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Research Trends

Using Propensity Scores to Examine the Association Between Behavioral Inhibition/Activation and Nonsuicidal and Suicidal Self-Injury

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Abstract. *Background:* Self-injurious behavior (e.g., nonsuicidal self-injury, suicide attempts) is a serious public health concern. One potentially important but understudied predictor of nonsuicidal and suicidal self-injury involves the behavioral inhibition and activation system (BIS/BAS). *Aims:* The goal of the current study was to examine the relationship between nonsuicidal and suicidal self-injury and BIS/BAS, and to consider the influence of related variables in the relationship. Examination through this framework allowed us to consider BIS and BAS as potential unique risk factors of self-injury. *Method:* After examining the relationship between nonsuicidal and suicidal self-injury and BIS/BAS among 1,912 participants, we used propensity scores to match participants' propensity for nonsuicidal self-injury and suicide attempts based on demographic variables (e.g., gender, age) and related risk factors (e.g., anxiety, depressive symptomology, impulsivity, and substance use problems). *Results:* Participants who reported nonsuicidal self-injury or attempted suicide scored higher on BIS and BAS compared with those without a history of these behaviors. After matching procedures, however, the only group difference found was on BIS between those with and without a history of nonsuicidal self-injury. *Conclusion:* Results support the notion that the behavioral inhibition system might play a role in nonsuicidal self-injury but not in suicidal self-injury.

Keywords: nonsuicidal self-injury, suicidal self-injury, behavioral inhibition, behavioral activation, propensity scores

Self-injurious behavior, a construct encompassing both nonsuicidal self-injury (NSSI) and suicide attempts (SA), is a problem of widespread concern. Lifetime prevalence rates of NSSI are estimated at 6% (Klonsky, 2011; Swannell, Martin, Page, Hasking, & St. John, 2014) and 5% for SA (Kessler, Borges, & Walters, 1999). NSSI and SA are considered distinct but related constructs, as both involve intentional self-harm, but vary in intention to die. NSSI and SA have many risk factors in common, including several forms of psychopathology. Depression and anxiety (Beck, Steer, Beck, & Newman, 1993; Chartrand, Sareen, Toews, & Bolton, 2012; Kerr & Muehlenkamp, 2010; Sareen et al., 2005), in addition to substance abuse (Gratz & Tull, 2010; Hilt, Nock, Lloyd-Richardson, & Prinstein, 2008; McManama O'Brien, Becker, Spirito, Simon, & Prinstein, 2014; Moller, Tait, & Byrne, 2013; Whiteside & Lynam, 2001), have been implicated in both NSSI and SA. Furthermore, the various facets of impulsivity (e.g., negative urgency, sensation seeking) have also been hypothesized to play a strong role in both NSSI and SA (Bender, Gordon, Bresin, & Joiner, 2011; Glenn & Klonsky, 2010; McCloskey, Look, Chen, Pajoumand, & Berman, 2012). Despite the attention on these constructs in the literature, they have demonstrated only moderate effect sizes in the prediction of NSSI and SA (e.g., $\eta^2 = 0.20$ for depression and anxiety in NSSI prediction; Kerr & Muehlenkamp, 2010), suggesting that the exploration of other risk factors is warranted.

The behavioral inhibition and activation system is understudied with respect to NSSI and SA (BIS/BAS; Gray, 1976, 1987, 1994). The behavioral inhibition system (BIS)/behavioral activation system (BAS) is a motivational system designed to identify and respond to stimuli associated with punishment or reward. More specifically, the BIS reflects a sensitivity to punishment such that this system is activated when an individual inhibits a behavior, or en-

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gages in a behavior, to avoid a punishing stimuli. On the other hand, the BAS is activated when an individual engages in an approach behavior toward a reward, reflecting a sensitivity to reward. Individual differences may exist in BIS and BAS; for example, one's sensitivity to punishing stimuli may increase their motivation to avoid such stimuli (Gray & Smith, 1969). Individual differences in BIS/BAS have been implicated in the occurrence of psychopathology, including depression, anxiety, and substance abuse (Campbell-Sills, Liverant, & Brown, 2004; Carver & White, 1994). Given the potential of such individual differences, in addition to the role that BIS/BAS may serve to regulate both affect and behavior, it seems reasonable to postulate this system also influences NSSI and SA.

Little research has directly examined the relationships between BIS/BAS and NSSI/SA, and many of these findings have been mixed. For example, both BIS and BAS have been associated with NSSI in a college sample (Cohen et al., 2014; Hamza & Willoughby, 2013; Jenkins, Sellbach, Conner, & Alloy, 2013) whereas only BIS was found to be predictive of suicidal ideation among those with a previous SA in college and clinical samples (O'Connor & Forgan, 2007; Rasmussen, Ellito, & O'Connor, 2012). One possible reason for the differing findings between NSSI and SA is that BIS and BAS may demonstrate unique relationships with each behavior. Another possibility, however, is that previous research has failed to account for individual differences in depressive symptomology, anxiety, substance use problems, and impulsivity – variables associated with both nonsuicidal and suicidal self-injury (Brunelle, Douglas, Pihl, & Steward, 2009; Carver & White, 1994; Franken & Muris, 2006; Hilt et al., 2008; Lynam, Miller, Miller, Bornovalova, & Lejuez, 2011; Moller, Tait, & Byrne, 2013; Scott-Parker, Watson, King, & Hyde, 2012; Seibert, Miller, Pryor, Reidy, & Zeichner, 2010), which may influence these relationships. To our knowledge, no study to date has considered these risk factors when examining the relationship between NSSI, SA, and BIS/BAS.

The goal of the current study was to examine the relationship between NSSI and BIS/BAS, in addition to SA and BIS/BAS. First, we aimed to replicate previous research findings of a positive association between BIS and BAS with NSSI, and BIS with SA. We next used propensity score matching (PSM) to examine these relationships. PSM estimates an individual's propensity to engage in certain behavior (e.g., NSSI, SA) based on covariates included in the model. The current model covariates included depressive symptomology, anxiety, substance use, and impulsivity, as these factors have strong implications in NSSI and SA. In line with recent research (e.g., Thibodeau, Welch, Sareen, & Asmundson, 2013), using PSM in a nonexperimental design allows for a more direct comparison of the relation between BIS and BAS with NSSI and SA than do traditional statistical techniques (e.g., ANCOVA). Examining the relationship between NSSI and SA with BIS/BAS in this framework will allow us to consider BIS and BAS as potential unique risk factors for each behavior as opposed to shared risk with other correlated factors.

Method

Participants

Participants were 1,912 undergraduate students from a large (e.g., approximately 30,000 students) urban university in Philadelphia, Pennsylvania. Participants were categorized based on their history of NSSI (no NSSI, $n = 1{,}341$; five or more NSSI acts, $n = 358$) and SA (no SA, $n = 1{,}838$; one or more SA, $n = 74$). The cut-off of five NSSI acts was chosen because it is the minimum number of acts needed to meet criteria for NSSI Disorder (APA, 2013). Sixty participants reported a history of both NSSI and SA; they were included in each set of analyses (SA+ and NSSI+). Individuals who reported from one to four lifetime acts of NSSI ($n = 213$) were excluded from NSSI analyses. The final sample consisted of participants (61% female) aged 17–57 years ($M = 21.01$, $SD = 3.46$). Approximately 61% of the sample identified as Caucasian, 13% Asian, 13% African American, and less than 1% as American Indian or Alaskan Native, or Native Hawaiian or Pacific Islander. Additionally, approximately 4% identified as more than one race, 6% identified as *other*, and 2% refused to answer.

Measures

Nonsuicidal Self-Injury

NSSI history was assessed with the Form and Function of Self-Injury (FAFSI; Jenkins, Connor & Alloy, 2011), a self-report measure consisting of two sections. Only the first section was used in the current study, which inquires about 13 different forms of NSSI. The second section, which asks about the reasons for engaging in NSSI (e.g., functions), was not used in the current study as these variables were not of interest. Participants are asked if they have engaged in several NSSI behaviors, in addition to their age at their first act, and number of lifetime acts. The current study used the cut-off of five lifetime NSSI acts. Potential NSSI acts included cutting self, carving skin, burning self, and banging head, in addition to eight other behaviors. The internal consistency of the measure has been supported (Jenkins et al., 2011).

Suicidal Self-Injury

The Suicide Behavior Questionnaire – Revised (SBQ-R; Osman et al., 2001), a 4-item self-report measuring dimensions of suicidality, was used to assess the presence of suicide attempts. Only the item regarding lifetime suicide attempts was used in the current study (e.g., "I have attempted to kill myself"). The current study used the criteria of the presence of a lifetime suicide attempt. The measure's internal consistency has been established in an undergraduate sample, $\alpha = 0.76$ (Osman et al., 2001).

BIS/BAS

BIS and BAS were assessed using the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Avila, Molto, & Caseras, 2001). The SPSRQ is a 48-item self-report measure, consisting of two subscales: sensitivity to punishment (SP; 24 items) and sensitivity to reward (SR; 24 items), developed to measure BIS and BAS, respectively. Consistent with recent changes to the child version of the SPSQR, we used a 5-point Likert scale (e.g., 1 = *very untrue of me*; 5 = *very true of me*; Luman, van Meel, Oosterlaan, & Geurts, 2012). The reliability and validity of the SPSRQ has been established (Conner, Jenkins, & Seelbach, 2010; O'Connor, Colder, & Hawk, 2004; Torrubia et al., 2001). In the current sample, the SP ($\alpha = 0.88$) and SR ($\alpha = 0.85$) subscales demonstrated good internal consistency.

Anxiety

The Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990) is a 16-item self-report measure assessing the tendency to engage in excessive, uncontrollable, and generalized worry. Items were answered on a 5-point Likert scale (e.g., 1 = *not at all typical of me;* 5 = *very typical of* me). The questionnaire has demonstrated excellent internal consistency, test–retest reliability, and validity (Brown, Antony, & Barlow, 1992; Meyer et al., 1990; Molina & Borkovec, 1994). In the current study, the scale demonstrated excellent reliability, $\alpha = 0.92$.

Depressive Symptomology

The Quick Inventory of Depressive Symptomology – Self-Report (QIDS; Rush et al., 2003) is a 16-item self-report measure used to assess depressive symptomology based on the DSM-IV-TR major depressive episode criteria. Items were summed to create a total score. The internal consistency and construct validity of this measure have been supported (Rush et al., 2003). In the current study, the scale had acceptable reliability, $\alpha = 0.78$.

Alcohol Use

The Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, de la Fuente, & Grant, 1993) is a 10-item self-report measure of alcohol use problems, including the domains of alcohol consumption (two items), drinking behavior (six items), and alcohol-related problems (two items). Items were summed to create a total score. The internal consistency (Saunders et al., 1993), and concurrent, construct, and discriminant validity (Bohn, Babor, & Kranzler, 1994) of the measure have been supported. In the current study the measure demonstrated good reliability, $\alpha = 0.87$.

Drug Use

The Drug Use Disorder Identification Test (DUDIT; Berman, Bergman, Palmstierna, & Schlyter, 2005) is an 11-item self-report measure of nonalcohol substance use problems, which evaluates level of drug intake (three items) and potential drug abuse and dependence (eight items). Items were summed to create a total score. The internal consistency and construct, convergent, and discriminant validity of this measure have been supported (Berman et al., 2005; Voluse et al., 2012). In the current study, the DUDIT demonstrated excellent reliability, $\alpha = 0.90$.

Impulsivity

The UPPS-P Impulsive Behavior Scale (UPPS-P; Whiteside & Lynam, 2001) is a 45-item self-report measure used to assess overall impulsivity and the five dimensions of impulsivity. Items were answered on a 4-point Likert scale (e.g., 1 = *strongly disagree*; 4 = *strongly agree*). The measure's internal consistency (Whiteside & Lynam, 2001) and construct validity have been supported (Whiteside, Lynam, Miller, & Reynolds, 2005). In the current study, the subscales demonstrated good reliability: negative urgency, $\alpha = 0.87$; premeditation, $\alpha = 0.88$; perseverance, $\alpha = 0.83$; sensation seeking, $\alpha = 0.88$; and positive urgency, $\alpha = 0.95$.

Procedures

Participants completed a series of self-report measures as part of a larger study on aggression and self-aggression on a secure website. All participants provided informed consent before taking part and all procedures were approved by the university Institutional Review Board (IRB). Participants received course credit for their participation.

Data Analysis

Group-level analyses were conducted on the entire sample to assess for NSSI+/NSSI− and SA+/SA− group differences on BIS, BAS and related constructs. Given the number of group comparisons, an alpha value of 0.01 was used for

all preliminary analyses. Groups were then each submitted to a propensity score-matching procedure. As there were less than 2% missing data, prior to matching, the predictor and covariate scales were randomly imputed (Gelman & Hill, 2006). The propensity score for each participant was calculated, incorporating 11 statistical covariates including demographic variables (i.e., gender, age), depressive symptoms, anxiety, alcohol and nonalcohol drug use problems, and impulsivity scales. Race was not included because it was neither dichotomous nor linear. The propensity score represents an individual's propensity to engage in a behavior (e.g., NSSI, SA) based on their reported levels of these covariates. Participants in each group (e.g., NSSI+ vs. NSSI−, SA+ vs. SA−) were subsequently matched using the nearest neighbor matching algorithm (Caliuendo & Kopeinig, 2008) and without replacement, wherein individuals were not allowed to match with more than one individual. Matching was conducted using the MatchIt package in R statistical software (Ho, Imiai, King, & Stuart, 2007a, 2007b). Following matching procedures group-level analyses were conducted on the matched data to assess for NSSI+/NSSI− and SA+/SA− group differences on BIS and BAS.

Results

Preliminary Results

Initial correlational analysis of the study variables (Table 1) showed an overall pattern of significant, small-to-moderate correlations across most of the scales. Sensitivity to punishment (SP) and sensitivity to reward (SR) scales were positively correlated with each other, in addition to all of the covariates, with the exception of a nonsignificant relationship between SR and perseverance. With respect to covariates, anxiety was not significantly correlated with perseverance, alcohol use problems, and nonalcohol drug use problems. Premeditation was also not significantly related to nonalcohol drug use problems. All other correlations between covariates revealed significant positive or negative relationships.

To evaluate whether group differences existed on the study covariates (e.g., NSSI+ vs. NSSI−, SA+ vs. SA−), a series of t tests (and χ^2 for gender) were conducted. NSSI+ participants reported greater levels of anxiety, depressive symptoms, alcohol and nonalcohol use problems, and impulsivity across all subscales, with the exception of (lack of) premeditation. Furthermore, the NSSI+ group was more likely to be female, but did not differ with respect to age (see Table 2). SA+ participants reported greater levels of anxiety, depression, negative urgency, sensation seeking, positive urgency, and drug use problems. They were also more likely to be female. Groups did not differ with respect to age, premeditation, perseverance, or alcohol use problems (see Table 3).

NSSI

Group-level analyses were first conducted on all data. The NSSI+ group ($M = 52.19, SD = 14.62$) reported higher levels of SP than the NSSI− group ($M = 44.75$, $SD = 16.20$), t (1,520) = −7.66, $p < .001$, 95% CI = −9.46−−5.60. The NSSI+ group ($M = 48.46$, $SD = 12.83$) also reported higher levels of SR than the NSSI− group ($M = 13.46$, $SD = 1346$), t (1,517) = −4.67, $p < .001$, 95% CI = −5.31−−2.07.

Propensity score matching procedures were conducted, incorporating the 11 statistical covariates. Participants belonging to the NSSI+ and NSSI− groups were subsequent-

Table 1. Correlation matrix of sensitivity to reward, sensitivity to punishment, and covariates

	SP	SR	A	D	NU	Prem.	Pers.	SS	PU	Alc.
SR	.48**									
A	.54**	.18**								
D	.35**	.19**	.43**							
NU	.47**	.48**	.40**	.43**						
Prem.	.30**	.11**	.11**	.01	−.06*					
Pers.	−.10**	.003	.003	−.23**	−.27**	.61**				
SS	−.10**	.31**	−.14**	−.04	.12*	.17**	.32**			
PU	.25**	41**	.14**	.29**	.61**	−.18*	−.27**	.14**		
Alc.	.06*	.32**	.04	.17**	.28**	−.13**	−.13**	.20**	.29**	
Drug	.07*	.22**	.04	.24**	.21**	−.08**	−.16**	.12**	.21**	.41**

Note. NSSI = nonsuicidal self-injury presence. SP = sensitivity to punishment. SR = sensitivity to reward. A = anxiety. D = depression. NU = negative urgency. Prem. = premeditation. Pers. = perseverance. SS = sensation seeking. PU = positive urgency. Alc. = alcohol use problem. Drug = drug use problem. * $p < .05$, ** $p \leq .01$.

Table 2. Means of all data and matched data on propensity score covariates as a function of NSSI status

	All data				Matched data			
	NSSI+ (n = 358)	NSSI– (n = 1,327)	Mean difference	t[a]	NSSI+ (n = 358)	NSSI– (n = 358)	Mean difference	t[a]
Age	20.82	21.07	–.26	–1.15	20.82	20.60	.22	–1.01
Gender (female)	1.69	1.60	.09	8.71*	1.69	1.68	–.01	.01
Anxiety	55.08	47.71	7.37	9.10**	55.08	54.55	.41	–.41
Depression	8.68	5.32	3.36	–2.86**	8.68	8.29	.39	–1.06
Premeditation	30.80	30.65	.14	.51	30.80	30.70	.10	–.23
Negative urgency	29.04	25.53	3.51	8.86**	29.04	28.73	.31	–.68
Perseverance	27.72	28.65	–.93	–3.14*	27.72	28.08	–.36	.98
Sensation seeking	35.68	34.24	1.44	2.83*	35.68	35.02	.66	–1.17
Positive urgency	26.88	25.33	1.55	2.56	26.88	26.41	.47	–.69
Alcohol use problem	7.41	5.99	1.42	4.16**	7.41	7.55	–.13	.29
Drug use problem	4.99	2.52	2.47	7.19**	4.99	3.94	1.05	–2.10
Distance	.33	.18	.15		.33	.30	.03	

Note. NSSI = nonsuicidal self-injury. Gender: 1 = male, 2 = female. Mean differences presented are the absolute standardized differences in means between the NSSI+ and NSSI– groups.
[a]χ^2 for gender.
* $p < .01$, ** $p < .001$.

Table 3. Means of all data and matched data on propensity score covariates as a function of suicide attempt status

	All data				Matched data			
	SA+ (n = 74)	SA– (n = 1,838)	Mean difference	t[a]	SA+ (n = 74)	SA– (n = 74)	Mean difference	t[a]
Age	21.77	20.97	.80	1.94	21.74	22.04	–.30	–.37
Gender (female)	1.76	1.61	.15	6.08	1.76	1.80	–.04	.35
Anxiety	57.08	48.95	8.13	5.07**	57.08	57.12	–.04	.02
Depression	10.23	5.80	4.43	8.10**	9.88	9.36	.52	.56
Premeditation	31.39	30.66	.73	1.03	31.39	31.43	–.04	–.05
Negative urgency	29.43	26.15	3.28	4.24**	29.43	30.36	–.93	–.86
Perseverance	28.73	28.46	.27	.46	28.73	28.64	.07	.08
Sensation seeking	36.73	34.46	2.27	2.42	36.73	36.82	–.09	.12
Positive urgency	28.47	25.56	2.91	2.64*	26.88	26.41	.47	.28
Alcohol use problem	5.96	6.29	–.33	–.48	5.96	5.09	.87	1.11
Drug use problem	5.05	2.96	2.09	3.20*	5.05	4.35	.70	.59
Distance	.11	.03	.08		.11	.11	.00	

Note. NSSI = nonsuicidal self-injury. Gender: 1 = male, 2 = female. Mean differences presented are the absolute standardized differences in means between the SA+ and SA– groups.
[a]χ^2 for gender.
* $p < .01$, ** $p < .001$.

ly matched on their propensity scores, resulting in 996 participants from the NSSI– group being discarded and a remaining sample of 716 participants (NSSI+, n = 358; NSSI–, n = 358). See Table 3 for group means on covariates for matched data in comparison with all data. Following the propensity score-matching procedures, group-level analyses were conducted using only the resultant matched data (n = 716). After propensity matching there were no significant differences on 11 covariates (see Table 2). Group-level analyses to examine levels of SP and SR were then conducted on the resulting matched data. The NSSI+ group reported higher levels of SP than the NSSI– group. However, no differences on levels of SR between the NSSI+ group were demonstrated. Thus, individuals in the NSSI+

Table 4. Means and standard deviations of sensitivity to punishment and reward after matching procedures

	NSSI+	NSSI−	t (95% CI)	SA+	SA−	t (95% CI)
SP	51.78 (14.97)	49.49 (14.97)	−2.06* (−4.50−−0.10)	51.77 (15.89)	52.20 (17.08)	0.16 (−4.92−5.79)
SR	48.13 (12.84)	47.56 (12.56)	−0.59 (−2.43−1.30)	49.50 (11.46)	47.14 (11.44)	−1.26 (−6.09−1.36)

Note. SP = sensitivity to punishment. SR = sensitivity to reward. NSSI = nonsuicidal self-injury. SA = suicide attempt. CI = confidence interval.
* = p <.05

reported higher levels of SP (but not SR) even after matching on all included covariates (see Table 4).

Suicide Attempts

Group-level analyses were first conducted on all data. The SA+ group (M = 51.81, SD = 16.15) reported higher levels of SP than the SA− group (M = 46.11, SD = 16.12), t (1731) = −2.87, p = .004, 95% CI = −9.59−−1.79. The SA+ group (M = 49.96, SD = 11.31) also reported higher levels of SR than the SA− group (M = 45.44, SD = 13.46), t (1731) = −2.78, p = .006, 95% CI = −7.70−−1.33.

Propensity score-matching procedures were conducted, incorporating the 11 statistical covariates. Participants who belonged to the SA+ and SA− groups were then matched on subsequent propensity scores, resulting in 1,764 participants from the SA− group being discarded and a remaining sample of 146 participants (SA+, n = 74; SA−, n = 74). See Table 2 for group means on covariates for matched data in comparison to all data. Following the propensity score-matching procedures, group-level analyses were conducted using only matched participants (n = 146). After propensity matching there were no significant differences on the 11 covariates (see Table 3). Group-level analyses were then conducted on the resulting matched data to examine levels of SP and SR. Results demonstrated there was not a significant difference between the SA+ group and SA− group on reported levels of SP. Similarly, there were no group differences on SR between the SA+ group and SA− group (see Table 4).

Discussion

The goal of the current study was to examine the relationship of NSSI and SA with BIS and BAS. We first aimed to replicate previous findings of these associations. Then, we used propensity score matching to further examine commonly correlated factors in the relationship. Findings demonstrated that both those with NSSI and SA history initially reported higher levels of BIS (e.g., sensitivity to punishment) and BAS (e.g., sensitivity to reward) compared with those without NSSI and SA, respectively. However, after matching on covariates, participants with NSSI were elevated only on BIS, whereas no differences in BIS or BAS were demonstrated between those with and without SA. The current study is the first to examine the unique risk associated with BIS and BAS in NSSI and SA, and to suggest implications for the distinct role of BIS in NSSI.

The current findings suggest that BIS may vary in its role for nonsuicidal and suicidal self-injury. Although the two groups illustrated elevated levels of both BIS and BAS prior to matching procedures, this was not the case following matching procedures; the only group difference that persisted was those with a history of NSSI demonstrating increased levels of BIS. Our results are not consistent with previous findings that suicidal ideation was positively associated with BIS (O'Connor & Forgon, 2007), and that increased BIS was related to higher NSSI frequency but not the presence of the behavior (Jenkins et al., 2013). One possibility why the current results differ from earlier findings is the inclusion of associated risk variables. As these factors are related to BIS as well as NSSI and SA, they may have impacted the BIS–NSSI and BIS–SA relationships, and accounted for such relationships in previous findings. The current analyses allow for consideration of these factors and highlight the potential differences in BIS between NSSI and SA not explained by the included covariates, and, further, a potentially distinct influence of BIS in NSSI engagement. The current findings suggest that individuals with a history of repeated NSSI may be particularly sensitive to stimuli perceived as threatening or punishing (e.g., hyperactive BIS). BIS may play an important role in the functions of NSSI, such that individuals engaging in NSSI may recognize more environmental cues as (potentially) punishing, impacting them at an intra- or interpersonal level. These individuals may use NSSI as a way to avoid, or escape, their negative emotions, or as a way to avoid, or escape, the negative stimuli or environment, consistent with the automatic-negative and social-negative reinforcement functions of NSSI, respectively (Nock & Prinstein, 2004). Although previously identified risk factors appear to play an important role in the BIS–NSSI relationship, they do not account for the entire relationship, suggesting something specific, or unique, about the role of punishment sensitivity (e.g., BIS) in NSSI. It will be valuable for future research to examine what other factors interact with BIS to lead to NSSI, since not everyone who has elevated levels of BIS chooses to harm themselves. For example, individuals who engage in NSSI also report higher levels of emotion

reactivity (Nock, Wedig, Holmberg, & Hooley, 2008), and, therefore, may be more reactive when perceiving potentially punishing or threatening stimuli, making the stimuli more salient.

Prior to the matching procedures, individuals with a history of NSSI and SA, compared with those without a history, reported higher levels of BAS; however, after matching procedures no significant differences were demonstrated. This finding adds to the mixed literature about the role of BAS in nonsuicidal and suicidal self-injury. For example, research has suggested BAS to be associated with increased NSSI frequency (Robertson, Miskey, Mitchell, & Nelson-Gray, 2013) but not related to the presence of NSSI behavior (Jenkins et al., 2013). The current findings suggest that individuals with NSSI and SA may not have an elevated sensitivity to reward as compared with those who have not engaged in NSSI or SA. That is, these individuals are not more likely to engage in approach behavior toward rewarding stimuli. Previous findings of elevated BAS in these populations may be due to individual differences in substance use and impulsivity, both of which have evidenced a strong relationship with reward sensitivity. This is supported by the fact that alcohol use, drug use, and impulsivity were found to be elevated among those with NSSI and SA in the present study. The current findings cannot speak to which of these variables may be most influential in the relationships between BAS and NSSI or BAS and SA, but, based on the observed associations of BAS with related personality and psychopathology constructs, it is likely the combination of these covariates may be most important to consider.

Finally, our study replicated previous research showing relationships between BIS and BAS with several nonsuicidal and suicidal self-injury risk factors. BIS was related to increased levels of anxiety, depressive symptomology, alcohol and drug use problems, in addition to being related to all dimensions of impulsivity (e.g., Campbell-Sills et al., 2004; Carver & White, 1994; Seibert et al., 2010). Similarly, BAS was associated with greater levels of alcohol and drug use problems and all but one dimensions of impulsivity, which is consistent with previous findings (Dawe & Loxton, 2004; Franken & Muris, 2006; Genovese & Wallace, 2007; Seibert et al., 2010). However, findings that BAS was also related to greater levels of anxiety and depressive symptomology are inconsistent with previous research suggesting an association with lower levels of depression and anxiety (Campbell-Sills et al., 2004). As hypothesized, individuals with a history of NSSI and SA reported higher levels of anxiety, depressive symptomology, alcohol and nonalcohol substance use problems, and most dimensions of impulsivity (with the exception of premeditation). These findings support the rich literature on the risk factors associated with both NSSI and SA (Glenn & Klonsky, 2010; Kerr & Muehlenkamp, 2010; Webb, 2002; Williams & Hasking, 2009).

Limitations

Study limitations include the use of a cross-sectional undergraduate sample, which may limit generalizability to noncollege populations. The inclusion criterion of five NSSI acts was utilized to include only individuals with more severe NSSI behavior. Relatedly, the small sample size of those with a history of SA may have resulted in underpowered analyses. To address this concern, group analyses on matched data for those with and without SA history were conducted using 1,000 bootstrapped samples. No group differences were found on BIS or BAS, suggesting that the findings of the original analyses were not just an artifact of the sample size. Though consistent with previous research on the NSSI/SA–BIS/BAS relationship, the reliance on online self-report data is a limitation. Future research should seek to replicate the current findings utilizing data gathered through in-person interviews, which would allow for the examination of comorbid psychopathology diagnosis and not just symptomology.

Clinical Implications

The current findings highlight the potentially unique role of BIS in NSSI engagement. As elevated levels of BIS represent a heightened sensitivity to punishing stimuli, important implications for NSSI treatment should be considered. It may be beneficial to focus on the recognition and response to stimuli that may be perceived as particularly threatening or punishing in treatment. One-way interventions may address this is through cognitive restructuring of thoughts that are related to perceived punishment, such as interpersonal conflict. Further, learning to identify and manage emotional reactions to these specific types of situations may be a particularly useful way to target antecedents or maintenance factors of NSSI behavior. Overall, the current study offers an advance in the examination of NSSI risk factors by considering the unique role of BIS in NSSI, independent of previously identified risk.

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