

Self-injurious implicit attitudes among adolescent suicide attempters versus those engaged in nonsuicidal self-injury

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Background: Suicide is among the most important mental health issues affecting adolescents today despite much research on its detection and prevention. Beyond suicide attempts (SAs), clinicians are increasingly confronted with another, potentially related problem: non-suicidal self-injury (NSSI)—defined as the deliberate destruction of body tissue without intent to die. NSSI may increase risk for making an SA by sevenfold, but many studies examining this link have involved youths engaging in both NSSI and SAs. Thus, there is a need to compare homogeneous groups of adolescents engaged in NSSI-only or SA-only, but not both, to advance what is known about each form of self-harm. The self-injurious implicit association task (SI-IAT) is a particularly important computerized behavioral task to study such adolescents because the SI-IAT provides objective behavioral data about problems for which people may lack insight or be motivated to conceal, such as SAs and NSSI. **Methods:** We evaluated implicit associations with cutting and death/suicide using the computerized SI-IAT in three mutually exclusive groups: (1) adolescents who made an SA but had never engaged in NSSI ($n = 47$); (2) adolescents who engaged in NSSI but had never made an SA ($n = 46$); and (3) typically developing control (TDC) adolescents without history of psychiatric problems ($n = 43$). **Results:** Nonsuicidal self-injury participants had stronger identification with cutting versus no cutting than either SA or TDC participants. Contrary to our hypothesis, NSSI participants had stronger identification with suicide/death versus life than either SA or TDC participants. **Conclusions:** Strong implicit attitudes towards suicide/death among adolescents with NSSI without a prior SA suggest that clinicians should not dismiss NSSI as not serious. Further work is required to elucidate the mechanism by which youths engaged in NSSI acquire these stronger identifications and make a first-time SA to develop novel treatment and prevention strategies blocking this transformation, ultimately reducing youth suicide. **Keywords:** Suicide, nonsuicidal self-injury, adolescent, cognition.

Introduction

Suicide is among the most important mental health issues affecting adolescents today. Despite much research on its detection and prevention, data from the 2011 Centers for Disease Control (CDC) Youth Risk Behavior Surveillance survey indicate that suicide remains the third leading cause of death among 10–24 year olds in the United States, with a sixfold rise in the prevalence of suicide attempts (SA) from childhood to late adolescence (Nock et al., 2013). Unfortunately, completed SAs are only the tip of the iceberg. Each year, 16% of high school students seriously contemplate suicide, 13% make a suicide plan, 8% make an SA, and 2% seek medical attention for their SA (Eaton et al., 2012). Research, policy, and clinical efforts to prevent and predict adolescent suicide have yielded important results; however, rates of these behaviors remain largely unchanged for decades (Kessler, Berglund, Borges, Nock, & Wang, 2005; Nock et al., 2013).

Although youth suicide has long been an important public health concern, clinicians are now

confronted with a burgeoning problem: nonsuicidal self-injury (NSSI; Muehlenkamp, Williams, Gutierrez, & Claes, 2009). Unlike an SA, NSSI has been defined as deliberate destruction of one's body tissue in the absence of intent to die (Bridge, Goldstein, & Brent, 2006; Nock, Joiner, Jr., Gordon, Lloyd-Richardson, & Prinstein, 2006). Self-cutting is the most common form of NSSI, accounting for 25% of those 7–24 years old seen in emergency departments for self-injury annually in 2005 (Olfson, Gameroff, Marcus, Greenberg, & Shaffer, 2005a). NSSI is a growing problem, as evidenced by a notable increase from 4.3% to 13.2% of those teenagers psychiatrically hospitalized engaged in NSSI by self-cutting in 1990 and 2000, respectively (Olfson, Gameroff, Marcus, Greenberg, & Shaffer, 2005b). Among non-clinical samples, prevalence estimates suggest that approximately 20% of adolescents in the U.S. and internationally have engaged in NSSI (Muehlenkamp, Claes, Havertape, & Plener, 2012; Muehlenkamp et al., 2009).

Despite NSSI having been defined as a distinct entity from SA, the relationship between these two types of self-harm is a complex and clinically important issue. For example, theoretical models of NSSI

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have incorporated many of the same factors implicated in adolescent SA, including depression, disruptive or aggressive behavior, interpersonal conflict, and, more globally, affect dysregulation (Esposito, Spirito, Boergers, & Donaldson, 2003; Messer & Fremouw, 2008; Nock & Kessler, 2006; Zlotnick, Donaldson, Spirito, & Pearlstein, 1997). Although NSSI and SA are operationalized as distinct behaviors, studies have shown that they are highly comorbid among adolescents (Andover, Morris, Wren, & Bruzese, 2012; Nock et al., 2006; Wilkinson, Kelvin, Roberts, Dubicka, & Goodyer, 2011). Furthermore, NSSI is an established risk factor for suicide—increasing the risk for SA by as much as sevenfold even after controlling for prior depression, SAs, and sex (Guan, Fox, & Prinstein, 2012; Nock et al., 2006). Similarly, in the Treatment of Resistant Depression in Adolescence (TORDIA) study, Asarnow et al. showed that baseline NSSI predicted future SA better than did baseline history of SA (HR = 7.31, $p < .001$) even when NSSI and past SA were incorporated in the model (Asarnow et al., 2011). Thus, there is a critical need for research to compare adolescents engaged in either NSSI or SA, but not both, to elucidate how these behaviors result from similar, or distinct, pathophysiology.

Studying implicit attitudes about NSSI, death, and suicide is an important way to advance what is known about the brain/behavior alterations underlying NSSI and SA. Implicit attitudes are governed by associative processes that are activated automatically when a given stimulus is encountered, and are thus independent of formal or conscious reasoning (Fazio & Olson, 2003). Implicit attitudes may be assessed with behavioral tasks, the most widely used being the Implicit Association Test (IAT) which evaluates the differential reaction time associated with classifying words or images belonging to two paired stimuli categories (Greenwald, McGhee, & Schwartz, 1998). Implicit attitudes assessed via computerized behavioral tasks may explain and predict behavior more effectively than explicit attitudes assessed via responses to questionnaires or clinician-administered interviews. Moreover, implicit measures are particularly useful to probe attitudes for which people either lack insight or may be motivated to conceal, like those towards NSSI and suicide.

Using the IAT, Nock has shown that stronger self-identification with death/suicide word stimuli was associated with a sixfold increase in risk of making a SA during the 6 months after testing among adults with prior histories of a SA seen in a psychiatric emergency department (Nock et al., 2010). Nock has also shown that the Self-Injury-IAT (SI-IAT) accurately predicted current suicide ideation and attempt status and future suicide ideation among teen suicide attempters, ideators, and nonsuicidal controls (Nock & Banaji, 2007b). However, such studies are somewhat limited in their ability to determine if

this was driven by SAs or NSSI because they included participants engaged in both suicidal and NSSI behaviors. Thus, there is a need for such work in more homogeneous samples of participants engaged in either SA or NSSI to advance what is known about altered implicit associations underlying both forms of self-harm behavior. Ultimately, greater knowledge of the brain/behavior alterations underlying SA or NSSI, including implicit associations, could guide biologically based targets for novel treatments (e.g., either pharmacological or psychotherapeutic approaches), more specific diagnostic approaches, and even prevention efforts.

To address this lack of knowledge, we evaluated implicit associations with NSSI, death, and suicide using the computerized SI-IAT in three mutually exclusive homogeneous groups of adolescents (13–17 years old): (1) those who had made an SA; (2) those engaged in NSSI (specifically, self-cutting); and (3) typically developing control (TDC) participants with no history of psychiatric problems including no lifetime history of either SAs or NSSI. We hypothesized that: (1) participants who engaged in NSSI would have stronger implicit identification with cutting than those who made an SA, and (2) participants who made SAs would have stronger implicit identification with death and suicide than those engaged in NSSI.

Methods

Participants

Three mutually exclusive groups of participants ages 13–17 years old were enrolled in a study conducted at, and approved by the Institutional Review Board of, Bradley Hospital: (1) psychiatric inpatients presenting with a recent SA; (2) psychiatric inpatients presenting with recent NSSI; and (3) typically developing controls (TDC).

SA participant ($n = 47$) inclusion criteria were having made an SA—defined as any action, regardless of lethality or resulting self-injury, completed with some intent to die as stated by the adolescent (Bridge et al., 2006; Nock et al., 2006)—within the 30 days prior to enrollment. Intent was based upon the adolescent's self-report and/or inference from the SA lethality (Posner, Oquendo, Gould, Stanley, & Davies, 2007; Silverman, Berman, Sanddal, O'Carroll, & Joiner, 2007). SA participants were excluded if they had ever engaged in NSSI.

NSSI participant ($n = 46$) inclusion criteria were meeting the Diagnostic and Statistical Manual 5th Edition (DSM-5) 'Conditions for Further Study' section criteria for NSSI Disorder, including having engaged in at least 5 days of NSSI during the past year, at least one of which was during the 30 days prior to enrollment (American Psychiatric Association, 2013; Zetterqvist, Lundh, Dahlstrom, & Svedin, 2013). NSSI participants were excluded if they had ever made an SA (including self-cutting with intent to die).

TDC participant ($n = 43$) inclusion criteria were the absence of lifetime psychiatric illness, including the absence of prior SA or NSSI, in themselves and their first-degree relatives.

Exclusion criteria from all groups were as follows: (1) having engaged in both SA and NSSI because we were interested in determining alterations that were specific to SA or NSSI; (2) having DSM-5 autism spectrum disorder (ASD; including DSM-IV Autistic Disorder, Asperger's Disorder, or Pervasive Developmental Disorder Not Otherwise Specified) given prior work suggesting that self-injury associated with ASD may

serve a different function (McCracken et al., 2002; Minshawi, 2008); and (3) factors that might limit participants' understanding of the SI-IAT, including current psychotic disorder, Wechsler Abbreviated Scale of Intelligence (WASI; Psychological Corporation, 2013) full scale intelligence quotient (FSIQ) ≤ 70 , or limited English fluency.

Procedures and measures

SA and NSSI participants were recruited from the hospital's inpatient adolescent psychiatric units. The rationale for recruiting inpatients was to study these teenagers in closest temporal proximity to their SA/NSSI events. We also sought to avoid potential sample bias that might have occurred if adolescents were recruited from two different levels of care—e.g., enrolling those with an SA from inpatient care and those with NSSI from outpatient care. TDC participants were recruited from the community through advertisements distributed to physicians' offices and local businesses. Participants were compensated for their time, with TDC participants receiving \$70 and NSSI/SA participants receiving \$110 due to the greater duration of assessments.

One hundred and fifty adolescents were identified as possible NSSI or SA participants through daily chart review and provided information regarding this study. Of the 150 teens, eight declined participation seven were interested but did not keep their appointment to consent, and 135 consented (90%). Forty-two consenting adolescents were excluded from this study due to incomplete data ($n = 9$, 6%), withdrawn consent ($n = 4$, 3%), comorbid NSSI and SA ($n = 20$, 13%), not meeting inclusion criteria ($n = 9$, 6%; e.g., SA was aborted or more than 6 months prior, insufficient NSSI, unclear intent), resulting in a total sample of 46 NSSI and 47 SA participants.

With respect to TDCs, parents of 55 prospective TDCs completed telephone screens. Of these, three did not keep their appointment to consent. Of the remaining fifty-two consented TDC participants (95%), nine were excluded from this study due to not meeting inclusion criteria ($n = 7$, 13%; e.g., having current psychopathology by KSADS interview) or incomplete data ($n = 2$, 4%), resulting in a total sample of 43 TDC participants.

To evaluate for DSM-oriented psychiatric disorders in all three participant groups, graduate-level clinicians with established inter-rater reliability ($\kappa \geq 0.85$) administered the Child Schedule for Affective Disorders and Schizophrenia, Present and Lifetime Version (KSADS-PL; American Psychiatric Association, 2000; Kaufman et al., 1997). The KSADS-PL was administered to TDC participants and their parents to ensure they met TDC inclusion criteria. The KSADS-PL was administered only to NSSI and SA participants and not their parents due to logistical constraints of assessing an inpatient population (e.g., short lengths of stay, somewhat limited access to family members). Our previously published examination of psychopathology in this sample confirms a high correlation between NSSI and SA participant KSADS-PL diagnoses and parent completed reports about psychopathology (Kim et al., 2014).

To better characterize the lifetime self-injury endorsed by NSSI and SA participants, as well as to determine if participants met the DSM-5 criteria for NSSI, trained and closely supervised research assistants administered the Self-Injurious Thoughts and Behaviors Interview (SITBI)—a structured interview that measures the presence, frequency, and characteristics of various types of self-injurious thoughts and behaviors. The SITBI has strong: (a) construct validity, converging with other measures of suicidal ideation (SI; average $K = 0.54$), suicide attempts (average $K = 0.65$), and NSSI (average $K = 0.87$); (b) inter-rater reliability (average $K = 0.99$; $r = 1.0$), and (c) test-retest reliability (average $K = 0.70$; intraclass correlation coefficient = 0.44) over a 6 month interval. (Nock, Holmberg, Photos, & Michel, 2007). NSSI and SA participants

also completed the Beck Scale for Suicide Ideation (BSS), a 19-item self-report measure assessing the severity of an individual's current suicidal thoughts and related behaviors (Beck, Brown, & Steer, 1997). Responses are rated from 0 to 2, with higher scores indicating higher levels of suicidality. Total scores can range from 0 to 38, but there is no formal cut-off score to delineate ideation severity.

SI-IAT task

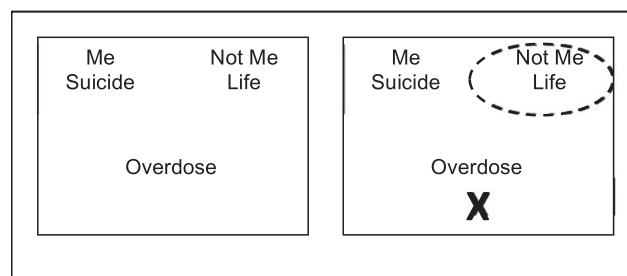
The SI-IAT is a performance-based computerized task founded on the assumption that it is easier to respond behaviorally (i.e., pressing a key on a keyboard) when two concepts are strongly associated than when two concepts are weakly associated (Nock & Banaji, 2007a,b; Nock et al., 2010). During the SI-IAT, participants were instructed to classify as fast as possible centrally placed stimuli as belonging to categories at the top left and right of the screen by pressing the 'E' (left) and 'P' keys (right; Figure 1).

Four self-injury constructs were used: (1) escape versus stay [e.g., leave, quit versus hold on, remain, etc.], (2) cutting versus no cutting [e.g., images of cut versus intact skin], (3) suicide versus life [e.g., overdose, hanging versus live, survive, etc.], and (4) death versus life [e.g., die, funeral versus live, survive, etc.].

Centrally placed stimuli represented these constructs of interest as well as the attributes of 'me' (i.e., *I, myself, self, etc.*) and 'not me' (i.e., *they, them, other, etc.*). Top-placed categories used word pairings with one construct of interest paired with one attribute on each side of the screen (i.e., left side: 'death' and 'me'; right side: 'life' and 'not me').

Each construct was presented during two blocks, one with 40 attitude-congruent trials (i.e., 'life' paired with 'me', and 'suicide' paired with 'not me') and another with 40 attitude-incongruent trials (i.e., 'suicide' paired with 'me', and 'life' paired with 'not me'). Correct classifications were followed by the presentation of the next stimulus, whereas incorrect classifications were followed by the presentation of a red 'X' below the stimulus, which remained until the correct classification is made.

The relative strength of the association between each self-injury construct and oneself was indexed by calculating a difference score (D score). For each participant, D scores were calculated by subtracting the average response latency of the attitude-congruent trials from that of the attitude-incongruent



Left panel shows sample screen with categories at the top and target centered below. Right panel shows example of feedback following incorrect classification of the target "overdose" in the category of "life."

Figure 1 Self-injurious implicit association task Sample Screen Attitude Incongruent Trial. Left: Suicide-related target center ('overdose') and categories at top showing an incongruent trial whereby 'suicide' and 'me' are paired (rather than congruent trial pairing 'me' and 'life' on the same side). Right: Participant pressed button for right side of screen and received feedback about incorrect selection of 'Not Me/Life' with red 'X'. Instead, if the participant had correctly selected the left side (because the target 'overdose' belongs to the 'suicide' category, they would have moved on to the next trial/next target

trials and dividing by the standard deviation of response latency for all trials assessing that construct. Higher D scores reflect stronger identification with the self-injury construct. Thus, positive D scores for the cutting/no-cutting construct represents faster responding and stronger association when 'cutting' and 'me' were paired, whereas negative D scores represent relatively slower responding and weaker association when 'cutting' and 'me' were paired. SI-IAT D scores were calculated in accordance with current standard guidelines (Nock & Banaji, 2007a,b; Nock et al., 2010). To facilitate comparison with prior SI-IAT studies, we aggregated death and suicide word stimuli to create single suicide/death variable for analyses (Nock et al., 2010).

Analytic plan

Analyses of variance (ANOVA) and chi-square comparisons were performed to test for possible between-group differences in continuous and categorical demographic and psychopathology-related variables. To address the study's main goal of evaluating SI-IAT performance, a multivariate ANOVA (MANOVA) with Bonferroni correction was performed. Cohen's *d* effect sizes were calculated for posthoc pair-wise comparisons. Secondary analyses explored potential effects of SI and comorbid depression on SI-IAT subtest performance.

Results

Sample characteristics

There were no significant between-group differences in age [$F(2,133) = 2.75, p = .07$], sex [$\chi^2 = 5.69, p = .06$], or race [$\chi^2(df) = 9.25, p = .51$] (Table 1). While on average each group's mean FSIQ was in the average range, there was a significant between-group difference in FSIQ [$F(2,133) = 10.20, p < .01$]. Post-hoc analyses showed that the SA group had a significantly lower FSIQ (98.1 ± 11.7) than the TDC ($108.8 \pm 12.6, p < .01$) and the NSSI groups ($105.4 \pm 10.5, p < .01$), with no significant difference between the NSSI and TDC groups. However, FSIQ did not significantly correlate with the SI-IAT performance dependent variables.

With regard to clinical/psychiatric characteristics (Table 2), there was a relatively even distribution of lifetime NSSI frequency among NSSI participants (5–9 times $n = 9$ [20%], 10–24 times $n = 10$ [21%], 25–49 times $n = 10$ [21%], 50–74 times $n = 8$ [18%],

Table 1 Sample characteristics

Group	SA ($n = 47$)	NSSI ($n = 46$)	TDC ($n = 43$)	Between-group differences
Sex				
Male	34.0% ($n = 16$)	17.4% ($n = 8$)	39.5% ($n = 17$)	$\chi^2(2, 136) = 5.69$
Female	66.0% ($n = 31$)	82.6% ($n = 38$)	60.5% ($n = 26$)	
Age (years)	15.85 ± 1.27	15.24 ± 1.26	15.47 ± 1.29	$F(2, 133) = 2.75$
Full-Scale IQ ^a	98.09 ± 11.71	105.43 ± 10.49	108.84 ± 12.57	$F(2, 133) = 10.20^{***}$
Race				
White	63.8% ($n = 30$)	84.5% ($n = 39$)	71.4% ($n = 33$)	$\chi^2(10,128) = 9.25$
Black/African American	4.3% ($n = 2$)	4.3% ($n = 2$)	7.0% ($n = 3$)	
American Indian/Alaskan	2.1% ($n = 1$)	2.2% ($n = 1$)	–	
Asian	4.3% ($n = 2$)	–	2.3% ($n = 1$)	
Multiracial	6.4% ($n = 3$)	–	7.0% ($n = 3$)	
Other	8.5% ($n = 4$)	2.2% ($n = 1$)	7.0% ($n = 3$)	

SA, suicide attempt; NSSI, non-suicidal self-injury; TDC, typically developing control.

Results = mean \pm standard deviation or percent of study group (n).

* $p < .05$; ** $p < .01$; *** $p < .001$.

^aFull-Scale IQ is reported as standard scores on the Wechsler Abbreviated Scale of Intelligence (WASI).

Table 2 Psychiatric characteristics of the sample^a

Demographic	SA group ($n = 47$)	NSSI group ($n = 46$)	Between-group differences
KSADS diagnosis (current)			
Major depressive disorder	68.6% ($n = 32$)	88.1% ($n = 41$)	$\chi^2(2, 93) = 8.47^*$
Generalized anxiety disorder	20.0% ($n = 9$)	40.5% ($n = 18$)	$\chi^2(2, 93) = 5.85$
Panic disorder	8.6% ($n = 5$)	28.6% ($n = 13$)	$\chi^2(2, 93) = 5.90$
Social phobia	22.9% ($n = 9$)	21.4% ($n = 9$)	$\chi^2(2, 93) = 1.43$
Post-traumatic stress disorder	17.0% ($n = 8$)	10.9% ($n = 5$)	$\chi^2(2, 93) = 1.69$
Attention deficit/Hyperactivity Disorder	8.6% ($n = 4$)	14.3% ($n = 6$)	$\chi^2(2, 93) = 1.59$
Oppositional defiant disorder	11.4% ($n = 7$)	14.3% ($n = 6$)	$\chi^2(2, 93) = 1.08$
Suicidal ideation			
Endorsed lifetime suicidal ideation	100% ($n = 47$)	91.3% ($n = 42$)	$\chi^2(2, 93) = 4.27$
Age of onset	13.82 ± 1.81	12.63 ± 2.15	$F(1, 85) = 7.84^{**}$
BSS total (current suicidal ideation)	10.55 ± 7.94	13.80 ± 8.68	$F(1, 88) = 3.44$

SA, suicide attempt; NSSI, nonsuicidal self-injury; KSADS, Child Schedule of Affective Disorders Present and Lifetime Version.

Results = mean \pm standard deviation, percent of study group (n), or modal response (n).

* $p < .05$; ** $p < .01$; *** $p < .001$.

^aGroup comparisons for psychiatric variables were made between only SA and NSSI groups.

>100 times $n = 9$ [20%]). Most SA participants indicated one lifetime SA (1 SA $n = 35$ [74%], 2 SAs $n = 7$ [15%], 3 SAs $n = 4$ [9%], 5 SAs $n = 1$ [2%]). Severity of current SI as assessed by BSS did not differ significantly between NSSI and SA participants (NSSI 13.8 ± 8.7 , SA 10.6 ± 7.9 ; $p = .07$), nor was the prevalence of lifetime SI significantly different (NSSI $n = 41$ [91.3%], SA $n = 47$ [100%]; $\chi^2 = 4.27$ $p = .06$). However, there was a significant between-group difference in the onset of their SI [$F(1,85) = 7.84$, $p < .01$], with the NSSI group reporting earlier SI onset (12.63 ± 2.2 years) compared to the SA group (13.82 ± 1.81 years). With regard to DSM-oriented psychiatric diagnoses, both the NSSI and SA groups were most characterized by depression and anxiety (SA: 69% Major Depressive Disorder [MDD], 20% Generalized Anxiety Disorder [GAD]; NSSI: 88% MDD, 41% GAD). However, the proportion of NSSI participants diagnosed with MDD [$\chi^2 = 8.47$, $p < .05$] was significantly greater than the proportion of SA participants diagnosed with the disorder per the KSADS-PL (Kim et al., 2014).

SI-IAT performance

Our MANOVA of SI-IAT performance showed a significant multivariate main effect of group [Wilks Lambda = 0.69, $F(6,262) = 8.73$, $p < .01$] (Table 3; Figure 2). There was a significant between-subjects effect for group on the escape versus stay sub-test [$F(2,133) = 3.12$, $p < .05$], cutting versus no cutting sub-test [$F(2,133) = 18.83$, $p < .01$], and suicide/death versus life sub-test [$F(2,133) = 6.88$, $p < .01$]. Follow-up pair-wise comparisons showed the following. NSSI participants had stronger identification with ‘escape’ (vs. ‘stay’) than TDC participants (D score_{NSSI} = -0.25 ± 0.31 , D score_{TDC} = -0.43 ± 0.36 , $p < .05$, Cohen’s $d = 0.54$) but not SA participants (D score_{SA} = -0.36 ± 0.33 , $p = .35$, Cohen’s $d = 0.34$). NSSI participants had stronger identification with ‘cutting’ (vs. ‘no cutting’) than either TDC (D score_{NSSI} = 0.20 ± 0.37 , D score_{TDC} = -0.23 ± 0.39 $p < .01$, Cohen’s $d = 1.13$) or SA participants (D score_{SA} = -0.17 ± 0.33 , $p < .01$, Cohen’s $d = 1.06$). NSSI participants had

Table 3 Implicit association task D score performance by group

All participants	SA ($n = 47$)	NSSI ($n = 46$)	TDC ($n = 43$)	Between-group differences
Escape versus Stay	-0.36 ± 0.33	-0.25 ± 0.31	-0.43 ± 0.36	$F(2, 114) = 3.12^*$
Cutting versus No cutting	-0.17 ± 0.33	0.20 ± 0.37	-0.23 ± 0.39	$F(2, 114) = 18.83^{***}$
Death/Suicide versus Life	-0.34 ± 0.29	-0.18 ± 0.28	-0.40 ± 0.31	$F(2, 114) = 6.88^{**}$

Group-level results = mean difference score \pm standard deviation; higher difference scores reflect stronger identification with self-injurious stimuli.

SA, suicide attempt; NSSI, nonsuicidal self-injury; TDC, typically developing control.

* $p < .05$; ** $p < .01$; *** $p < .001$.

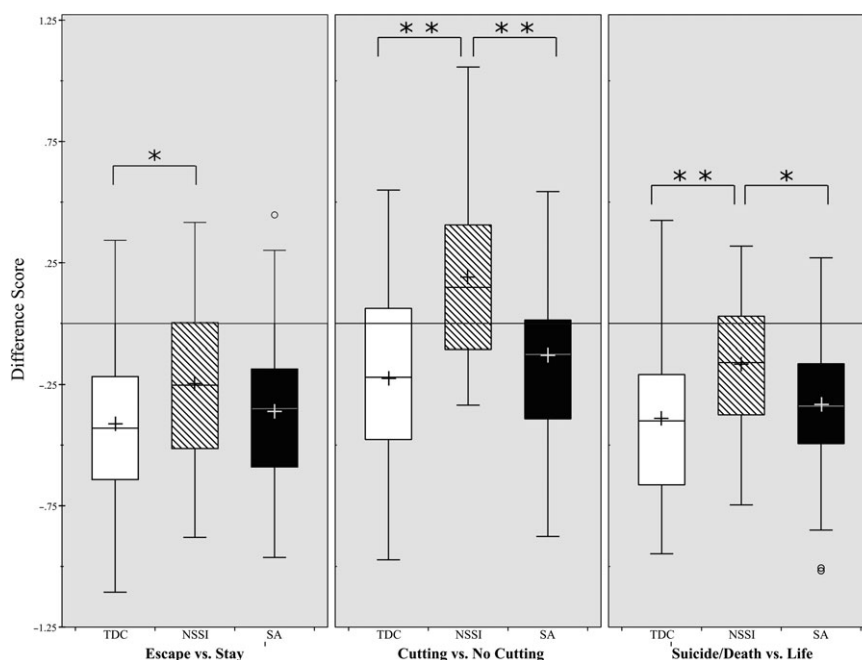


Figure 2 Between-group differences in SI-IAT Subtest Performance. Note: TDC, typically developing control; NSSI, nonsuicidal self-injury; SA, suicide attempt. * $p < 0.05$, ** $p < 0.01$; + represents group mean

greater identification with 'suicide/death' (vs. 'life') than TDC ($D \text{ score}_{\text{NSSI}} = -0.18 \pm 0.28$, $D \text{ score}_{\text{TDC}} = -0.40 \pm 0.31$, $p < .01$, Cohen's $d = 0.74$) and SA participants ($D \text{ score}_{\text{SA}} = -0.34 \pm 0.29$, $p < .05$, Cohen's $d = 0.56$).

Secondary analysis: SI-IAT performance and suicidality

Given the finding running contrary to our hypothesis that the NSSI group had greater identification with suicide/death versus life than the SA and TDC groups, we explored the effect of current SI (SI) on SI-IAT performance with a multiple regression. The criterion variable was suicide/death versus life sub-test performance. The predictor variables were group (NSSI or SA), current SI (BSS scores), and a group by current SI interaction. BSS scores were selected to represent participants' SI instead of SI age of onset because they are significantly correlated with the criterion ($r = .37$, $p < .01$) but not significantly correlated with the other primary predictor (e.g., group, $r = -.19$, $p = .07$). A significant model emerged [$F(3,86) = 6.90$, $p < .01$], accounting for 16.6% of the variance in suicide/death versus life sub-test performance (Adjusted $R^2 = .17$). Group was a significant predictor ($B = -0.23$, $SE B = 0.10$, $\beta = -.39$, $p < .05$), whereas BSS scores and the interaction between group ($B = -0.00$, $SE B = 0.01$, $\beta = -.03$, $p = .94$) and BSS scores ($B = -0.01$, $SE B = 0.01$, $\beta = -.38$, $p = .23$) were not. These analyses confirm that alterations in SI-IAT performance were driven primarily by group status, rather than SI.

Secondary analysis: SI-IAT performance and depression

While our study was focused on examining SI-IAT performance among adolescents engaging in NSSI or SA, secondary analyses to explored potential effects of major depressive disorder (MDD) on our results.

Restricting our sample to those NSSI ($n = 41$) or SA ($n = 32$) participants meeting KSADS-PL criteria for current MDD and the entire TDC sample, we found a significant multivariate effect group on the SI-IAT [Wilks' Lambda = 0.69, $F(6,222) = 7.45$, $p = .000$], with a significant between-subject effect of group on the cutting versus no cutting [$F(2,113) = 16.7$, $p = .000$] and suicide/death versus life [$F(2,113) = 5.33$, $p = .006$], but not escape versus stay [$F(2,113) = 2.05$, $p = .13$] sub-tests. Pair-wise comparisons showed that the between-group effect on 'cutting' (vs. 'no cutting') was driven by NSSI+MDD participants' stronger identification than either TDC ($D \text{ score}_{\text{NSSI+MDD}} = 0.21 \pm 0.37$, $D \text{ score}_{\text{TDC}} = -0.23 \pm 0.39$, $p = .000$, Cohen's $d = 1.16$) or SA+MDD ($D \text{ score}_{\text{SA+MDD}} = -0.19 \pm 0.35$, $p = .000$, Cohen's $d = 1.11$) participants. Also, NSSI+MDD participants' had significantly stronger

identification with 'suicide/death' (vs. 'life') versus TDC participants ($D \text{ score}_{\text{NSSI+MDD}} = -0.19 \pm 0.29$, $D \text{ score}_{\text{TDC}} = -0.41 \pm 0.31$, $p = .001$ Cohen's $d = 0.73$); however, while this was not significantly different from SA+MDD, given the small effect size, this is potentially a type II error ($D \text{ score}_{\text{SA+MDD}} = -0.29 \pm 0.29$, $p = .14$ Cohen's $d = 0.34$),

Discussion

Our study, the first to evaluate implicit attitudes about suicide and NSSI in mutually exclusive samples of adolescents engaged in either NSSI or who had made an SA, had two important findings. First, while perhaps not surprising, adolescents engaged in NSSI had stronger implicit associations with self-cutting than adolescents who had made an SAs without history of NSSI, and also than TDC participants. Second, contrary to our hypothesis, we found that between-group differences in implicit attitudes about suicide/death versus life were driven by NSSI participants having stronger self-identification with suicide/death versus life than either SA or TDC participants. Secondary analyses show that these alterations are primarily driven by group status, rather than by SI or comorbid depression, although further work is required to examine these potential interactions in stratified samples sufficiently powered to examine these potential interactions. These data suggest two important possibilities. First, it is possible that previous findings of heightened implicit identification with suicide/death among SA patients may be partially explained by these individuals' history of engaging in both SA and NSSI. Another possibility is that other variables underlie the relationship between NSSI and identification with suicide/death. For example, while not assessed in this study, perhaps impulsive aggression—defined as reactive unplanned physical or emotional anger—is the explanatory link between NSSI and identification with suicide/death, given data strongly linking it to suicide (Brent et al., 2003; Mann et al., 2009; Melhem et al., 2007). Further research is needed to examine the brain/behavior interactions mediating the relationship between heightened implicit identification with self-injury and future suicidality or self-harm among youth engaged in NSSI.

Greater self-identification with cutting by adolescents engaged in NSSI aligns with several prior studies. For example, Nock et al. found that SI-IAT performance using cutting/no cutting with both 'me/not me' and 'good/bad' discriminated between adolescents who had engaged in NSSI within the past year versus those who had no NSSI history above and beyond both demographic (i.e., age, sex) and psychiatric (i.e., mood, anxiety, impulse control disorders or IQ) variables (Nock & Banaji, 2007a). Relatedly, SI-IAT performance using cutting/no cutting discriminated between adolescents

who had engaged in an SA in the past year, SI within the past year, and a third group of non-suicidal controls even when controlling for lifetime history of NSSI (Nock & Banaji, 2007b). Similar findings have been shown in adults (Glenn & Klonsky, 2011). Thus, while our data and other studies show greater self-identification with cutting among those engaged in NSSI, the mechanism by which individuals acquire this strong association remains unknown. This is an important fundamental question whose answer may help disentangle the complicated relationship between NSSI and SAs. Such work will require a multimodal approach, such as imaging to understand the neural circuitry involved with this mechanism, and also longitudinal assessment of symptoms (of NSSI and SA) coupled with behavioral SI-IAT assessment to delineate the trajectory of this mechanism.

While we hypothesized that SA participants would have greater implicit attitudes towards death and suicide since they had tried to kill themselves, instead, we found that NSSI participants had greater self-identification with suicide and death than SA participants. This aligns with a recent study using data from 10,678 adults from the Australian Twin Registry showing a substantial correlation between NSSI and SI ($r = .49$ for men $.61$ for women) largely driven by overlapping genetic factors (NSSI: 37% for men, 59% for women; SI: 41% for men, 55% for women), while shared/family environment did not seem to play a role (Maciejewski et al., 2014). Although that study examined SI but not SAs, these data suggest the need for further examination of the biological underpinnings between NSSI and SI—including functional neuroimaging studies to probe the brain/behavior alterations underlying implicit attitudes towards suicide and SI among homogeneous groups of NSSI-only and SA-only youths. Such data holds the potential as a novel target for brain-based diagnostics, treatment, and prevention approaches to NSSI and its relationship with making an SA.

Our data raise an important question: Why did the NSSI participants not try to attempt suicide previously if they have stronger identification with ‘death’ and ‘suicide’, and they have access to potentially lethal means, including sharp objects? Following Joiner’s interpersonal theory of suicide, it is possible that our NSSI-only participants have not yet fully acquired all of the ingredients necessary to make an SA at the time that we assessed them with the SI-IAT. Specifically, Joiner postulates that NSSI increases risk for SA by the combination of three factors: (1) acquired capability—defined as overcoming the fear and pain associated with suicide; (2) social isolation; and (3) perceived burdensomeness—defined as the belief that one is a stress to others (Hamza, Stewart, & Willoughby, 2012; Joiner, Jr., Brown, & Wingate, 2005; Van Orden

et al., 2010). The NSSI-only participants did demonstrate acquired capability, having engaged in NSSI at an earlier age of onset than SA participants made their first SA. They also showed greater social isolation than SA participants via greater levels of withdrawn/depressed and internalizing problems on the CBCL (Kim et al., 2014). Thus, it is possible that perceived burdensomeness is the missing ingredient preventing our NSSI-only participants from having yet made an SA, but unfortunately, we did not specifically assess perceived burdensomeness. Future work is required to determine if the lack of perceived burdensomeness prevents the conversion of adolescents engaged in NSSI from making an SA. If true, this is an important potential treatment target. Alternatively, it is possible that perceived burdensomeness may be a developmentally salient risk factor in the process of going from engagement in NSSI to making an SA—i.e., it may differentially affect this risk in adolescents versus adults.

Another interpretation is that NSSI provides a coping strategy to avert an SA (Nock & Prinstein, 2005). In our prior study of psychopathology among this group of adolescents engaged in either NSSI-only or SA-only, we found that NSSI participants were significantly more likely to report engaging in self-harm to cope with their current emotional state than SA participants, whereas SA participants were more likely to endorse escaping from someone or something (Kim et al., 2014). This aligns with Nock and Prinstein’s four-function model of NSSI, suggesting that NSSI is an automatically/self-reinforcing process (rather than being reinforced by others) helping the individual cope with negative emotions (Klonsky & Olino, 2008; Nock & Prinstein, 2004). However, data demonstrating high levels of functional impairment, including elevated rates of psychopathology and risk of subsequent SA, suggest that although some consider this a coping mechanism, it is ineffective at best and, for some, a dangerous precursor for an SA at worst. Given the call for precision medicine approaches to suicide and related behaviors, identifying the mechanism by which NSSI participants’ acquire stronger implicit attitudes with ‘death’ and ‘suicide’, and their NSSI behavior transforms into a first-time SA is an important novel target for psychotherapeutic (including cognitive remediation) and psychopharmacological treatment (Ougrin, Tranah, Leigh, Taylor, & Asarnow, 2012).

A third possibility is that when studied, self-cutting had already become engrained as a chronic behavior among our NSSI participants, thus facilitating the identification with cutting and death/suicide, whereas most of our SA participants’ self-harm behavior was their first SA, and was not yet a chronic behavior. In our study, this may be due to the fact that all NSSI participants met DSM-5 criteria for NSSI Disorder. Specifically, these crite-

ria require at least 5 days of self-cutting during the past year—a threshold that was based on a review of extant studies and publications, and that was meant to ensure that the disorder represented a repeated behavior, rather than a one-time event, akin to the distinction between panic disorder and a panic attack (Shaffer & Jacobson, 2009). Thus, it is possible that these implicit associations would be weaker in adolescents earlier on in their NSSI behavior, when they had subthreshold frequencies of NSSI. Testing this possibility will require additional studies in adolescents representing the high and low frequency spectrum of NSSI behavior, using the SI-IAT as well as longitudinally following these youths to identify the relationship between NSSI frequency, implicit associations, and future course of NSSI and SA behaviors. Our study has several limitations, including between-group demographic differences, cross-sectional design, potential selection bias, and co-occurring depression and/or anxiety. First, there were significant between-group differences with respect to FSIQ, with the SA group having a significantly lower mean FSIQ. While one potential limitation of implicit association tasks generally (rather than specifically to the SI-IAT) is possible confounding with cognitive ability, we did not find any significant correlation between FSIQ and any SI-IAT outcome measure (Brunel, Tietje, & Greenwald, 2004; McFarland & Crouch, 2002). Second, we used a cross-sectional design due to funding constraints. Future studies are required to evaluate the potential link between adolescents engaged in either NSSI or SA's SI-IAT performance and subsequent SA, as has been shown in prior work in adult populations (Nock & Banaji, 2007b; Nock et al., 2010). Third, it is possible NSSI and SA participants—both of which were recruited from our inpatient adolescent psychiatric unit—were subject to Berkson's selection bias, which states that hospital samples are inherently biased as the probability for being hospitalized differs related to an individual's disease (Westreich, 2012). Specifically, it is possible that NSSI and SA participants were subject to a between-group bias in criteria for inpatient hospital admission, such as greater level of functional impairment. However, participants in this study were subject to the same overall level of impairment criteria for admission (i.e., Children's Global Assessment Scale score ≤ 30 ; (Shaffer et al., 1983)) by clinicians who were not in any way connected with our study, including no financial support or incentive either to admit patients or to enroll them as research participants. Our rationale in enrolling both NSSI and SA participants from our inpatient adolescent psychiatric service was to assess them within closest temporal proximity to their index self-harm event as well as to avoid the

potential selection bias inherent in comparing participants from different levels of care (i.e., inpatient SA vs. outpatient NSSI). Moreover, we were not attempting to conduct an epidemiological study of implicit associations of self-harm in teens engaged in NSSI and/or SA behaviors. Instead, we sought to evaluate homogeneous samples of teens engaged in NSSI or SA, but not both, to advance what is known about behavioral differences underlying NSSI and SA. Finally, additional work is warranted to examine the potential effects of depression and/or anxiety on implicit associations in youths engaging in NSSI or SA, with subsamples sufficiently powered for to examine such potential interactions. Future studies to evaluate the neural underpinnings of these behavioral differences will require NSSI and SA participants drawn from multiple settings, including psychiatric inpatients and outpatients and also nonpsychiatric referral sources. Nevertheless, our study is an important step in understanding the mechanism underlying NSSI and SA behaviors.

Conclusions

Our study is among the first to evaluate implicit attitudes towards cutting and suicide/death among homogeneous groups of adolescents engaged in NSSI-only or SA-only. Our primary findings are that NSSI participants had stronger identification with cutting and suicide/death than either SA or TDC participants, suggesting that clinicians should not dismiss NSSI as not serious. Further study is warranted to determine the mechanism by which youths engaged in NSSI acquire these stronger identifications and make a first-time SA, as preventing this transformation is a key target for novel treatment development and prevention projects so as precision medicine approaches to reduce the morbidity and mortality from youth suicide.

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Key points

- Suicide attempts (SA) and non-suicidal self-injury (NSSI) are severely impairing health problems affecting adolescents.
- Prior research often enrolled youths engaging in both behaviors, hindering the ability to identify the specific mechanism underlying either behavior.
- We compared NSSI-only, SA-only, and typically developing control adolescents on the Self-injurious implicit association task (SI-IAT)—a computerized performance task assessing attitudes for which people either lack insight or may be motivated to conceal, like NSSI and suicide.
- NSSI participants had stronger identification with cutting versus no cutting and suicide/death versus life than either SA or TDC participants.
- Strong implicit attitudes towards suicide/death among adolescents with NSSI without a prior SA suggests that clinicians should not dismiss NSSI as not serious.
- Identifying the mechanism by which youths engaged in NSSI develop these stronger identifications and make a first-time SA in order to foster novel treatment and prevention strategies blocking this transformation, ultimately reducing youth suicide.

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