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Impulsivity and nonsuicidal self-injury: A longitudinal examination among emerging adults

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ABSTRACT

Introduction: Nonsuicidal self-injury (e.g., self-cutting without lethal intent) is a widely occurring behavior among adolescents and emerging adults. Heightened impulsivity during the adolescent and emerging adult years may contribute to an increased risk for nonsuicidal self-injury onset and engagement during these developmental periods; however, longitudinal research on impulsivity and nonsuicidal self-injury among young persons is lacking.

Method: To extend previous research, and elucidate the direction of effects between impulsivity and nonsuicidal self-injury, 782 emerging adults (75% female) completed assessments of impulsivity and nonsuicidal self-injury annually for three years.

Results: Path analysis revealed a bidirectional relation, such that higher impulsivity predicted greater nonsuicidal self-injury frequency over time, and greater nonsuicidal self-injury frequency predicted higher impulsivity over time, even after taking into account past scores on these variables as well as other participant factors (e.g., age, sex, depressive symptoms, anxiety). Gender did not moderate the pattern of associations.

Conclusions: The present findings indicate that impulsivity may not only lead to nonsuicidal self-injury, but that frequent engagement in nonsuicidal self-injury may undermine regulatory skill development and lead to greater impulsivity over time during the emerging adult years.

1. Introduction

Nonsuicidal self-injury, which can be defined as the direct and deliberate destruction or alteration of bodily tissue in the absence of lethal intent, includes behaviors such as self-cutting, burning, and hitting (American Psychiatric Association, 2013). Nonsuicidal self-injury often has its onset in mid-adolescence, but emerging adulthood (ages 18–24 years) also is a period of increased risk for the initiation of nonsuicidal self-injurious behaviors (Heath, Toste, Nedecheva, & Charlebois, 2008; Whitlock et al., 2011). Emerging adults who attend post-secondary school report higher rates of nonsuicidal self-injury as compared to emerging adults who do not attend post-secondary school, suggesting that college and university students may represent unique at risk groups (Swannell, Martin, Page, Hasking, & St John, 2014). As many as 20% of post-secondary students report engaging in nonsuicidal self-injury during the college and university years (Muehlenkamp, Xhunga, & Brausch, 2018; Wester, Trepal, & King, 2017) and prevalence rates may be increasing (Wester et al., 2017). Engagement in nonsuicidal self-injury is associated with increased risk for a variety of mental health concerns, including depressive symptoms (Marshall, Tilton-Weaver, & Stattin, 2013; Zielinski, Veilleux, Winer, & Nadorff, 2017),

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anxiety (Selby, Bender, Gordon, Nock, & Joiner, 2012; Wang, You, Lin, Xu, & Leung, 2017) and suicidal behavior (Klonsky, May, & Glenn, 2013; Whitlock, Muehlenkamp, et al., 2013). Given the widespread prevalence of nonsuicidal self-injury, and the risk is confers for suicidal behavior (Hamza, Stewart, & Willoughby, 2012; Kiekens et al., 2018), understanding the processes through which nonsuicidal self-injury develops and can be prevented is critically important to promoting positive mental health outcomes for emerging adults.

1.1. Impulsivity and nonsuicidal self-injury

Impulse control, or lack therefore, has long been thought to be relevant to the understanding of nonsuicidal self-injury. Prior to being differentiated as its own diagnosis in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) (American Psychiatric Association, 2013), nonsuicidal self-injury only appeared as a symptom of borderline personality disorder, of which a core feature is impulsivity (Peters, Upton, & Baer, 2012). Broadly, the term impulsivity has been used to describe a variety of personality traits related to lack of planning or premeditation, lack of task persistence, and the tendency to act rash particularly in the context of negative emotions (Buss & Plomin, 1975; Depue & Collins, 1999; Peterson & Fischer, 2012; Whiteside & Lynam, 2001; Whiteside, Lynam, Miller, & Reynolds, 2001). In a synthesize of the literature on impulsivity it was found that impulsivity was most commonly conceptualized as lack of premeditation (i.e., acting without careful thinking or planning), although the tendency to act rash in the context of negative emotions also was common (i.e., negative urgency) (Whiteside & Lynam, 2001).

Recent theory and research suggest that impulsivity (particularly lack of thinking, and planning) may be an important predictor of nonsuicidal self-injury. According to the motivational volitional model of suicidal behavior (O'Connor & Kirtley, 2011, 2018), the escalation of self-injurious ideation to behavior may be particularly pronounced among individuals high in impulsivity (who are likely to act without thinking or planning). This theory is supported by findings that emerging adults who attempt suicide can be differentiated from those who experience ideation (but have not made an attempt) by higher levels of impulsivity (Dhingra, Boduszek, & O'Connor, 2015). Impulsivity may similarly increase the likelihood that an individual will engage in nonsuicidal self-injury (Lockwood, Daley, Townsend, & Sayal, 2017). Individuals who are quick to act without thinking may be less deterred by the potential long term consequences of engaging in nonsuicidal self-injury (e.g., scaring, stigmatization, heightened risk for suicidal behavior), and thus more likely to act on an urge. Research suggests that individuals are motivated to engage in nonsuicidal self-injury for a variety of reasons (i.e., affect regulation, self-punishment, interpersonal affiliation, sensation seeking) (Batejan, Swenson, Jarvi, & Muehlenkamp, 2015; Klonsky, 2009; Turner, Chapman, & Layden, 2012; Turner, Cobb, Gratz, & Chapman, 2016). Highly impulsive individuals also may prioritize these potential benefits, over and above later consequences of the behavior.

Impulsivity has been implicated in many forms of risky behaviors (e.g., alcohol and substance use, risky sexual behavior, aggression) (Argyriou, Um, Carron, & Cyders, 2018; Curry et al., 2018; Fisher, Johnson, Fisher, Sharma, & Ceballos, 2016; Leung et al., 2017), but impulsivity may be especially relevant to engaging in nonsuicidal self-injury. According to Nock's (2009) theoretical model on the development and maintenance of nonsuicidal self-injury, one reason individuals may choose nonsuicidal self-injury over other forms of risky behavior is because nonsuicidal self-injury is more readily accessible than many other behaviors which take longer to implement (e.g., accessing drugs or alcohol) (i.e., the pragmatic hypothesis) (Nock, 2010). Thus, impulsive individuals may be especially at risk for nonsuicidal self-injury because the behavior can be performed with little planning or preparation. Consistent with this notion, research has shown that the less time young adults spend considering whether to act on nonsuicidal self-injury behavior after first having the thought, the more likely they are to engage in the behavior (Nock, Prinstein, & Sterba, 2009).

There is mounting research on the association between impulsivity and nonsuicidal self-injury (Claes et al., 2013; Glenn & Klonsky, 2010; Hamza, Willoughby, & Heffer, 2015; Maxfield & Pepper, 2017; Mullins-Sweatt, Lengel, & Grant, 2013; Taylor, Peterson, & Fischer, 2012). Studies tend to converge on the finding that higher self-reported lack of planning or premeditation (i.e., acting without thinking, a preference for short term rewards) and higher levels of negative urgency (i.e., the tendency to act rashly in the context of negative emotions) (Whiteside & Lynam, 2001) are associated with nonsuicidal self-injury (Hamza et al., 2015). For example, in a recent meta-analysis of 27 studies, Hamza et al. (2015) found that, on average, individuals who engaged in nonsuicidal self-injury self-reported higher levels of impulsivity (broadly defined) as compared to individuals who did not engage in nonsuicidal self-injury ($d = 0.593$, a moderate effect size). Moreover, the link between impulsivity and nonsuicidal self-injury was maintained for the different subscales of the Urgency (negative), Premeditation (lack of), Persistence (lack of), and Sensation-seeking Scale (UPPS) (Whiteside et al., 2001; Whiteside & Lynam, 2001), as well as all the subscales on the Barratt Impulsiveness Scale (Barratt, 1993; Patton, Stanford, & Barratt, 1995). In a more recent review, Lockwood et al. (2017) also found that broadly defined, impulsivity was associated with increased risk for nonsuicidal self-injury. Although negative urgency seemed to most strongly differentiate those with a history of nonsuicidal self-injury from those without a history of nonsuicidal self-injury, lack of premeditation was most strongly associated with nonsuicidal self-injury frequency, and increased likelihood that nonsuicidal self-injurious thoughts would lead to behaviors (i.e., intention to action). In contrast to research relying on self-report measures of impulsivity, lab-based measures of impulsivity (e.g., Go/No Task, Stop/Signal Task, Conner's Continuous Performance Test) were not associated with nonsuicidal self-injury (Allen & Hooley, 2017; Glenn & Klonsky, 2010; Janis & Nock, 2009; McCloskey, Look, Chen, Pajoumand, & Berman, 2012). Lab-based measures of impulsivity are often weakly associated with self-report measures, and may assess different facets of impulsivity (Bagge, Rosellini, & Coffey, 2012; Cyders & Coskunpinar, 2012). Thus, trait impulsivity may be more strongly associated with nonsuicidal self-injury than state impulsivity and may be a more clinically useful indicator of risk.

Although cross-sectional research suggests that there is a link between self-reported impulsivity and nonsuicidal self-injury, there is comparatively less longitudinal research on this association, and findings have been mixed (Lockwood et al., 2017). In two studies of emerging adults in university, self-reported impulsivity (measured as negative urgency, lack of premeditation, and sensation

seeking) and nonsuicidal self-injury were associated concurrently, but baseline impulsivity was not positively associated with nonsuicidal self-injury at 8-month and one-year follow-up (Glenn & Klonsky, 2011; Peterson & Fischer, 2012). However, researchers in both studies noted concerns about statistical power; Glenn and Klonsky (2011) utilized a small longitudinal sample of students who self-injured, and Peterson and Fischer (2012) highlighted that there was strong stability in nonsuicidal self-injury in their study, which may have reduced the predictive value of impulsivity. In a larger longitudinal study of adult women (N = 410), Black and Mildred (2013) specifically tested whether negative urgency predicted impulsive nonsuicidal self-injury one year later; they found a predictive effect of negative urgency on nonsuicidal self-injury, controlling for gender, negative affect, and child maltreatment (Black & Mildred, 2013). Similarly, You, Deng, Lin, and Leung (2016) found that increases in negative urgency predicted greater increases in nonsuicidal self-injury behavior over time in their large sample of Chinese adolescents, and that high levels of negative urgency strengthened the association between emotion dysregulation and nonsuicidal self-injury (You et al., 2016). In other studies, engagement in other impulsive behaviors (e.g., substance use, alcohol use, binge eating etc.) was predictive of increased risk for nonsuicidal self-injury engagement longitudinally, even after taking into account other intra- and interpersonal risk factors for nonsuicidal self-injury (Wang et al., 2017; You, Lin, & Leung, 2015).

1.2. Current study

Recent research and theory suggest that impulsivity may be an important individual-level factor that increases the likelihood that an individual will engage in nonsuicidal self-injury (Hamza et al., 2015; Lockwood et al., 2017; Nock, 2010), but there are a number of important limitations of the existing research that need to be addressed. First, few large scale longitudinal research studies have been conducted on the association between impulsivity and nonsuicidal self-injury. In particular, longitudinal studies focused on emerging adulthood are lacking, and existing studies also often have been limited to female samples (Black & Mildred, 2013; Peterson & Fischer, 2012; Riley, Combs, Jordan, & Smith, 2015). Given that emerging adulthood represents a period of increased risk for nonsuicidal self-injury onset and engagement (Heath et al., 2008; Whitlock et al., 2011), findings that post-secondary students may be especially at risk (Swannell et al., 2014), and findings that difficulties in impulsive control are not uncommon among post-secondary students (Kasen, Cohen, & Chen, 2011; Littlefield, Sher, & Steinley, 2010), it is important to elucidate the role of impulsivity in the onset and maintenance of nonsuicidal self-injury during the college and university years. Second, measures of nonsuicidal self-injury are often limited to lifetime assessments (rather than more recent nonsuicidal self-injury, or frequency of nonsuicidal self-injury), which may provide a more nuanced understanding of the role of impulsivity in the initiation and maintenance of nonsuicidal self-injury across the emerging adult years (Lockwood et al., 2017). Third, to the best of our knowledge, there is no longitudinal research on impulsivity and nonsuicidal self-injury that takes into account the direction of effects between these variables. Impulsivity may increase risk for nonsuicidal self-injury, but it also is possible that engaging in nonsuicidal self-injury may circumvent the development of regulatory control over time – leading to greater impulsivity. Indeed, if engaging in nonsuicidal self-injury is reinforced (for emotional or social reasons), it may undermine the development of impulse control and other alternative regulatory strategies (Chapman, Gratz, & Brown, 2006; Cyders & Smith, 2008; Dir, Karyadi, & Cyders, 2013; Fischer, Smith, & Cyders, 2008; Gandhi et al., 2017; Peterson & Fischer, 2012). In other words, engaging in nonsuicidal self-injury may also impact the development of regulatory control (and exasperate cognitive control deficits).

To extend past cross-sectional research on impulsivity and nonsuicidal self-injury, and to elucidate the nature of the associations between impulsivity and nonsuicidal self-injury, the present study examined the link between self-reported impulsivity and nonsuicidal self-injury over time, controlling for other risk factors for nonsuicidal self-injury (i.e., depressive symptoms, anxiety). Given the need for additional research on the link between impulsivity and nonsuicidal self-injury frequency (rather than a reliance on nonsuicidal self-injury vs no nonsuicidal self-injury group comparisons), as well as recent findings that cognitive control deficits may be particularly relevant in understanding the processes through which nonsuicidal self-injury is maintained over time (Glenn & Klonsky, 2010; Lockwood et al., 2017), we chose to utilize a measure of impulsivity specifically related to the tendency to act without little thinking or planning. A self-report measure also was chosen, given research that suggests that trait based self-report measures may be the most clinically useful for identifying those at risk for nonsuicidal self-injury (Allen & Hooley, 2017; Liu, Trout, Hernandez, Cheek, & Gerlus, 2017). Although our examination of the direction of effects was exploratory, we anticipated that the association between impulsivity and nonsuicidal self-injury would be bidirectional, such that impulsivity would predict increased risk for nonsuicidal self-injury over time, and nonsuicidal self-injury also would predict increased impulsivity over time. Given that longitudinal research on impulsivity and nonsuicidal self-injury among emerging adults has been limited to female samples (Riley et al., 2015; Taylor et al., 2012), we also examined whether the pattern of results was invariant across gender.

2. Methodology

2.1. Participants

The current sample was drawn from a larger sample of 1,132 (71% female) first-year undergraduate students (*M*age = 19.11, SD = 1.05) who participated in a larger longitudinal study on stress, coping, and academic achievement at a Canadian university. Participants completed a self-report survey annually for six years, starting in their first-year of university. The sample was composed of mostly domestic-Canadian students (88%). Within this domestic-Canadian group, participants also indicated whether their family belonged to another ethnic background (options were defined by the investigators) – the most common ethnic groups identified were British (19%), Italian (17%), French (10%), and German (9%), consistent with the broader demographics for the region (Statistics

Canada, 2006). The remaining participants were international students (13%) who were predominantly from Asia (4%), the European Union (2%), the Caribbean (1%), and Africa (1%). Participants' socioeconomic status was inferred by the mean level of education of participants' parents, which fell between "some college, university, or apprenticeship program" and "completed a college/apprenticeship and/or technical diploma." Given that a measure of impulsivity was not added to the survey until the fourth assessment point, only data from the fourth, fifth, and sixth waves were analyzed in the present study – these waves were completed by 782 students (*M*age = 18.98 at time of study enrollment, 75% female). Participants in this reduced sample did not differ from the 350 participants who did not complete the fourth, fifth, and sixth waves in baseline (i.e., first wave of the study) measures of nonsuicidal self-injury or many of the covariates (i.e., whether they were born in Canada, parental education, depressive symptoms, anxiety), but they were more likely to be younger and female ($p < 0.05$). Given that the current study's analyses are based on three time points, we refer to these as Time 1, Time 2, and Time 3 throughout the rest of the manuscript.

2.2. Procedure

At study onset, first-year university students were recruited through posters, classroom announcements, website posting, and residence visits. All participants who completed the baseline assessment were invited to participate again at each subsequent wave through email and phone, even if they skipped a year and/or left the university. For the three assessment waves included in the present study, students completed online self-report surveys and were given momentary compensation for their participation (i.e., students received $30 at Time 1, $40 at Time 2, and $40 at Time 3). The University Research Ethics Board approved the study, and all study participants provided informed consent. It is important to note that research has consistently found that asking about self-injurious behaviors (both nonsuicidal self-injury and suicidal behavior) has not been shown to increase risk for these behaviors (Bjarehed, Pettersson, Wangby-Lundh, & Lundh, 2012; Gould et al., 2005; Lewis, Rosenrot, & Santor, 2011; Muehlenkamp, Walsh, & McDade, 2010; Whitlock, Pietrusza, & Purington, 2013). Nevertheless, several precautions were taken to ensure the safety of participants: 1) participants were informed at time of consent that the study included questions about nonsuicidal self-injury, 2) participants were told that they could withdraw from the study any time, 3) participants received a list of available mental health resources at each assessment, 4) participants were given an extensive debrief at the end of the study, and 5) participants were given an opportunity to provide their personal information during the survey if they wanted to be contacted directly by a mental health practitioner.

2.3. Measures

2.3.1. Demographics

Participant age, sex, whether the participant was born in Canada or not, and parental education (one item per parent using a scale of 1 = *did not finish high school* to 6 *professional degree*, averaged for participants reporting on both parents; $r = .40$) were assessed at time of study enrollment.

2.3.2. Nonsuicidal self-injury

Participants completed an adapted version of the Inventory of Statements about Self-Injury (Klonsky & Glenn, 2009) to specifically assess whether they had engaged in nonsuicidal self-injury in the past year at each assessment point. A list of seven self-injurious behaviors that involved tissue damage (e.g., cutting, burning, head banging, biting, severe scratching to the point of bleeding, preventing wounds from healing, and rubbing skin against a rough surface) was provided. Participants were asked to indicate how many times in the past year they had intentionally engaged in behaviors listed without lethal intent using the following seven categories: 1 = I *have engaged in nonsuicidal self-injury at some point in lifetime but not in the past year*, 2 = *1 incident,* 3 = 2–4 *incidents*, 4 = *5–10 incidents*, 5 = *11–50 incidents*, 6 = *51–100 incidents*, 7 = *more than 100 incidents*) (scoring was adopted from Hamza & Willoughby, 2014; Heath et al., 2008). The Inventory of Statements about Self-Injury has been shown to have good test-retest reliability in previous research on undergraduate students (Glenn & Klonsky, 2011; Klonsky & Glenn, 2009; Klonsky & Olino, 2008). Cronbach's alpha for the ISAS items was .76 at Time 1, .80 at Time 2, and .80 at Time 3.

2.3.3. Impulsivity

Impulsivity was assessed using seven items from the Barratt Impulsiveness Scale-11 (Patton et al., 1995), including four items assessing non-planning impulsivity (i.e., I say things without thinking, I plan tasks carefully – reverse coded, I am self-controlled – reverse coded, I am a carefree thinker – reverse coded), two items assessing attentional impulsivity (i.e., I concentrate easily – reverse coded, I don't pay attention), and one item assessing motor impulsivity (e.g., I do things without thinking). Participants answered using a 4-point Likert scale from 1 = *rarely or never* to 4 = *almost always or always*. The Barratt Impulsiveness Scale-11, as well as previously used shortened versions of scale (Spinella, 2007) have been well validated in previous research (Meule et al., 2015; Spinella, 2007; Stanford et al., 2009). In the present study, Cronbach's alpha for the shortened version of the scale was 0.78 at Time 1, 0.81 at Time 2, and 0.81 at Time 3.

2.3.4. Mental health indicators

At Time 1, depressive symptoms were measured using the Center for Epidemiological Studies Depressive Symptoms Scale (CES-D) (Radloff, 1977). This assessment required participants to indicate how often they experienced 20 depressive symptoms (e.g., felt sad) on a 5-point scale (1 = *none of the time* to 5 = *most of the time*) within the past two weeks. Cronbach's alpha for this scale was 0.93. At

Time 1, social anxiety also was assessed using 14 items (e.g., I feel shy around people my age that I do not know) from the Social Anxiety Scale for Children-Revised (SASC) (La Greca & Stone, 1993). Participants responded using a 4-point scale (1 = *almost never or never* to 4 = *almost always or always*). Cronbach's alpha for this scale was .90.

2.4. Missing data

Missing data occurred within each assessment time point because some students did not finish the entire questionnaire (less than 5% per time point), and because some students did not complete all three waves of the survey (i.e., 88% of participants from Time 1 completed the survey at Time 2, and 83% of participants completed the survey at Time 3). Little's MCAR test was significant, chi-square (237) = 352.768, $p < .001$, indicating that the missing data was not missing completely at random. Participants who completed the survey at all three times were more likely to be female than participants who completed the survey at one or two time points, $t(780) = -2.868$, $p = 0.004$, but these groups did not differ on the other study measures. Pairwise covariance coverage estimates ranged from .720 to 1.00. Given our knowledge of the NSSI and impulsivity field, it is likely that the missing data are missing at random (MAR). The Full Information Maximum Likelihood method (FIML) for handling missing data, therefore, was used in our autoregressive cross-lagged model analyses in MPlus 7, with missing data estimated using all study variables, including sex. This is an acceptable method for MAR data, and this approach is preferable to pairwise or list-wise deletion, which can lead to biased parameter estimates (Schafer & Graham, 2002).

2.5. Plan of analysis

To examine the nature of the associations between impulsivity and nonsuicidal self-injury, an autoregressive cross-lagged path analysis using all manifest variables in MPlus 7 was conducted (Muthen & Muthen, 2017). The model included the two measured variables (i.e., impulsivity and nonsuicidal self-injury) assessed at each of the three years, and included autoregressive paths (i.e., associations within variables across time) and cross-lagged paths (i.e., associations between impulsivity and nonsuicidal self-injury over time). Further, age, sex, parental education, whether participants were born in Canada, depressive symptoms, and anxiety were included as covariates in the model, with paths from the covariates to study variables at Times 2 and 3. Concurrent associations between impulsivity and nonsuicidal self-injury also were included within each wave, and correlations were specified among the covariates and the study variables at Time 1. Model fit was evaluated using the comparative fit index (CFI) and the root mean square error of approximation (RMSEA) (Kline, 2005), with a recommended cut-off criteria of .95 for the CFI and a RMSEA 0.06 (simultaneously) being used to identify good fit (Hu & Bentler, 1999). After a good fitting-model was identified, we re-ran the model with gender as a moderator (rather than a covariate) to examine whether the pattern of associations varied for males and females.

3. Results

All of the study variables were normally distributed except for past year nonsuicidal self-injury, which was transformed using the square root method to correct for non-normality. Frequency of engagement in nonsuicidal self-injury is presented in Table 1. In order to identify the best fitting-model, we first tested whether the pattern of results was invariant over time by comparing a model in which all cross-lagged paths were constrained to be equal across time to an unconstrained model in which all paths were free to vary. The Chi-Square Difference Test of Relative Fit indicated that the unconstrained model was not a significantly better fit than the constrained model (X^2diff (2) = 4.342, $p > .05$). Similarly, there were no changes in CFI or RMSEA fit indices (comparing the constrained model to the unconstrained model). As the constrained model was the more parsimonious model, all further interpretations were based on the constrained model, which provided good model fit [CFI = .99, RMSEA = .0.022]. Standardized regression coefficients, standard errors, and p values are presented in Table 2, and significant paths between impulsivity and nonsuicidal self-injury variables are presented in Fig. 1. As predicted, cross-lagged analyses demonstrated that there was a significant bidirectional relation between impulsivity and nonsuicidal self-injury, such that higher levels of impulsivity predicted increased frequency of nonsuicidal self-injury over time and greater frequency of nonsuicidal self-injury predicted higher levels of impulsivity over time, when controlling for participant age, gender, whether they were born in Canada, parental education, depressive symptoms, and anxiety. When we re-ran the model, including gender as a moderator (rather than a covariate), the Chi-Square Difference Test of Relative Fit revealed that gender did not significantly moderate the pattern of associations among variables, X^2diff (2) = .571, $p > .05$. Although there is not a standard for comparing changes in other fit indices, the CFI and RMSEA changes also indicated that

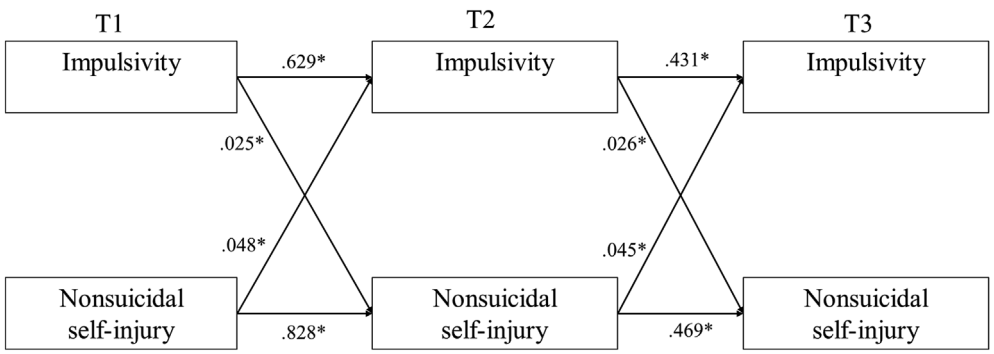
Table 1
Percentage of participants endorsing nonsuicidal self-injury engagement at each wave.

	Time 1	Time 2	Time 3
Lifetime history (but not past year)	20.90	26.00	26.90
Once in the past year	3.90	2.80	2.00
2–4 times in the past year	4.30	2.20	2.30
5–10 times in the past year	2.10	1.50	1.40
11–50 times in the past year	1.60	1.10	1.40
50 or more times	0.07	0.07	.060

Table 2
Standardized regression coefficients, standard errors and p-values.

	B	SE	*p*
Covariates			
AgeT1 → ImpulsivityT2	-.046	.029	.115
AgeT1 → ImpulsivityT3	.006	.028	.827
AgeT1 → Self-injuryT2	.001	.020	.950
AgeT1 → Self-injuryT3	-.004	.015	.802
GenderT1 → ImpulsivityT2	-.027	.029	.351
GenderT1 → ImpulsivityT3	-.025	.030	.412
GenderT1 → Self-injuryT2	.017	.020	.418
GenderT1 → Self-injuryT3	.024	.016	.126
BornT1 → ImpulsivityT2	-.013	.030	.673
BornT1 → ImpulsivityT3	.006	.029	.841
BornT1 → Self-injuryT2	-.004	.020	.854
BornT1 → Self-injuryT3	-.006	.015	.689
Parental EducationT1 → ImpulsivitiyT2	-.072	.030	.016
Parental EducationT1 → ImpulsivityT3	-.027	.029	.362
Parental EducationT1 → Self-injuryT2	-.026	.021	.206
Parental EducationT1 → NSSIT3	.021	.015	.177
Depressive SymptomsT1 → ImpulsivityT2	.042	.034	.224
Depressive SymptomsT1 → ImpulsivityT3	.045	.033	.169
Depressive symptomsT1 → Self-injuryT2	.015	.024	.523
Depressive symptomsT1 → Self-injuryT3	.021	.017	.222
AnxietyT1 → ImpulsivityT2	.038	.032	.236
AnxietyT1 → ImpulsivityT3	.029	.032	.357
AnxietyT1 → Self-injuryT2	.010	.023	.665
AnxietyT1 → Self-injuryT3	.010	.017	.560
Autoregressive paths (within variables)			
ImpulsivityT1 → ImpulsivityT2	.629	.024	.000*
ImplusivityT1→ ImpulsivityT3	.323	.038	.000*
ImpulsivityT2→ ImpulsivityT3	.431	.038	.000*
Self-injuryT1 → Self-injuryT2	.828	.013	.000*
Self-injuryT1 → Self-injuryT3	.501	.027	.000*
Self-injuryT2 → Self-injuryT3	.469	.027	.000*
Cross-lagged paths (between variables)			
ImpulsivityT1 → Self-injuryT2	.025	.012	.047*
ImpulsivityT2 → Self-injuryT3	.026	.013	.047*
Self-injuryT1 → ImpulsivityT2	.048	.022	.027*
Self-injuryT2 → ImpulsivityT3	.045	.020	.028*

Note: * = significant at $p < 0.05$, born (born in Canada, 1 = yes, 2 = no).



Note: * = significant at $p < 0.05$.

Fig. 1. Significant autoregressive and cross-lagged paths.
Note: * = significant at p < 0.05.

null hypothesis of model invariance should not be rejected (i.e., CFI changes less than .02, and RMSEA of .03) (Rutkowski & Svetina, 2014).

4. Discussion

There is mounting research on the link between impulsivity and nonsuicidal self-injury, with studies supporting a positive relation between impulsivity-related traits (e.g., lack of planning and premeditation, acting rashly in the context of negative emotions, etc.) and nonsuicidal self-injury behavior (Glenn & Klonsky, 2010; Hamza et al., 2015; Lockwood et al., 2017; Maxfield & Pepper, 2017; Taylor et al., 2012; You et al., 2016). A significant limitation of this literature to date, however, is that it has been overwhelmingly cross-sectional. Of the few longitudinal studies on nonsuicidal self-injury (Black & Mildred, 2013; Glenn & Klonsky, 2011; Peterson & Fischer, 2012; Wang et al., 2017; You et al., 2016), findings on the association between impulsivity and nonsuicidal self-injury have been mixed. Additionally, the direction of the association between impulsivity and nonsuicidal self-injury has not been tested; that is, it is not clear whether impulsivity is a predictor of nonsuicidal self-injury over time and/or whether engaging in nonsuicidal self-injury may have a detrimental effect on the development of impulse control, particularly during the emerging adult years. The present study sought to address these gaps in the literature by examining associations among impulsivity and nonsuicidal self-injury among emerging adults in university using a large-scale longitudinal research design.

As predicted, we found that higher levels of impulsivity (as defined by lacking of planning and thinking ahead) predicted increased frequency of nonsuicidal self-injury over time, controlling for other risk factors for nonsuicidal self-injury (e.g., depressive symptoms, anxiety). Moreover, the link between impulsivity and nonsuicidal self-injury was not found to be moderated by gender, suggesting that impulsivity was relevant to nonsuicidal self-injury engagement among both male and females during the emerging adult years. Impulsivity may be an important risk factor for nonsuicidal self-injury, because it may increase the likelihood that self-injurious ideation or thoughts are acted on (i.e., intention to action) (Lockwood et al., 2017; O'Connor & Kirtley, 2018). Indeed, individuals who are highly impulsive (e.g., demonstrate a lack of premeditation and planning) may be more likely to engage in nonsuicidal self-injury because they give little thought to the long-term consequences of the behavior (e.g., scaring, stigmatization, heightened risk for suicidal behavior) (Chapman et al., 2006; Van Orden et al., 2010). Our findings also are in line with other emerging large scale longitudinal research (Peterson & Fischer, 2012; Wang et al., 2017; You et al., 2016), and the suggestion that highly impulsive individuals may choose to engage in nonsuicidal self-injury to mitigate intra- and interpersonal situations because it is quickly accessible (e.g., pragmatic hypothesis – Nock, 2010). In contrast, depressive symptoms and anxiety did not come through as significant predictors of nonsuicidal self-injury in the multivariate model. These findings are in line with past research on impulsivity and nonsuicidal self-injury (Arens, Gaher, & Simons, 2012; Di Pierro, Sarno, Perego, Gallucci, & Madeddu, 2012; Glenn & Klonsky, 2010) and underscore that impulsivity may be a stronger or more proximal predictor of nonsuicidal self-injury behavior than other risk factors for nonsuicidal self-injury.

To further extend existing research, we also examined whether repetitive engagement in nonsuicidal self-injury may undermine the development of impulse control, leading to heightened impulsivity over time (Dir et al., 2013). Given the emphasis of recent research and theoretical models of nonsuicidal self-injury on the intra- and interpersonal reinforcement afforded by nonsuicidal self-injury engagement (Hooley & Franklin, 2017; Nock & Prinstein, 2004; Turner et al., 2016), we anticipated that engagement in nonsuicidal self-injury would undermine the development of self-regulatory capacities, as well as the development of alternative coping strategies. In support of this contention, nonsuicidal self-injury predicted heightened impulsivity over time, after controlling for depressive symptoms and anxiety. Our findings suggest that nonsuicidal self-injury may disrupt the development of impulse control, and suggest that when problem coping behaviors are emotionally or socially reinforcing, these behaviors may be preformed more often, and at the expense of the development of alternative regulatory capacities (Fischer, Anderson, & Smith, 2004; Peterson & Fischer, 2012). Unfortunately, given the bidirectional nature identified in the present study, this heightened impulsivity may then only further exasperate an individual's risk for nonsuicidal self-injury, as well as other problem behaviors (Fischer et al., 2004; Glenn & Klonsky, 2010; Lejuez et al., 2010; Maxfield & Pepper, 2017; Mullins-Sweatt et al., 2013; Perry & Carroll, 2008; Taylor et al., 2012).

Although effect sizes were small in the present study, small effect sizes are common in longitudinal research. When controlling for past behavior in the context of an autoregressive model (e.g., self-injury from Time 1 to Time 2) there is often high stability within variables over time. As a result, the potential effect of a temporally earlier predictor is often attenuated. Small effects sizes are meaningful when there is strong stability in the outcome and when there is at least moderate overlap between the predictor and the outcome variables at time of onset (Adachi & Willoughby, 2014), as was the case in the present study. The strength of associations identified in the present study are comparable to effect sizes from other longitudinal studies on predictors of nonsuicidal self-injury (Daly & Willoughby, 2019; Voon, Hasking, & Martin, 2014; Xavier, Pinto-Gouveia, Cunha, & Dinis, 2017).

Despite the strengths of the present study, including the use of a large sample and a multi-wave longitudinal design, there also are several important limitations that should be addressed in future research. First, data was collected from a predominantly Caucasian middle-class sample of emerging adults recruited from an undergraduate institution in Canada. Thus, study findings may not be representative of emerging adults from more diverse or socially disadvantaged areas, or clinical populations of emerging adults. Second, we relied on retrospective self-report measures to assess nonsuicidal self-injury engagement, which may be subject to errors in recall bias. To extend the present findings, researchers could utilize daily diary and ecological momentary assessment approaches to capture changes in state impulsivity both before and after a self-injury episode in real time. Third, we used a shortened version of the Barratt Impulsiveness Scale; thus, we could not examine whether different subtypes of impulsivity included in the full measure (e.g., nonplanning, motor, attentional) were differentially related to nonsuicidal self-injury. Cross-sectional research has found positive associations between nonsuicidal self-injury and the different subscales (Hamza et al., 2015), but future research would benefit

from using the full measure and examining associations between the subscales of impulsivity on the Barratt Impulsiveness Scale and nonsuicidal self-injury. Finally, given the large scale multi-wave longitudinal design of the present study, lab-based measures of impulsivity were not included in the present study; future research should specifically examine longitudinal associations between nonsuicidal self-injury and the different facets of impulsivity using both self-report and lab-based measures, to further differentiate which aspects of impulsivity may be most relevant to understanding nonsuicidal self-injury. Nevertheless, the present findings underscore that self-reported impulsivity may be an important marker of those at risk for nonsuicidal self-injury, and can assist in efforts to identify persons at risk for self-injury and intervene early.

5. Conclusions

During early emerging adulthood, individuals who perceive themselves as more impulsive may be more likely to engage in nonsuicidal self-injury behaviors. In turn, more frequent engagement in nonsuicidal self-injury may lead to greater impulsivity over time. Findings are consistent with a broader literature which has implicated impulsivity-related traits in the prediction of increased risk for a variety of problem behaviors during this period of development (Fischer et al., 2004; Lejuez et al., 2010; Nock, 2010; Perry & Carroll, 2008; Van Orden et al., 2010). In addition, results extend previous research by demonstrating that repetitive engagement in nonsuicidal self-injury may undermine the development of self-regulatory capacities and lead to a cycle of increasing impulsivity and nonsuicidal self-injury. These findings underscore the importance of developing targeted nonsuicidal self-injury prevention and intervention efforts aimed at highly impulsive emerging adults. Moreover, the present results highlight the value of teaching young persons who self-injure better strategies to self-regulate and delay impulses, which may reduce risk for both impulsivity and nonsuicidal self-injury over time.

Declarations of conflict of interest

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