level was saturated (i.e.,

Table 1
Descriptive and Temporal Instability Statistics for State Self-Criticism and Self-Punishment

	Descriptive statistics		Instability statistics	
	M (range)		TC MSSD (range)	
Variable	NSSI–	NSSI+	NSSI–	NSSI+
SC	1.27 (.00-7.28)	2.43 (.00-7.22)	2.37 (.00-12.82)	4.14 (.00-15.01)
SP	0.15 (.00-3.91)	0.58 (.00-6.74)	0.54 (.00-9.94)	1.76 (.00-10.14)

Note. *M* = mean; TC MSSD = time-corrected mean squared successive differences; NSSI = nonsuicidal self-injury; SC = self-critical cognitions; SP = self-punishment cognitions.

identified with 0 *df*; all correlations among indicators at the within-person level are estimated). The portion of the model that was saturated does not contribute to the ill fit of the model; consequently, the fit statistics can be used to evaluate level-specific model fit of the nonsaturated level. Between-person factor scores were then saved for subsequent use in regression analyses.[1]

Of note, we also examined Aim 1 through employing a series of binary logistic regressions utilizing the raw scores of both the trait and aggregated mean self-critical and self-punishment cognition scores. Analyses were conducted in Mplus (Version 8; Muthén & Muthén, 2017) for invariance testing and multilevel modeling, and in *R* using the stats package for regression analyses (Version 1.2.5019; R Core Team) and the Cocor package (Diedenhofen & Musch, 2015) for the correlation comparison analyses.

Temporal Instability

We used SPSS (Version 23.0) to examine the temporal instability of self-critical and self-punishment cognitions by calculating time-corrected mean squared successive difference (MSSD), an index of instability that incorporates both the variability and temporal dependency of state measures (Jahng et al., 2008). In the current study, the MSSD score reflects the average of squared differences between successive self-reported state self-critical and self-punishment cognition scores (Jahng et al., 2008).

Results

Participants in the NSSI+ group engaged in a mean of 54.34 lifetime NSSI acts (*SD* = 124.8, range = 2–720), employing an average of 1.97 methods (*SD* = 1.07, range = 1–6). Approximately 43.75% (*n* = 28) of participants reported engaging in NSSI over the past year, 20.3% (*n* = 13) over the past month, and 4.7% (*n* = 3) over the past week. A total of 73.4% (*n* = 47) endorsed cutting or carving skin, 26.6% (*n* = 17) scraping skin to the point of drawing blood, 25% (*n* = 16) hitting self on purpose, 18.8% (*n* = 12) burning skin, 6.3% (*n* = 4) inserting sharp objects into skin or nails, 18.8% (*n* = 12) picking areas of body to the point of drawing blood, 1.6% (*n* = 1) giving self a tattoo,[2] and 26.6% (*n* = 17) other.

Participants across groups in the present study completed 3,269 signal-contingent alerts, such that participants completed an average of 88.93% of the three times daily alerts over the 10-day study period (*M* = 26.68, *SD* = 3.49). The NSSI+ and NSSI– groups completed signal-contingent alerts at similar rates, $t(121) = 1.40$, $p = .166$, $d = 0.25$. For the purpose of the present study, only alerts that were completed within 60 minutes of the time at which the alert was sent were used in the present analyses to ensure alerts were temporally ordered (2,912 total signal-contingent alerts; 78.9% of the three times daily alerts). The NSSI+ and NSSI– groups completed signal-contingent alerts within this 60-minute time frame at similar rates, $t(121) = -.396$, $p = .639$, $d = 0.07$.

Table 1 depicts descriptive statistics for the EMA measures of self-critical and self-punishment cognitions. Significant correlations were found between trait and state self-critical cognitions measures ($r = .538$, $p < .001$) and between trait and state self-punishment cognitions measures ($r = .581$, $p < .001$).

DO TRAIT AND AGGREGATED STATE LEVELS OF SELF-CRITICAL AND SELF-PUNISHMENT COGNITIONS DIFFER BETWEEN YOUNG ADULTS WITH AND WITHOUT A HISTORY OF NSSI?

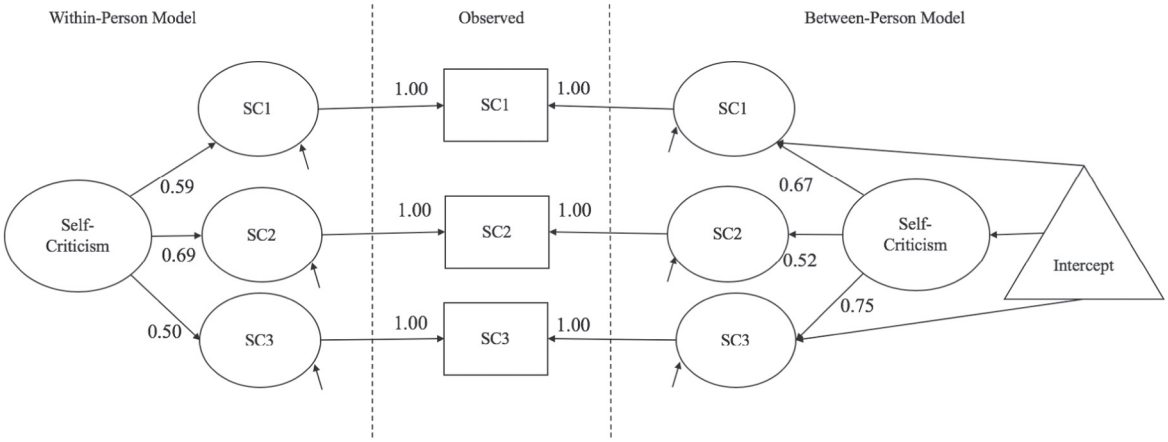
SRS Factorial Invariance

Configural invariance. Due to a relative lack of endorsement of the highest values for Item 3 on the SRS (see Hooley et al., 2010) in the NSSI–

[1] When we attempted to conduct regression analyses in a multilevel structural equation modeling framework in Mplus, the models did not converge. To circumvent this issue, we proceeded by saving factor scores and utilizing them as manifest variables in regression analyses in *R*.

[2] It is debated whether this method of self-harm should be considered NSSI, given that tattoos are socially sanctioned. We note that this participant engaged in several additional methods of NSSI.

Self-Critical Cognition Multilevel Confirmatory Factor Analysis Model



Self-Punishment Cognition Multilevel Confirmatory Factor Analysis Model

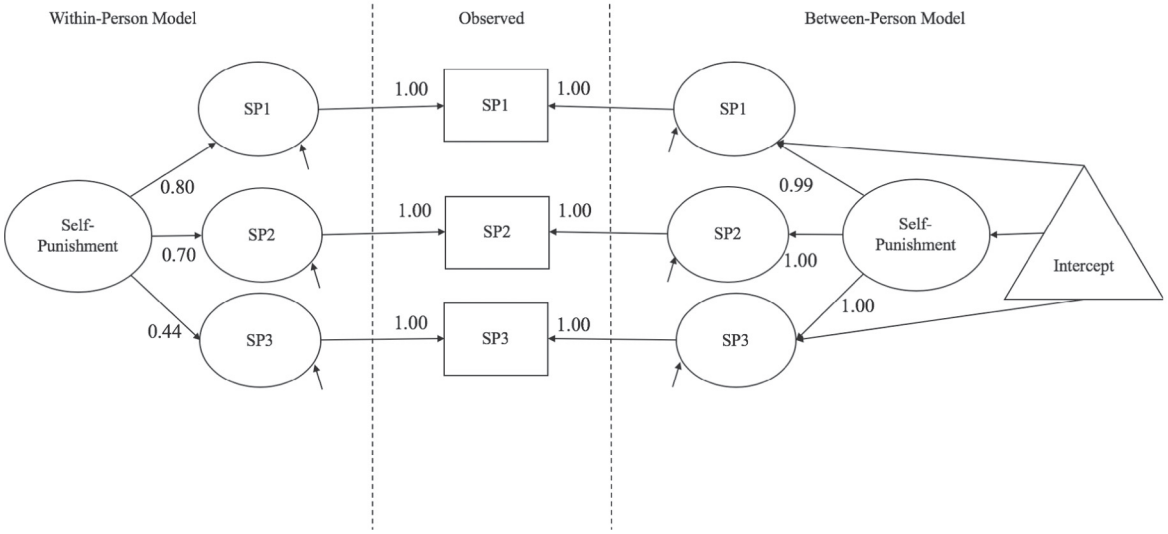


FIGURE 1 *Note.* SC = self-critical cognitions; SP = self-punishment cognitions.

group, we collapsed the top two response options across both the NSSI+ and NSSI– groups before proceeding. The single-factor SRS model demonstrated adequate fit in both the NSSI+ (CFI = .95, TLI = .93, RMSEA = .21) and NSSI– (CFI = .98, TLI = .98, RMSEA = .14) groups when estimated in separate models. Similarly, when estimated in a multigroup analysis—wherein separate CFA models are parameterized in both the NSSI+ and NSSI– groups simultaneously—the configural model demonstrated excellent fit to these data (CFI = .98, TLI = .96, RMSEA = .05). Factor loadings for configural models are presented in Supplementary Table 1.

Metric and strong invariance. Constraining factor loadings and thresholds to equality across groups resulted in a similarly well-fitting model (CFI = .97, TLI = .97, RMSEA = .05) when compared with the configural modal, with additional parsimony.

Group mean differences. Given that strong invariance was achieved across groups, we then examined differences in self-critical cognitions factor means between groups. To do so, we parameterized the single-factor model across both groups. We constrained the factor mean to 0 in the NSSI– group, and we allowed the factor mean in the

NSSI+ group to be freely estimated. Therefore, the factor mean in the NSSI+ group represents the difference—in standard deviation units—of the mean factor level in the NSSI+ group when compared with that of the NSSI– group. Similar to the results found using scale scores, individuals who engaged in NSSI were significantly higher on the SRS than those who did not ($M = 0.67$, $p < .001$).

SRS factor model across groups. Inasmuch as we found evidence for factorial invariance, we parameterized a single-factor SRS model across both the NSSI+ and NSSI– groups, with all item indicators in their original metric (i.e., we did not collapse the highest response options to Item 3 in these analyses). This single-factor model demonstrated good fit to these data (CFI = .95, TLI = .94, RMSEA = .07). Factor loadings are presented in Supplementary Table 2.

Multilevel Analyses

Self-criticism. The single-factor self-criticism model fit the data well (CFI/TLI > .99, RMSEA < .001). In addition, when individual-level fit was examined, the model demonstrated excellent fit at both the within- (CFI/TLI > .99, RMSEA < .001) and between- (CFI/TLI > .99, RMSEA < .001) factor levels. Standardized factor loadings are presented in Figure 1.

Self-punishment. The single-factor self-punishment model fit the data well (CFI/TLI > .99, RMSEA < .001). In addition, when individual-level fit was examined, the model demonstrated excellent fit at both the within- (CFI/TLI > .99, RMSEA < .001) and between- (CFI/TLI > .99, RMSEA < .001) factor levels. Standardized factor loadings are presented in Figure 1.

Group Classification Analyses

A binary logistic regression demonstrated that the SRS factor score significantly predicted group status (log $OR = 0.93$, $SE = 0.23$, $z = 4.11$, $p < .001$). Similarly, the MCFA self-critical and the self-punishment between-individual factor scores were associated significantly with group status (see Table 2). Providing evidence of the stability of these findings, univariate binary logistic regressions were run with the raw SRS total score, self-punishment cognitions trait item, and state self-critical and self-punishment cognitions aggregated means, and all were significantly, positively related to group status (see Table 3).

To examine our exploratory aim, to ascertain the relative strength of the relationships between raw trait and state self-critical cognitions and group status, and between raw trait and state self-punishment cognitions and group status, we examined whether the correlation relationships were significantly different from one another. We found that there was no significant difference in the strength of relationships between raw trait and state self-critical cognitions and group status (Zou's CI [–0.28, 0.04]). However, we found that there was a significant difference observed in self-punishment cognitions, such that although both trait and state self-punishment cognitions were significantly correlated with group status, trait self-punishment cognitions had a significantly stronger relationship with group status (Zou's CI [–0.31, –0.01]).

Temporal Instability of Self-Critical and Self-Punishment Cognitions

Time-corrected MSSD was calculated for self-critical and self-punishment cognitions for both groups. Table 1 depicts the raw MSSD scores. Findings demonstrate that self-critical and self-punishment MSSD scores were associated significantly with group status (see Table 4), such that significantly greater fluctuations in self-critical and self-punishment cognitions were associated with NSSI+ group membership.

Discussion

Our findings provide evidence supporting the Benefits and Barriers Model of NSSI. Employing bivariate and multivariate frameworks, our results demonstrate that both trait and state levels of self-critical and self-punishment cognitions robustly differentiate between young adults with and

Table 2
Binary Logistic Regression Models of Group Membership Classification Using MCFA Standardized Factor Scores

Predictors	Log odds (*SE*)	*z* value
SC between	0.63 (0.21)	3.00**
SP between	0.82 (0.38)	2.14*

Note. MCFA = multilevel confirmatory factor analysis; *SE* = standard error; SC = self-critical cognitions; SP = self-punishment cognitions; between = MCFA between-persons factor score.
* <0.05, ** <0.01, *** <0.001.

Table 3
Binary Logistic Regression Models of Group Membership Classification Using Raw Values

Predictors	Log odds (*SE*)	*z* value
Self-Rating Scale	0.07 (0.02)	4.19***
Self-punishment item	0.84 (0.23)	3.71***
SC aggregated mean	0.30 (0.10)	3.01**
SP aggregated mean	0.83 (0.38)	2.11*

Note. *SE* = standard error; SC = self-critical cognitions; SP = self-punishment cognitions.
* <0.05, ** <0.01, *** <0.001.

Table 4
Binary Logistic Regression Models of Group Membership Classification Using Indices of Temporal Instability

Predictors	Log odds (*SE*)	*z* value
SC TC MSSD	0.17 (0.06)	2.74**
SP TC MSSD	0.35 (0.13)	2.70**

Note. *SE* = standard error; SC = self-critical cognitions; SP = self-punishment cognitions; TC MSSD = time-corrected mean squared successive differences.
* <0.05; ** <0.01; *** <0.001.

without a lifetime history of NSSI. The present results also confirm that the temporal instability of these cognitive states also differentiates meaningfully between groups, such that those who exhibit greater fluctuations in these cognitive states are more likely to have a history of NSSI.

The first aim of this study was to assess whether trait and state levels of self-critical and self-punishment cognitions differ between young adults with and without a history of NSSI. We found that higher levels of trait self-critical and self-punishment cognitions, as well as greater aggregated raw mean state levels of self-critical and self-punishment cognitions were associated with a history of NSSI. Our findings were confirmed through the employment of MCFA. Employing MCFA permitted us to partition error variance from our repeated measures of self-critical and self-punishment cognitions and estimate latent between- and within-person portions while taking into account the nature of the nested, multivariate, and time-structured nature of the current data. Our results indicate that individuals with a history of engagement in NSSI showed that they not only portray themselves as more self-critical and deserving of pain and punishment on measures asking them to provide a static characterization of themselves, but also that they experience these cognitions to a greater degree in real time.

Correlations between trait and state measures of self-critical cognitions were strong; similarly, correlations between trait and state self-punishment cognitions were strong. These correlations suggest that our trait and state measures share significant variance. However, the exploratory aim of this study was to examine the *relative* strength of relationships between trait and state self-critical and self-punishment cognitions and NSSI history (e.g., group status). Findings suggested that there was no significant difference in the strength of relationships between state and trait self-critical cognitions and NSSI history. However, results suggest that trait self-punishment cognitions were more strongly associated with NSSI history than state self-punishment cognitions. These findings suggest that trait and state self-critical cognitions, and trait and state self-punishment cognitions, respectively share significant variance, and that trait levels of self-punishment cognitions may capture variance beyond that of state levels. Even though trait self-punishment cognition measures in this study appear to offer superior incremental validity in terms of classification of groups, it is not clear whether this would be the case when evaluating the prediction of proximal risk for NSSI; future research is needed in this area.

Our findings demonstrate that NSSI+ participants not only experience more severe self-critical and self-punishment momentary cognitions but also that they experience greater fluctuations in these cognitive experiences than their non-self-injuring counterparts. Our confidence in this finding is strengthened given our employment of a statistic of temporal stability that takes into account both the variability and the temporal dependency of these state measures. As previously outlined, evidence of affective temporal instability has been found in those with a history of NSSI (e.g., Bresin, 2014; Santangelo et al., 2017; Selby et al., 2013). The current study extends this body of research suggesting that those with a history of NSSI also experience heightened temporal instability in their experience of self-critical and self-punitive negative self-focused cognitions. It is possible that the rapid fluctuation of these cognitive states may contribute to the aversive internal states that typically precede episodes of NSSI, inasmuch as NSSI may be used to stabilize these cognitions; future research should explore this hypothesis. Future EMA research also should investigate the extent to which these cognitive states are regulated through engagement in NSSI, which may provide greater ecologically valid evidence for the Benefits and Barriers Model of NSSI (Hooley & Franklin, 2018) and the Defective Self Model of NSSI (Hooley et al., 2010).

The emotional cascade model of NSSI (Selby et al., 2013) suggests that "cascades" of ruminative thinking (i.e., perseverative thinking about one's feelings and problems) and negative emotions lead to the distressing internal states that NSSI serves to regulate. Ecologically valid research supports this model, suggesting that instability in ruminative thinking and negative emotionality interact to predict NSSI engagement (Hughes et al., 2019; Selby et al., 2013). Future research should examine the extent to which self-critical and self-punitive cognitions may be the content of such ruminative thinking. Future research should also investigate the temporal relations between affective and negative self-focused cognitive states in those with

a history of NSSI to determine whether the instability in these cognitive states may be considered a downstream or upstream effect of affective dysregulation, as the real-time direction of the observed effects may inform treatment development.

CLINICAL IMPLICATIONS

Identifying indices of cognitive vulnerability associated with NSSI history may serve to enhance our risk models and identify target mechanisms for timely and sensitive intervention. Cognitive-behavioral intervention approaches emphasize the identification and modification of maladaptive cognitions and have proven effective for treating and preventing a range of psychiatric problems, such as self-harm in adults (see Hawton et al., 2016, for a review). Despite advances in the efficacy of interventions targeting self-harm behaviors, few studies have directly tested mechanisms of change in the context of psychosocial interventions. Self-critical and self-punishment cognitions may be important mechanisms to assess, both at the trait and state levels, to determine whether changes in these cognitions lead to reductions in NSSI behaviors over the course of treatment. In addition, studies are needed to examine the developmental trajectory of these cognitive processes, as it is also possible that self-critical and self-punishment cognitions serve as indicators of enhanced risk for the development of NSSI behaviors, informing preventive intervention development.

STRENGTHS AND LIMITATIONS

The current study has several important strengths that build upon prior research in this area. First, we examined both state- and trait-level cognitions, employing ecologically valid methods to capture self-critical and self-punishment cognitions in real time. Although studies have largely relied on trait-level measures of these cognitions, few have utilized ecologically valid designs that offer several advantages to conventional self-report measures (i.e., reduced recall bias, sensitivity to the dynamics of cognitive processes, temporally delineated assessments). We also examined self-critical and self-punishment cognitions in young adults both with and without a history of engaging in NSSI. To date, studies employing ecologically valid designs largely have examined mechanisms of risk in samples of individuals with NSSI histories, and relatively fewer also have included a control group with no self-injury history. Our findings are strengthened by high compliance rates with the EMA protocol across both groups, which support the feasibility of using this methodology in high-risk groups. The results are further strengthened by the use of invariance testing to ensure the validity of comparing the SRS across groups. Identical results across aggregated state-level cognitions and modeled with MCFA similarly increase our confidence in our results.

The present study has some methodological limitations to consider. First, the inclusion criterion for the NSSI+ group was a minimum of two lifetime NSSI acts—as a result, the NSSI+ group may be considered heterogeneous in their severity and recency of NSSI. Future studies should consider replicating the current findings in a sample meeting criteria for NSSI disorder, a disorder included in the fifth edition of *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013) as one for further study. Although recent evidence suggests that the proposed NSSI frequency threshold (engaging in NSSI on 5+ days within the past 12 months) for this disorder lacks validity, and future research is needed to inform a clinically meaningful cutoff (Muehlenkamp et al., 2017), employing this higher threshold may reduce sample heterogeneity and increase generalizability to a clinical population. However, it is important to consider that those with *any* history of NSSI, let alone repetitive history, are at greater risk for future NSSI (Fox et al., 2015) and future suicidal behavior (Ribeiro et al., 2016), suggesting that the NSSI+ group examined in this study represents a relatively clinically high-risk sample. Second, although we employed an EMA design, we did not examine the prospective associations between self-critical and self-punishment cognitions and NSSI thoughts or behaviors in this paper. Examining prospective relations was beyond the scope of the present report, which focuses on evaluating differences in these trait and state cognitions in young adults with and without a lifetime history of NSSI. Third, whereas the SRS is a well-validated scale for the assessment of self-critical thoughts, a single item was employed to assess trait self-punishment. Additionally, the state self-critical and self-punishment cognition assessment via EMA consisted of single-item prompts. Notably, it is common for EMA studies to use single-item measures (e.g., Hughes et al., 2019; Nock, 2009) as the demands of completing surveys multiple times per day requires concise assessment batteries. Nevertheless, our design presents challenges for assessing the reliability and validity of the items used to capture momentary cognitions. Fourth, our single-item assessment of self-punishment cognitions conflates feeling deserving of pain and feeling deserving of punishment. We encourage future

research to examine these constructs separately to ascertain their individual trait and state associations with NSSI urges, and to determine whether examining them as distinct constructs is justified. Further, the optimal assessment (e.g., content and number of items) of state-level self-critical and self-punishment cognitions remains to be determined. Studies utilizing EMA to validate effective methods for capturing state-level changes of these cognitions and assessing the context under which they occur are needed (Horstmann & Ziegler, 2020). Finally, it is possible that constructs associated with both self-critical and self-punishment cognitions and NSSI (e.g., symptoms of depression) may underly their relationships, and future studies should investigate such constructs as potential mediators. Despite these challenges, EMA provides a unique opportunity to assess temporal features of cognitive and affective processes, that in conjunction with static methods may illuminate critical target mechanisms for the prevention of NSSI behaviors.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.beth.2020.08.006.

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