Impulsivity and clinical symptoms among adolescents with non-suicidal self-injury with or without attempted suicide

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ABSTRACT

This study examined clinical characteristics and laboratory-measured impulsive behavior of adolescents engaging in either non-suicidal self-injury with (NSSI + SA; $n = 25$) or without (NSSI-Only; $n = 31$) suicide attempts. We hypothesized that adolescent with NSSI + SI would exhibit more severe clinical symptoms and higher levels of behavioral impulsivity compared to adolescents with NSSI-Only. Adolescents were recruited from an inpatient psychiatric hospital unit and the two groups were compared on demographic characteristics, psychopathology, self-reported clinical ratings, methods of non-suicidal self-injury, and two laboratory impulsivity measures. Primary evaluations were conducted during psychiatric hospitalization, and a subset of those tested during hospitalization was retested 4–6 weeks after discharge. During hospitalization, NSSI + SA patients reported worse depression, hopelessness, and impulsivity on standard clinical measures, and demonstrated elevated impulsivity on a reward-directed laboratory measure compared to NSSI-Only patients. In the follow-up analyses, depression, hopelessness, suicidal ideation, and laboratory impulsivity were improved for both groups, but the NSSI + SA group still exhibited significantly more depressive symptoms, hopelessness, and impulsivity than the NSSI-Only group. Risk assessments for adolescents with NSSI + SA should include consideration not only of the severity of clinical symptoms but of the current level impulsivity as well.

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1. Introduction

Suicide, suicide attempts, and non-suicidal self-injurious behaviors are prevalent, costly, and preventable public health problems. Non-suicidal self-injury (NSSI) is defined as a non-fatal act that results in bodily injury without the intent to die, while suicide attempts (SA) are acts committed with the intent to cause death (O'Carroll et al., 1996). Both NSSI and suicidal behaviors are prevalent among adolescents and are often initiated during this developmental transition to adulthood. NSSI most often begins during adolescence (Pattison and Kahan, 1983), and estimates of prevalence rates range widely. Estimates of NSSI in adolescents range from 5.1% to 40% (Darche, 1990; Patton et al., 1997; Ross and Heath, 2002) and NSSI has been reported in different community cohorts (Patton et al., 1997; Ross and Heath, 2002) and in clinical samples (Hjelmeland and Grohalt, 2005). The nationwide 2005 Youth Risk Behavior Survey reported a prevalence rate of 8.4% (i.e., 1169 of 13,917 adolescents) for at least one suicide attempt within the last 12 months (Eaton et al., 2006).

Community-based studies show that suicide is the 4th leading cause of death among 10–14 year olds and the third leading cause of death among 15–24 year olds (Anderson and Smith, 2003).

Although NSSI and SA are two forms of behavior that exist on a continuum of self-injury that ends with completed suicide (O'Carroll et al., 1996), a fundamental question in the field has been whether those with NSSI and/or SA represent distinct clinical populations. The expressions of these behaviors often co-occur (Muehlenkamp and Gutierrez, 2007; Nock et al., 2006); studies have shown that the majority of adults (55%–85%; Roy, 1978) and adolescents (55%–70%; Nock et al., 2006) with NSSI also have histories of attempted suicide. While these studies have documented the co-occurrence of these behaviors, the question of their differentiation remains. Two key studies have tested this question, finding that individuals with both NSSI + SA are more clinically impaired than those with either SA-Only or NSSI-Only. In one test of this question, Stanley et al. (2001) compared clinical characteristics of adult patients (primarily Borderline Personality Disorder) with attempted suicide presenting with (NSSI + SA, $n = 30$) or without NSSI (SA-Only, $n = 23$). Compared to patients with histories of SA-Only, patients with histories of NSSI + SA reported significantly higher levels of anxiety, depression, hopelessness, suicidal ideation, aggression, and impulsivity (Stanley et al., 2001). Another study (Muehlenkamp and Gutierrez, 2007) compared four groups of adolescents, those without self-harm or suicide attempts ($n = 406$), SA-Only

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($n=10$), NSSI-Only ($n=87$), and NSSI + SA ($n=38$) behaviors. Compared to adolescents with NSSI-Only, those with histories of NSSI + SA reported significantly higher levels of suicidal ideation, more depressive symptoms, and fewer reasons for living, although the SA-Only group did not differ significantly from either the NSSI + SA or the NSSI-Only groups, which was "likely the result of the small n-size" (Muehlenkamp and Gutierrez, 2007; p. 84). Together, these two studies suggest that individuals with both NSSI + SA report more clinical symptoms than either of those self-harm behaviors alone. Building on these findings, continued research in this area is needed to understand the clinical distinctions between individuals with NSSI and/or SA to refine treatment for these behaviors.

Theories of suicidal behavior (e.g., Mann et al., 1999) have included impulsivity as an important component that may be especially relevant to understanding both suicidal and self-injurious behaviors. Impulsivity has been defined as "a predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these reactions to themselves or others" (Moeller et al., 2001; p. 1784). While this type of behavior is a common characteristic of adolescent development, impulsivity has been specifically identified as an important risk factor for suicidal behavior in both adolescent community-based and clinical samples (Gorlyn, 2005; Horesh, 2001; Sanislow et al., 2003). The propensity for Impulsive behavior has also been consistently linked to biological mechanisms implicated in suicidal behaviors (Kety, 1990; Mann et al., 2001) and has been shown to account for variance that is independent of other known suicidal risk factors (e.g., depression; Kingsbury et al., 1999).

Despite growing appreciation of impulsivity as a risk factor for suicidal behaviors, research is limited by the nearly exclusive use of self-report measures that rely on accurate personal insight and recollection regarding complex behavior patterns (Horesh, 2001). As an alternative, objective performance-based laboratory methodologies have proven useful for studying clinically relevant processes (Dougherty et al., 2003, 2004a; Swann et al., 2003, 2005), which is especially important since laboratory measures have the "potential for bridging some important gaps between research on causal processes and interventions" (Frick & Loney, 2000, p. 553). Using laboratory performance-based methodologies, two studies have reported increased impulsivity among suicide attempters as compared to those without attempts (Dougherty et al., 2004b; Horesh, 2001). However, there is no research using these laboratory methodologies to test distinctions between NSSI with or without suicide attempts.

Previous research has identified an overlap between NSSI and SA (Muehlenkamp and Gutierrez, 2007; Nock et al., 2006), and some studies have found that self-report measures can be used to distinguish between individuals with NSSI who do or do not go on to attempt suicide (Muehlenkamp and Gutierrez, 2007; Stanley et al., 2001). However, none has used objective behavioral methods to test for these differences. The aim of the current study was to determine whether laboratory behavioral impulsivity measures would be useful for distinguishing which individuals engaged in NSSI are at greater risk for attempting suicide. To accomplish this, we recruited adolescents with histories of NSSI from a psychiatric inpatient unit and assigned them to groups depending on the presence (NSSI + SA) or absence (NSSI-Only) of a history of attempted suicide. The two groups were compared using a battery of clinical interviews, self-reported ratings of mood and behavior, and laboratory behavioral measures of impulsivity. We hypothesized that adolescents with histories of both NSSI and SA would have significantly higher levels of depressive symptoms and greater behavioral impulsivity compared to adolescents with NSSI alone.

2. Methods

2.1. Subjects

Boys and girls (ages 13–17 years) who had a history of non-suicidal self-injury (NSSI) with and without suicide attempt(s) were recruited from the Child and Adolescent Inpatient Psychiatry Service at Wake

Forest University Baptist Medical Center (WFUBMC), Winston-Salem, NC. This study was reviewed and approved by the WFUBMC Institutional Review Board. After a complete description of the study to the participants and their guardians, written informed assent was obtained from the adolescent and consent was obtained from the guardian. Participants were paid $30 for each of the inpatient and follow-up interview procedures.

Based on reviews of medical records and clinical information from the treatment team's rounds, adolescents with a history of NSSI were approached for participation. Potential participants completed a screening interview that included measures of psychiatric symptoms (Schedule for Affective Disorders Schizophrenia for School-Age Children-Present and Lifetime Version; K-SADS-PL, Kaufman et al., 1997), general intellectual functioning (Wechsler Abbreviated Scale of Intelligence,™ San Antonio, TX), and history of NSSI and suicidal behaviors (Lifetime Parasuicide Count II; LPC-2, Linehan and Comtois, 1996). Current psychiatric diagnoses were determined by consensus of the research team (i.e., consensus best-estimate diagnostic procedure; Roy et al., 1997), based on the adolescents' responses to psychiatric interview (i.e., the K-SADS-PL) and ancillary information obtained from medical records and treatment staff. None of the diagnostic team members was an attending physician for any of the adolescent participants. Socioeconomic status of the sample was characterized using the Four Factor Index of Social Status (Hollingshead, 1975). Based on the screening interview, volunteers were included if they had a history of NSSI and an IQ greater ≥ 70. Potential participants were excluded if they had a psychiatric disorder that would interfere with comprehension of task instructions (e.g., psychosis or autism) or were in the custody of the state.

Boys and girls who qualified were recruited into one of two groups: (1) NSSI-Only ($n=31$), consisting of adolescents with a history of NSSI behaviors without the intent to cause death; and (2) NSSI + SA ($n=25$), consisting of adolescents with a history of separate incidents of attempted suicide and of NSSI behaviors. Classification of self-harm behaviors as either NSSI or suicide attempts was made based adolescent self-report on the LPC-2 (Linehan and Comtois, 1996) along with ancillary information to corroborate this report from medical records and case conference with the treatment team. The LPC-2 is a 16-item interview assessing the intent, frequency, and degree of suicidal behaviors and non-suicidal self-harm by 11 different methods (e.g., "cut self", "burned self", "swallowed poison"; Linehan and Comtois, 1996). Consistent with established definitions of these behaviors (see O'Carroll et al., 1996), a suicide attempt was defined as a behavior causing self-injury that was committed with the intent to cause death, while non-suicidal self-injury was defined as an act that was committed without this intent. The LPC-2 has been used previously to characterize self-injurious and suicidal acts among adolescents (Mori et al., 1999; Velting and Miller, 1998).

2.2. Assessment

Participants completed a battery of clinical and behavioral measures after admission (mean $=3$ days, S.D. $=1.3$). Testing was completed between 2:00 pm and 5:00 pm. All measures were counterbalanced and administration of computerized behavioral tasks was alternated with clinical self-report measures. The self-report measures used included the Beck Depression Inventory-II (Beck et al., 1996), the Beck Hopelessness Scale (Beck and Steer, 1988), and the Beck Scale for Suicidal Ideation (Beck and Steer, 1991). Self-reported trait impulsivity was assessed using the Barratt Impulsiveness Scale (Patton et al., 1995), and aggression was measured using the Lifetime History of Aggression (Coccaro et al., 1997).

In addition, behavioral assessment of impulsivity was completed using the Two Choice Impulsivity Paradigm (TCIP; Dougherty et al., 2003, 2005a) and the GoStop Impulsivity Paradigm (GoStop; Dougherty et al., 2003, 2005a). The TCIP is a discrete-choice delay-discounting

Table 1
Comparison of demographic characteristics of adolescents with self-injurious behaviors only (NSSI-Only) or self-injurious behavior with suicide attempt(s) (NSSI + SA).

Characteristic	Group				Analyses		
	NSSI-Only ($n = 31$)		NSSI + SA ($n = 25$)				
	Mean	S.D.	Mean	S.D.	t	df	P
Age (years)	15.1	1.3	14.6	1.2	1.23	54	0.226
Education (years)	9.2	1.4	9.0	1.6	1.07	54	0.289
SES	31.0	12.5	28.0	12.5	0.87	49	0.389
WASI Score	93.8	10.9	94.7	10.5	0.29	49	0.770
	n	%	n	%	χ^2	df	P
Gender					1.95	1	0.162
Female	21	67.7	21	75.0			
Male	10	18.2	4	25.0			
Ethnicity					2.67	3	0.445
Caucasian	26	83.9	20	80.0			
African American	5	14.7	3	12.0			
Hispanic	0	0.0	1	4.0			
Other	0	0.0	1	4.0			
Psychiatric diagnosis							
MDD	18	58.1	18	72.0	1.17	1	0.279
ODD	3	9.7	3	12.0	0.078	1	0.780
CD	3	9.7	2	8.0	0.048	1	0.827
SUD	1	3.2	1	4.0	0.024	1	0.877
PTSD	0	0.0	1	4.0	1.26	1	0.261
Bulimia	1	3.2	0	0.0	0.821	1	0.365
GAD	1	3.2	0	0.0	0.821	1	0.365
ADHD	4	12.9	0	0.0	3.47	1	0.062
Abuse category							
Physical	9	31.0	7	33.3	0.03	1	0.863
Sexual	5	17.2	4	19.0	0.03	1	0.870
Neglect	1	3.4	2	9.5	0.80	1	0.372

SES = Socioeconomic Status; WASI = Wechsler Abbreviated Scale of Intelligence; MDD = Major Depressive Disorder; ODD = Oppositional Defiant Disorder; CD = Conduct Disorder; SUD = Substance Use Disorder; PTSD = Post-traumatic Stress Disorder; GAD = Generalized Anxiety Disorder; ADHD = Attention Deficit Hyperactivity Disorder.

measure requiring 50 choices between smaller-sooner and larger-later rewards that are exchanged for actual money. A preference for smaller-sooner choices rather than larger-later choices is interpreted as an indicator of greater impulsivity (Dougherty et al., 2005a). This response style is consistent with what has been described as consequence sensitivity aspects of impulsivity (Dougherty et al., 2005b). The GoStop is a stop-task requiring responses to target stimuli (i.e., identically-matching 5-digit numbers presented in black) and inhibiting responses when the target is unpredictably coupled with a stop signal (identically-matching 5-digit number that changes in color from black to red) at one of four stop delays (50, 150, 250, and 350 ms). Participants are instructed to respond while a number is still on the monitor, but to withhold responding if that number turns red (the stop signal). The proportion of responses to stop trials are interpreted as impulsive responding (Dougherty et al., 2005a) and this type of responding is consistent with what has been described as response inhibition aspects of impulsivity (Dougherty et al., 2005b).

2.3. Statistical analyses

To compare group characteristics during hospitalization, two-tailed independent samples *t*-tests were used to analyze age, education, socioeconomic status, and intelligence. Chi-square tests were used to analyze gender, ethnicity, psychiatric disorder, and abuse categories. Data from the 150 ms stop delay was chosen to use for this study since this variable typically provides the best group discrimination (e.g., Marsh et al., 2002). Group comparisons of self-report and laboratory behavioral data gathered during hospitalization were conducted with one-way analyses of variance (ANOVA). Following the initiation of the original study, we revised the protocol to include preliminary follow-up testing at 4 to 6 weeks after hospital discharge.

Analyses of these additional data were made using 2×2 [Group (NSSI-Only and NSSI + SA) × Time (initial assessment and follow-up)] between-within ANOVAs. The follow-up analyses were conducted using univariate repeated-measures or between-group ANOVA comparisons, as appropriate. For all analyses, Cohen's *d* was calculated as an indicator of the magnitude of group differences that is independent of sample size. Using Cohen's *d*, conventional estimates of 0.2, 0.5, and 0.8 are considered small, medium, and large effect sizes (respectively; Cohen, 1988). Alpha was set at 0.05 for all analyses. Data were analyzed using SPSS® version 15.0 (SPSS Inc; Chicago, IL).

3. Results

3.1. Demographic comparisons

Fifty-six adolescents were enrolled and completed the study. Adolescents in the non-suicidal self-injury group (NSSI-Only, $n = 31$) had committed at least one self-harm act without the intent to cause death. Adolescents in the combined NSSI and SA group (NSSI + SA, $n = 25$) had committed at least one NSSI act (without intent to cause death) and at least one suicide attempt (with intent to cause death). There were no significant differences between groups in age, education, socioeconomic status, general intelligence, gender, ethnicity, psychiatric diagnoses or histories of abuse (see Table 1). The most common primary diagnosis was DSM-IV Major Depressive Disorder. For adolescents in both groups, the current hospitalization was most often the patient's first inpatient psychiatric treatment (72% of the NSSI-Only and 65% of NSSI + SA groups; $\chi^2_1 = 0.306$, $P = 0.58$), although most had previously participated in some form of outpatient therapy (82% of the NSSI-Only and 76% of NSSI + SA groups; $\chi^2_1 = 1.469$, $P = 0.48$).

3.2. Non-suicidal self-injury and suicide attempt histories

The average number of lifetime acts of NSSI was 40 and 38, respectively, for the NSSI-Only and NSSI + SA groups. The NSSI + SA group had a median of two previous suicide attempts; 12 adolescents had a single suicide attempt, and 13 had more than one suicide attempt. The NSSI + SA and NSSI-Only groups reported similar numbers of visits to the emergency department as a result of their NSSI or SA (48% versus 35%, respectively; $\chi^2_1 = 0.896$, $P = 0.34$). Of those with SA, 52% received no medical intervention for their attempts, while 48% had a visit to the emergency department and 33% of those initially seen in the emergency department were admitted to a medical floor for further treatment of their injuries. The two groups did not differ in the methods of NSSI they had committed in their lifetime, and the most common method of NSSI for both groups was cutting (Table 2).

Table 2
Group comparison of methods of non-suicidal self-injurious behavior reported across the lifetime of adolescents with self-injurious behaviors only (NSSI-Only) or self-injurious behavior with suicide attempt(s) (NSSI + SA).

Method of self-injury	Group		Analyses		
	NSSI-Only ($n = 31$)	NSSI + SA ($n = 25$)			
	%	%	χ^2	df	P
Cutting	77.4	84.0	0.38	1	0.538
Drug overdose	32.3	20.0	1.06	1	0.303
Banging head	25.8	40.0	1.28	1	0.258
Burning	22.6	20.0	0.55	1	0.815
Stabbing	9.7	24.0	2.11	1	0.147
Hanging	6.5	16.0	1.32	1	0.251
Poisoning	3.2	8.0	0.62	1	0.430
Asphyxiating	3.2	4.0	0.02	1	0.877
Jumping	0.0	4.0	1.26	1	0.261

Table 3
Comparison of initial self-reported clinical characteristics and laboratory-measured impulsivity of adolescents with self-injurious behaviors only (NSSI-Only) or self-injurious behavior with suicide attempt(s) (NSSI + SA).

	Group				Analyses				
	NSSI-Only ($n=31$)		NSSI + SA ($n=25$)						
	Mean	S.D.	Mean	S.D.	F	df	P	Observed power[a]	Cohen's d
Self-report measures									
Beck Depression Inventory	14.6	11.7	22.3	9.5	7.04	1,54	0.010	0.74	0.72
Beck Hopelessness Scale	4.3	4.3	6.9	4.7	4.22	1,54	0.045	0.52	0.55
Beck Scale for Suicidal Ideation	2.8	5.1	10.9	10.8	13.70	1,54	0.001	0.95	0.96
Barratt Impulsiveness Scale	72.9	12.5	80.6	6.5	7.68	1,53	0.008	0.78	0.77
Lifetime History of Aggression	19.7	8.5	22.4	7.0	1.70	1,54	0.327	0.25	0.35
Laboratory behavioral impulsivity									
TCIP % smaller-sooner choices	26.5	23.9	43.0	29.0	5.47	1,54	0.023	0.63	0.62
GoStop 150 ms % disinhibited	26.3	14.9	35.4	23.3	3.13	1,54	0.082	0.41	0.46

GoStop = GoStop Impulsivity Paradigm; TCIP = Two Choice Impulsivity Paradigm.
[a] Computed using alpha = 0.05.

3.3. Self-reported clinical characteristics and behavioral impulsivity

As shown in Table 3, the NSSI + SA group reported significantly higher ratings on the Beck Depression Inventory, Beck Hopelessness Scale, Beck Scale for Suicide Ideation, and Barratt Impulsiveness Scale compared to the NSSI-Only group. There were no significant group differences on the Lifetime History of Aggression (self-harm and suicide items were not included in the scores). Table 3 also shows data from the Two Choice Impulsivity Paradigm (TCIP) and the GoStop Impulsivity Paradigm (GoStop). Compared to the NSSI-Only group, the NSSI + SA group had a significantly greater preference for the smaller-sooner rewards during the TCIP. There were no statistically significant differences between the two groups for GoStop response inhibition failures (i.e., % Disinhibited) at the 150 ms stop delay.

3.4. Preliminary findings: follow-up comparisons at 4–6 weeks after hospital discharge

Follow-up assessment occurred between 4 and 6 weeks after discharge from the inpatient unit. Due to factors such as distance from the research laboratory and changes in contact information (e.g., phone number disconnected), only 28 of the original participants were able to return for follow-up (NSSI-Only, $n=15$; NSSI + SA, $n=13$). There were no group differences in the proportion of those lost to follow-up at the post-hospitalization testing ($\chi^2_1 = 0.072$, $P=0.788$). The time from hospital discharge to follow-up assessment showed no significant group differences (NSSI-Only mean = 33.7 days, S.D. = 8.9; NSSI + SA mean = 38.4 days, S.D. = 11.8; $t_{26} = 1.20$, $P=0.24$) and averaged 35 days (S.D. = 10.5) across the two groups. The follow-up

Table 4
Comparisons of initial and 4–6 week follow-up measures in a subset of adolescents with self-injurious behaviors only (NSSI-Only) or self-injurious behavior with suicide attempt(s) (NSSI + SA).

	Group							
	NSSI-Only ($n=15$)				NSSI + SA ($n=13$)			
	Initial visit		Follow-up		Initial visit		Follow-up	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Self-report measures								
Beck Depression Inventory	11.9	8.5	7.5	4.9	23.5	8.8	14.5	6.4
Beck Hopelessness Scale	3.1	3.0	2.3	2.5	7.9	4.5	5.5	4.1
Beck Scale for Suicidal Ideation	3.6	5.8	1.5	3.6	11.0	11.2	1.1	3.3
Laboratory behavioral impulsivity								
TCIP % smaller-sooner choices	26.7	21.9	23.5	26.1	46.6	27.1	48.1	28.1
GoStop 150 ms % disinhibited	28.7	18.3	23.3	19.5	40.0	26.5	41.2	28.3

GoStop = GoStop Impulsivity Paradigm; TCIP = Two Choice Impulsivity Paradigm.

assessment included the same primary dependent measures obtained initially, except for the Lifetime History of Aggression and Barratt Impulsiveness Scale, which are stable trait measures that would not be expected to change over the 4–6 week follow-up period.

As seen in Table 4, both groups' ratings of depression and hopelessness declined between the initial and follow-up assessments (main effect of Time: Beck Depression Inventory, $F_{1,26} = 18.27$, $P<0.001$; Observed Power = 0.98; Cohen's $d = 0.76$; Beck Hopelessness Scale: $F_{1,26} = 4.58$, $P = 0.042$; Observed Power = 0.54; Cohen's $d = 0.36$). However, the NSSI + SA group reported both a greater number and greater severity of depression and hopelessness symptoms than the NSSI-Only group (main effect of Group: Beck Depression Inventory: $F_{1,26} = 16.65$, $P<0.001$; Observed Power = 0.98; Cohen's $d = 1.16$; Beck Hopelessness Scale: $F_{1,26} = 12.02$, $P = 0.002$; Cohen's $d = 1.09$). Self-reported symptoms of suicidal ideation showed a significant Group by Time interaction (Beck Scale for Suicide Ideation: $F_{1,26} = 7.27$, $P = 0.012$; Observed Power = 0.74). As expected, follow-up simple effects analyses indicated that the NSSI + SA group reported significantly more symptoms of suicidal ideation than the NSSI-Only group at the initial assessment during hospitalization (univariate ANOVA: $F_{1,26} = 5.03$, $P = 0.034$; Observed Power = 0.58; Cohen's $d = 0.83$). However, at the follow-up assessment, both groups showed similarly low suicidal ideation symptoms ($F_{1,26} = 0.89$, $P = 0.768$; Observed Power = 0.06; Cohen's $d = 0.11$). The interaction was confirmed by the significant decline in suicidal ideation symptoms from the initial to the follow-up assessment for the NSSI + SA group ($F_{1,12} = 13.21$, $P = 0.003$; Observed Power = 0.92; Cohen's $d = 1.20$), but no significant change across time for the NSSI-Only group ($F_{1,14} = 2.75$, $P = 0.120$; Observed Power = 0.34; Cohen's $d = 0.44$).

Table 4 also shows that, compared to the NSSI-Only group, the NSSI + SA group exhibited elevated impulsive responding on the consequence sensitivity measure (TCIP) regardless of the time of assessment. The NSSI + SA group showed a significantly greater preference for the impulsive smaller-sooner choices on the TCIP compared to the NSSI-Only group (main effect of Group: $F_{1,26} = 6.37$, $P = 0.018$; Observed Power = 0.68; Cohen's $d = 0.88$). The response inhibition failures for the NSSI + SA group at the 150 ms stop delay were not statistically different from those of the NSSI-Only group ($F_{1,26} = 3.39$, $P = 0.077$; Observed Power = 0.43; Cohen's $d = 0.63$). There were no main effects of Time or interactions of Group by Time for either of the two impulsivity tasks.

4. Discussion

This study examined the clinical features of adolescent psychiatric inpatients with histories of non-suicidal self-injury only (NSSI-Only) compared to adolescents with histories of both non-suicidal self-injury

and at least one suicide attempt (NSSI + SA). Most of the adolescents in both groups were experiencing their first psychiatric hospitalization, and had a primary diagnosis of either a mood or disruptive behavior disorder. While the two groups were similar in their demographic characteristics, psychiatric diagnoses, NSSI frequency, treatment history, and histories of abuse, they differed on measures of impulsivity and the severity of psychological distress. We found that, relative to the NSSI-Only group, the NSSI + SA group: (1) was more severely depressed and hopeless; (2) had higher self-ratings of trait impulsivity and suicidal ideation; and (3) performed more impulsively on a laboratory measure of consequence sensitivity. Additionally, *follow-up* comparisons indicated that the groups differed with regard to many of these symptoms at 4 to 6 weeks following hospitalization. Laboratory measures of consequence sensitivity impulsivity and self-reported symptoms of depression and hopelessness were twice as high in the NSSI + SA group compared to the NSSI-Only group.

The relatively poorer clinical presentation of NSSI + SA group is especially troubling when interpreted within the context of theories that have been developed to explain suicidal behavior. For example, Joiner et al. (2005) surmised that neurobiological dysregulation of impulsivity and the tendency to experience intense psychological distress are the two primary categories of suicide risk. Specifically, those who experience relatively greater impulsivity and who have more experience with self-harm behaviors, in this case our NSSI + SA group, are most likely to experience future suicidal behaviors. From another perspective, stress-diathesis theory (Mann et al., 1999) would predict that suicidal behavior is the outcome of the interaction between stressors and an underlying predisposition for impulsive behavior. In this latter model, although impulsivity is the final stage of behavior prior to a suicidal act, other factors can interact with impulsivity, leading to an increased risk for suicide (Mann et al., 1999). These interactions are proposed to occur through two major pathways: one that includes psychiatric state and life events, and a second that includes serotonergic dysfunction. The former pathway is particularly important with respect to our data. In the context of Mann and colleagues model, the high levels of subjective states of depression and hopelessness reported by our adolescent NSSI + SA patients that coincided with high levels of impulsivity and suicidal ideation make them most at risk for future suicidal behavior. Regardless of theoretical orientation, the relatively greater number of clinical symptoms and impulsivity found in the NSSI + SA would suggest that they are at elevated risk for future suicidal behaviors relative to those with NSSI-Only.

Appreciation for the different components of behavioral impulsivity may be another important aspect to consider in testing NSSI and SA. Two types of behavioral impulsivity tasks were included in the current investigation because impulsivity has been described as a complex construct requiring multiple forms of measurement (Barratt and Patton, 1983; Dougherty et al., 2003; Gorlyn 2005) and these different tasks have been shown to measure distinct aspects of behavior (Dougherty et al., 2005b, 2009). While the two groups tested in this study differed on their performance on the measure of consequence sensitivity aspects of impulsivity (i.e., TCIP), they did not differ on the measure of response inhibition aspects of impulsivity (i.e., GoStop). Thus the preference for more immediate gratification at the expense of longer-term gain may be more salient in the NSSI + SA group compared to the NSSI-Only group.

Based on the present findings, a number of conclusions can be drawn about the treatment of adolescents with NSSI with without SA. First, adolescents with both NSSI and SA appear to have a clinically distinct presentation from those with NSSI-Only, including elevated depression, hopelessness, and impulsivity. This clinical presentation is consistent with recommendations requiring a thorough bio-psycho-social assessment prior to planning treatment (AACAP, 2001; Gould et al., 2003). Second, the presence of NSSI should not cause the treating clinician to discount the seriousness of risk posed by a suicide attempt.

The increase in the number of risk factors for suicidal behavior among those with NSSI + SA has now been reported relative to both SA-Only (Guertin et al., 2001; Stanley et al., 2001) and NSSI-Only groups (current laboratory behavioral findings and Muehlenkamp and Gutierrez, 2007), lending confidence to the interpretation that the convergence of both forms of self-harm behaviors imparts greater risk for suicide. Third, understanding the clinical significance of NSSI with and without SA is relevant to treatment planning: (1) for those adolescents with a recent history of SA, the suicide attempt should be targeted as a priority in treatment; (2) for treatment of adolescents with both NSSI and SA, the diminished capacity to appreciate long-term consequences, which may make it easier to act on suicidal impulses, should be targeted as a priority; (3) for adolescents with both NSSI and SA, as well as comorbid depression, hopelessness, and high levels of impulsivity, long-term psychotherapy (greater than 6 months) is generally required; (4) for adolescents with NSSI-Only and without significant psychiatric comorbidity, brief treatments (e.g., skills training) may be considered; and (5) for therapies that target both NSSI and SA, the clinician should also monitor treatment response for comorbid psychopathology and symptom substitution, and should use specific validated measures to assess treatment outcome (AACAP, 2001; Gould et al., 2003; Sansone et al., 2006).

The interpretation of the results of the current study must be considered within the context of its limitations. First, the preliminary follow-up comparisons of post-hospitalization testing represent only half of the original sample. The data from the follow-up group are intriguing, especially the stability of the high level of impulsivity both in and outside of the hospital. But the sample that could be retested 4–6 weeks later was limited to those willing, or having the means, to return for testing, which may represent a selected sample. Future research may consider a prospective study of these measures to better ascertain the correspondence of NSSI and/or SA with clinical symptoms and impulsivity over time. This prospective method will be of special interest for understanding adolescent samples since they are experiencing developmental changes in impulsivity, which may alter the course of suicidal behaviors. Second, while the classification tool for assessing suicidal intent used in this study (i.e., the LPC-2; Linehan and Comtois, 1996) relies on subjective report of the adolescents, recent studies (e.g., Nock and Banaji, 2007) have indicated that objective performance-based measures may be useful for characterizing self-harm behaviors. Given that performance-based measures of impulsivity may be important to advance our understanding of NSSI, this same argument would apply to performance-based measures of suicidal behaviors.

In conclusion, our findings show that both self-report and laboratory-measured behavioral impulsivity, as well as self-reported depression and hopelessness, are elevated in NSSI + SA adolescents, compared to NSSI-Only adolescents. These findings advance our understanding of the relationship of impulsivity, depression severity, and suicidality in NSSI adolescents. Impulsivity is likely to be a key risk factor in adolescents with NSSI, especially in adolescents with NSSI + SA. Furthermore, our findings advance previous studies of unique populations of suicide attempters with NSSI (e.g., Muehlenkamp and Gutierrez, 2007; Nock et al., 2006; Stanley et al., 2001) by including both self-reported clinical symptoms and laboratory-measured impulsivity in NSSI adolescents. Research in adolescent samples with NSSI and SA is particularly important, given that adolescence is characterized by underdeveloped impulse control and elevated severity of depression, hopelessness, and impulsivity compared to adult samples (Stanley et al., 2001). Adolescents with NSSI + SA appear to be clinically distinct from those with NSSI-Only. Therefore, clinicians should be cognizant of the risk for suicide among adolescents presenting with NSSI, particularly when histories of SA are also reported, since adolescents with NSSI + SA appear to differ in severity of depression and risk for suicide compared to adolescents engaging in NSSI-Only. It would be prudent for clinician assessment of the risk for a

suicide attempt in adolescents to include a comprehensive assessment of impulsivity (including consideration of state/trait, and components behaviors) in addition to psychopathology.

Acknowledgements

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