

Self-Damaging Behaviour as an Emotion Regulation Strategy in Young Adults with Recent,
Distal, or No History of Non-Suicidal Self-Injury

by

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Bachelor of Arts (Honours), University of Victoria, 2017

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We acknowledge and respect the lək^wəŋən peoples on whose traditional territory the university stands, and the Songhees, Esquimalt and WSÁNEĆ peoples whose historical relationships with the land continue to this day.

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Abstract

Nonsuicidal Self-Injury (NSSI), or the deliberate damage of bodily tissue without suicidal intent, is a prevalent issue in young people. Relative to those who have never self-injured, young people with either recent (i.e., past-year) or distal (i.e., lifetime, but not in the past year) histories of NSSI demonstrate difficulties with emotion regulation, the process of modulating emotional responses. Emotion regulation difficulties are a risk factor for other forms of Self-Damaging Behaviours (SDBs), including binge drinking, substance use, and binge eating, which are more prevalent among individuals with a history of NSSI. Prominent theoretical models of NSSI and other SDBs posit that these behaviours may share a common function of altering negative mood states, explaining their frequent co-occurrence. The present study hypothesized that first-year university students with distal, recent, or no history of NSSI a) would differ in their rates of SDB engagement over seven months, and b) would differ in their strength of association between changes in stress and concurrent SDB engagement. Further, the present study hypothesized that emotional dysregulation would moderate the association between stress and SDB engagement. Multilevel modelling with longitudinal data from two cohorts of first-year undergraduates (N=540) revealed that students with either distal or recent NSSI histories were more likely to engage in substance use than their peers who had never self-injured, but did not report a greater frequency of binge eating or binge drinking. Regardless of NSSI history, substance use was unrelated to within-person changes in stress or emotional dysregulation. Higher-than-usual stress was associated with increased frequency of binge eating and binge drinking, but this association was unrelated to NSSI history or emotional dysregulation. Results suggest that elevated risk for substance use may persist even after NSSI has stopped, while other forms of SDBs (i.e., binge drinking and binge eating) were not predicted by NSSI history. Further, results suggest that some SDBs (i.e., binge drinking and binge eating) are enacted more frequently during periods of stress, but that this pattern is not unique to those with a history of NSSI or those who struggle to regulate their emotions. Consistent with person-centred models of NSSI recovery, these results suggest that vulnerability to some SDBs may persist even after NSSI has stopped. Future research should further examine the mechanisms underlying the complex association between NSSI and SDBs.

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Introduction

Nonsuicidal self-injury (NSSI), which is defined as any intentional, self-inflicted damage to the surface of the body without suicidal intent (American Psychiatric Association [APA], 2013), is a prevalent issue in young people, with approximately 18% of youth and 13% of young adults reporting at least one lifetime instance of the behaviour (Swannell, Martin, Page, Hasking, & St John, 2014). NSSI commonly includes behaviours such as self-cutting, -carving, -burning, -scratching, -hitting, head-banging, and interference with wound healing (Rodav, Levy, & Hamdan, 2014). NSSI can occur in the absence of any psychiatric diagnosis (Kiekens et al., 2018), but frequently co-occurs with other DSM diagnoses, including depressive disorders, anxiety disorders, post-traumatic stress disorder, borderline personality disorder, substance use disorders, and eating disorders (Nock, Joiner, Gordon, Lloyd-Richardson, & Prinstein, 2006; Svirko & Hawton, 2007). NSSI Disorder is also included in the DSM-5 as a condition for further study (APA, 2013).

Onset of NSSI typically occurs between ages 12-15 (Plener, Schumacher, Munz, & Groschwitz, 2015; Whitlock et al., 2011), with most individuals continuing the behaviour for around 2-4 years (Whitlock & Selekman, 2014). The population prevalence of NSSI peaks around age 15-17 and declines around age 18 (Plener et al., 2015), suggesting that many individuals cease engaging in NSSI during the transition to adulthood. However, around 35-43% of young adults with a history of NSSI also report engaging in self-injury at least once within the past year (Wilcox et al., 2011; Hamza & Willoughby, 2013), with estimated 12-month prevalence rates ranging from 2-14% in college students (Kiekens et al., 2018; Serras, Saules, Cranford, & Eisenberg, 2010; Whitlock et al., 2011; Wilcox et al., 2011). Thus, NSSI remains a prevalent clinical issue in young adulthood.

NSSI carries a number of physical risks such as unintentionally severe injuries, infection, and unwanted scarring, and is often accompanied by emotional distress including feelings of guilt, shame, and self-stigma (Nock, 2010). Additionally, continued NSSI is associated with an increase in frequency and severity of injuries over time (Andrews, Martin, Hasking, & Page, 2013; Whitlock, Muehlenkamp, & Eckenrode, 2008) as well as an increased risk for suicidality (Hamza & Willoughby, 2013), even after controlling for co-occurring psychiatric diagnoses (Kiekens, 2018). Given this clinical picture, identifying predictors of NSSI maintenance (i.e. continued engagement in NSSI) or cessation (i.e. stopping engagement in NSSI) has become a clinical and research priority (Flaherty, 2017; Lewis & Hasking, 2019). Indeed, a considerable amount of research in the field of NSSI has focused on NSSI cessation, typically defined as a six-month or one-year period without any instances of the behaviour (Andrews et al., 2013; Kiekens et al., 2017; Tatnell, Kelada, Hasking, & Martin, 2014). Although understanding how and why individuals are able to cease engaging in NSSI is a worthwhile aim, some researchers and clinicians have argued that considering only desistance of the behaviour overlooks broader, long-term issues related to recovery (Lewis & Hasking, 2019).

Historically, researchers and clinicians in the mental health field have drawn upon a medical model to conceptualize recovery from mental health disorders and related issues, typically by defining recovery as a reduction in symptom frequency or severity or as a total remittance of symptoms (Jacob, 2015). Recently, person-centred approaches to recovery have aimed to take a more holistic view of the individual by considering a broader picture of wellbeing and functioning (Jacob, 2015; Hummelvoll, Karlsson, & Borg, 2015). Such conceptualizations acknowledge that recovery is a non-linear, ongoing (even life-long) process

that involves personal empowerment to work towards positive change (Leamy, Bird, Le Boutillier, Williams, & Slade, 2011).

In a recent commentary paper, the past and current presidents of the *International Society for the Study of Self-Injury* (Lewis & Hasking, 2019) suggest that when NSSI research focuses only on cessation of the behaviour, several key issues are overlooked. First, people with a history of NSSI frequently report recurrences of the behaviour even after long periods without any NSSI (Glenn & Klonsky, 2011; Hamza & Willoughby, 2013). For instance, Hamza and Willoughby (2013) found that around 19% of undergraduate students who had not self-injured in the past year experienced a recurrence of NSSI in the subsequent 12 months. This suggests that operationalizing cessation using a six-month or one-year criterion may not sufficiently capture a true, lasting desistance of the behaviour. Second, qualitative research with people with lived experience of self-injury supports a broader conceptualization of NSSI recovery that captures experiences that may persist long after the behaviour itself has stopped, including coping with NSSI urges and finding alternative strategies to manage distress (Kelada, Hasking, Melvin, Whitlock, & Baetems, 2016; Sutherland, Dawczyk, De Leon, Cripps, & Lewis, 2014). Finally, many people report that they were motivated to stop engaging in NSSI for reasons that do not seem to accord with an empowered, person-centred conceptualization of recovery, such as wanting to avoid unwanted scarring, shame, and upsetting loved ones (Deliberto & Nock, 2008; Turner, Chapman, & Gratz, 2013; Whitlock, Prussien, & Pietrusza, 2015). This suggests that for some individuals, stopping self-injury may be more of a practical decision due to the negative consequences of the behaviour, rather than reflecting the resolution of an underlying difficulty.

In light of these issues in the field, Lewis and Hasking (2019) advocated for researchers and clinicians to consider a more holistic conceptualization of NSSI recovery that looks beyond

just cessation of the behaviour to reflect a broader picture of wellbeing. Specifically, the authors urge researchers and clinicians to take a person-centred approach to considering how coping behaviour, responses to difficult emotions, and mental health difficulties unfold before, during, and after NSSI cessation. These factors are considered germane to NSSI recovery because prominent theoretical models of NSSI conceptualize self-injury as a maladaptive strategy for inhibiting, enhancing, or modulating emotional responses, a process which is known as emotion regulation (Gratz & Roemer, 2004; Gross, 2015; Klonsky, 2007; McKenzie & Gross, 2014; Nock & Prinstein, 2004). Thus, developing alternative strategies for coping with or modifying difficult emotions is thought to be a core component of the NSSI recovery process (Kelada et al., 2016; Lewis & Hasking, 2021; Sutherland et al., 2014; Whitlock, Prussien, & Pietrusza, 2015).

Although research has implicated emotion regulation in NSSI cessation (Anderson & Crowther, 2012; Horgan & Martin, 2016), only limited research has examined whether emotion regulation difficulties may persist after the behaviour has stopped (Duggan, Heath, & Hu, 2015). Further, the extant literature has largely failed to examine possible consequences of continued emotion regulation difficulties following NSSI cessation, or how such difficulties might affect future behaviour. Importantly, emotion regulation deficits are a risk factor that underlie not only NSSI, but also other Self-Damaging Behaviours (SDBs; Aldao, Nolen-Hoeksema, & Schweizer, 2010; Hasking, & Claes, 2019), a category of behaviours that carry a risk for bodily harm, either through immediate or cumulative effects (Turner, Layden, Butler, & Chapman, 2013). In addition to NSSI, this also includes behaviours such as alcohol misuse, substance use, and disordered eating behaviour (Evans & Lacey, 1992; Lacey, 1993; Turner et al., 2013).

Thus, the present thesis will review the extant literature relating to the role of emotion regulation in NSSI and other SDBs, the association between NSSI and other SDBs, and the

theoretical rationale for when and why NSSI and SDBs may be enacted. This study aims to take a person-centred approach to considering how other forms of self-harmful behaviour may accompany self-injury or persist after self-injury has ceased as a means of emotion regulation. Consistent with a holistic conceptualization of NSSI recovery (Lewis & Heath, 2019), the present study aims to better understand how individuals respond to difficult emotions following NSSI by examining whether individuals with either recent histories (i.e., in the past year) or distal histories (i.e., lifetime histories, but not in the past year) of NSSI are at greater risk for engaging in other forms of SDBs, namely binge eating, binge drinking, and illicit substance use, when experiencing distress, relative to those who have never self-injured. Further, the present study aims to determine whether emotion regulation difficulties contribute to higher rates of SDBs during distress for individuals with recent or distal NSSI histories, suggesting that other SDBs may serve as alternative maladaptive emotion regulation strategies to NSSI.

NSSI and Emotion Regulation

When asked to report why they engage in NSSI, many people who self-injure describe that NSSI helps them feel better, change their emotions, or reduce unwanted emotional or cognitive experiences (Chapman & Dixon-Gordon, 2007; Klonsky, 2009; Laye-Ginhu & Schonert-Reichl, 2005). Specifically, those who self-injure often report experiencing negative emotions such as sadness, anger, and tension before they engage in NSSI, (Chapman & Dixon-Gordon, 2007; Klonsky, 2009; Laye-Ginhu & Schonert-Reichl, 2005), with negative emotions decreasing and positive emotions increasing following engagement in NSSI (Army et al., 2011; Muehlenkamp, 2009). Moreover, many people who self-injure specifically report that altering or controlling their emotional states (especially reducing negative emotions) is a key motivation for engaging in NSSI (Klonsky, 2007; Klonsky, 2009; Klonsky & Glenn, 2009; Laye-Ginhu &

Schonert-Reichl, 2005). These desirable emotional changes that follow NSSI are hypothesized to reinforce the behaviour and lead to repetition of the behaviour during times of emotional distress (Klonsky, 2007; Nock & Prinstein, 2004).

Additional research has also demonstrated that people who experience difficulties regulating their emotional states are more likely to engage in NSSI, relative to those who do not experience such difficulties (Andover & Morris, 2014; You et al., 2018). Moreover, relative to people who have never engaged in self-injury, cross-sectional analyses suggest that young adults who have recently engaged in NSSI report difficulties with identifying and accepting emotions, poorer emotional impulse control, fewer emotion regulation strategies, poorer distress tolerance, and more emotional avoidance behaviours than those who have never self-injured (Anderson & Crowther, 2012; Horgan & Martin, 2016). Further, emotion regulation difficulties are linked to more frequent and more severe NSSI (Adrian, Zeman, Erdley, Lisa, & Sim, 2010; Jenkins & Schmitz, 2012). Deficits in emotion regulation skills have also been shown to prospectively predict the onset (Voon, Hasking, & Martin, 2014) and continuation (Andrews et al., 2013; Kiekens et al. 2017) of NSSI. As such, emotion regulation skills are frequently targeted in the treatment of NSSI (Garisch, Wilson, O'Connell, Robinson, 2017; Guerdjikova, Gwizdowski, McElroy, McCullumsmith, & Suppes, 2014).

Given that difficulties with emotion regulation are thought to create a vulnerability for self-injury (Andover & Morris, 2014), some researchers have suggested that improvements in emotion regulation abilities may be related to cessation of NSSI (Anderson & Crowther, 2012; Duggan et al., 2015; Horgan & Martin, 2016). Cross sectional research suggests that young adults with a distal history of NSSI (i.e., those who have engaged in NSSI in their lifetime, but not in the past year) show fewer difficulties with some aspects of emotion regulation and distress

tolerance relative to those with a recent history of NSSI (i.e., those who have engaged in NSSI in the past year) (Anderson & Crowther, 2012; Horgan & Martin, 2016). This could suggest that improvements in emotion regulation abilities contribute to NSSI cessation. Despite these group differences between young adults with recent and distal NSSI, young adults with distal histories of NSSI also show deficits in emotion regulation and distress tolerance relative to those who have never engaged in NSSI (Anderson & Crowther, 2012; Duggan et al., 2015; Horgan & Martin, 2016). This could indicate that young people with a history of NSSI continue to experience difficulties with regulating their emotions, even after they have stopped engaging in NSSI. Those with distal histories of NSSI also report greater levels of depressive symptoms and negative emotion than people with no history of NSSI, further suggesting that some level of clinical vulnerability is maintained even after NSSI has stopped (Anderson & Crowther, 2012; Duggan et al., 2015; Horgan & Martin, 2016).

Longitudinal studies echo this pattern of results suggesting three distinct populations. In a longitudinal study of adolescents, youth who stopped self-injuring during the course of the study reported fewer depressive symptoms and difficulties with emotion regulation than those who continued to self-injure, but more depressive symptoms and difficulties with emotion regulation relative to adolescents who had never self-injured (Duggan et al., 2015). A cohort study of Swedish youth demonstrated that young adults who had engaged in NSSI as adolescents had significantly higher levels of stress, anxiety, depression, and emotional dysregulation compared to peers who did not self-injure in adolescence (Daukantaitė et al., 2020). In a longitudinal study of university students, those who ceased engaging in NSSI during the study reported fewer internalizing symptoms and less suicidal ideation than those who continued to self-injure, but more internalizing symptoms and suicidal ideation than those who had never engaged in NSSI

(Hamza & Willoughby, 2013). Further, students who had ceased engaging in NSSI prior to the beginning of this study reported more suicidal ideation at baseline than those who had no history of NSSI, but did not differ from those with no history of NSSI at the one-year follow-up assessment. This suggests that the recency of the last instance of NSSI is germane to mental health functioning within those with distal NSSI history, as vulnerabilities may dissipate over time. Notably, students who ceased engaging in NSSI prior to the study also did not differ significantly from those who ceased engaging in NSSI during the course of the study in terms of internalizing symptoms, suicidal ideation, or other mental health indices.

Some researchers have theorized that engaging in NSSI may damage future emotion regulation abilities by preventing the development of distress tolerance (Chapman, Gratz, & Brown, 2006) and decreasing feelings of coping self-efficacy (Hasking, Whitlock, Voon, & Rose, 2017). In support of this hypothesis, one study found a reciprocal relationship between NSSI engagement and emotional dysregulation over time, such that problems with emotion regulation were predictive of subsequent engagement in NSSI, which in turn predicted declines in emotion regulation abilities (Robinson et al., 2019). Taken together, these findings suggest that difficulties with emotion regulation may create a vulnerability to engage in NSSI, but that these emotion regulation difficulties may also persist (albeit to a lesser degree) after NSSI has ceased (Anderson & Crowther, 2012; Andover & Morris, 2014; Duggan, Heath, & Hu, 2015; Horgan & Martin, 2016; You et al., 2018). Since prominent theories of NSSI postulate that NSSI serves as a maladaptive emotion regulation strategy (Chapman et al., 2006; Nock & Prinstein, 2004), it may be that some individuals with a history of NSSI may employ other maladaptive strategies, such as other SDBs, that could serve this emotion regulation function. If this is the case, considering a person's use of other maladaptive emotion regulation strategies in following

NSSI cessation as a means of coping with sustained emotion regulation would be an important aspect of a holistic conceptualization of NSSI recovery.

Emotion Regulation and SDBs

The psychopathological risks associated with emotion regulation deficits are not unique to self-injury. First, there is a growing body of evidence to suggest that emotion dysregulation is a transdiagnostic risk-factor that is implicated in a range of SDBs and psychopathology (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Hasking, & Claes, 2019). For instance, emotion regulation difficulties are robustly associated with both sub-clinical disordered eating behaviours as well as clinical eating disorders. Specifically, emotion regulation deficits have been associated with binge eating (Cooper & Wade, 2015), restrictive eating (Haynos, Wang, & Fruzzetti, 2018), purging and compensatory behaviours (Cooper & Wade, 2015), and overall disordered eating symptomology (Buckholdt et al., 2014; Hasking, & Claes, 2019) in non-clinical populations. Emotion regulation deficits are also related to full-threshold anorexia nervosa (Lavendar et al., 2015), bulimia nervosa (Lavendar et al., 2015), and binge-eating disorder (Dingemans, Danner, & Parks, 2017) diagnoses. Difficulties with emotion regulation are also associated with risky drinking behaviour (Aurora & Klanecky, 2016; Hasking, & Claes, 2019) and illicit substance use (Aldao et al., 2010; Wong et al., 2013). Co-occurring SDBs (e.g., engagement in both NSSI and substance use) are associated with even greater emotion regulation deficits (Andrews, Martin, & Hasking, 2012; Buckholdt et al., 2015), suggesting that SDBs may be an indicator of the severity of the underlying emotion dysregulation, or that individuals with greater emotion regulation difficulties may enact multiple behaviours to modify unwanted affective states (Selby & Joiner, 2009).

Co-Occurrence of NSSI and SDBs

SDBs occur at a higher than expected rate in individuals who engage in NSSI. For instance, between 24-61% of people who report a lifetime history of NSSI also report a lifetime history of disordered eating (Jacobson & Luik, 2014), with evidence that these behaviours also commonly co-occur during three-month and one-day intervals (Turner et al., 2015; Turner, Yiu, Claes, Muehlenkamp, & Chapman, 2016). Adolescents and college students who engage in NSSI are more likely to report binge drinking than their peers (Serras et al., 2010; Xin, Wang, Fang, Ming, & Yao, 2017) and some young adults specifically report that they are more likely to engage in NSSI while intoxicated (Whitlock et al., 2011). Substance use also frequently co-occurs with NSSI in college students, with around 25% of illicit substance users reporting past-year NSSI (Serras et al., 2010). Further, adolescents who have recently engaged in NSSI are more likely to report engaging in substance use than their peers (Brausch & Boone, 2015; Giletta, Scholte, Engels, Ciarano, & Prinstein, 2012).

Although prospective research is limited, it appears that individuals with a past history of NSSI also exhibit higher than average rates of SDBs. For instance, a UK birth cohort study found that youth who reported NSSI at age 16 were more likely to report harmful alcohol use, problem cannabis use, regular smoking, and illicit drug use at age 18, even after controlling for socioeconomic background and adolescent depressive symptoms (Mars et al., 2014). They also exhibited higher rates of anxiety and depression and poorer educational and employment outcomes in adulthood relative to peers with no adolescent NSSI. Rates of illegal drug use were found to be significantly higher in undergraduate students with a history of NSSI than those without NSSI history (Taliaferro & Muehlenkamp, 2015). A longitudinal cohort study of Australian adolescents found that any incidence of self-harm (with or without suicidal intent)

during adolescence was associated with greater likelihood of daily cigarette use, heavy binge drinking, illicit substance use, and substance dependence (nicotine, alcohol, and/or cannabis) in young adulthood (age 20-29; Moran et al., 2014), relative to adolescents without any history of self-harm. This relation remained significant even after controlling for differences in adolescent depression, anxiety, and socioeconomic factors. However, after controlling for different rates of substance use in adolescence, adolescent self-harm was only significantly associated with multiple substance dependence in adulthood. This suggests that differential rates of substance use in populations with versus without self-harm are established by mid to late adolescence, when problematic substance use often begins (Nelson, Van Ryzin, & Dishion, 2015). Later analyses with this same cohort found that adolescent self-harm (with or without suicidal intent) predicted illicit drug use, illicit drug dependence, and daily tobacco use, as well as greater risk for mental health difficulties, unemployment, and financial hardship, at age 35 (Borschmann et al., 2017), suggesting that these associations with adolescent self-harm may persist long into adulthood. Finally, presenting to a hospital for self-harm (with or without suicidal intent) has also been linked to greater likelihood of premature death due to a mental or behavioural disorder (most often due to psychoactive substance use) within a six-year follow up in one multi-site UK cohort study (Bergen et al., 2012).

NSSI history is also associated with disordered eating. Meta-analytic findings suggest that a lifetime history of NSSI is reported by approximately 33% of adolescents and young adults with a current bulimia nervosa diagnosis (Cucchi et al., 2016). Similarly, women with a lifetime history of NSSI prior to starting college were more likely to report an onset of purging behaviour during their first academic year of post-secondary education (Riley, Davis, Combs, Jordan, & Smith, 2015). Serra and colleagues (2020) observed that undergraduate students who reported

recent binge eating or both bingeing and purging were more likely to report a lifetime history of NSSI than students with no binge/purge behaviour. These findings suggest that a lifetime history of self-injury is associated with greater likelihood of future SDBs. However, by examining only lifetime history, it is impossible to determine how many participants within these samples are continuing to engage in NSSI, and whether ongoing vs historical NSSI is associated with different levels of risk for SDBs.

Some research has examined risks for SDBs specific to those with a recent (i.e., past-year) or distal (i.e., lifetime, but not in the past year) history of NSSI. For instance, cross-sectional research by Brown, Williams, and Collins (2007) found that young adults who had distal histories of NSSI were more likely to report using substances as a coping strategy than those with *either* recent NSSI or no history of NSSI, suggesting that substance use could emerge as an alternative maladaptive coping strategy in place of NSSI. However, no differences in coping by using substances were found between those with recent NSSI, distal NSSI, or no history of NSSI in a study with a similar population and measures by Horgan and Martin (2016). Hamza and Willoughby (2013) found no differences between those with recent NSSI, distal NSSI, or no NSSI history in “problem behaviours,” a composite measure of alcohol use behaviours and delinquency behaviours (e.g., shoplifting, property destruction, impaired driving), though risk for SDBs was not assessed independently of this composite variable. In a longitudinal study of 51 adults with a lifetime history of NSSI, those who engaged in NSSI over the one-year follow-up did not differ from those who abstained from NSSI in terms of their rates of alcohol abuse or bulimia (binge/purge) symptoms, suggesting a statistically similar prevalence of these behaviours in those with recent and distal NSSI histories (Glenn & Klonsky, 2011). Unfortunately, the study did not include a non-NSSI comparison group, making it impossible to

determine if either of these groups were engaging in alcohol abuse or bulimia behaviours at a greater frequency than their peers without histories of NSSI.

Taken together, these findings suggest that a history of NSSI is a risk factor for future SDBs, potentially even after self-injury has stopped. Given that young adults with both recent and distal NSSI histories demonstrate deficits in emotion regulation and distress tolerance relative to peers who have never engaged in NSSI (Anderson & Crowther, 2012; Duggan, Heath, & Hu, 2015; Horgan & Martin, 2016), it is possible that SDBs are used concurrently with NSSI, or subsequent to NSSI cessation, as a means of emotion regulation. For instance, in a sample of first-year university students, those who reported any lifetime history of NSSI were more likely to report regulating their affect (i.e. reducing stress, reducing anxiety, or feeling good) by using alcohol, using marijuana, smoking tobacco, punching someone, and binge eating or under eating than students who had never self-injured (Hamza, Willoughby, & Good, 2013). Notably, they were no more likely to report biting their nails, exercising, or shopping as a way to regulate affect than the no NSSI history group, suggesting this may be a difference that is unique to SDBs or high-risk behaviour. Further, in qualitative research with people who have ceased engaging in NSSI some individuals describe turning to substance use and disordered eating as strategies to use either in place of NSSI or to cope with NSSI urges, suggesting that there could be a direct relationship between NSSI cessation and future SDBs for some individuals (Gelinias & Wright, 2013).

Theoretical Models of NSSI and SDBs

Theoretical models that seek to explain why NSSI and other SDBs are enacted typically emphasize the role of proximal stressors, distress tolerance, and emotion regulation abilities to explain *who* engages in NSSI and other SDBs. Further, these models often emphasize the change

in emotional experiences that follows NSSI and other SDBs to explain *why* these behaviours occur (Nock & Prinstein, 2004; Chapman, 2006; Selby & Joiner, 2009).

Experiential avoidance.

The experiential avoidance model of NSSI, proposed by Chapman and colleagues (2006), suggests that NSSI is part of a class of experientially avoidant behaviours that function to avoid or escape unwanted internal states or their external causes. Although the model primarily relies on supporting evidence of this function in relation to NSSI, Chapman et al. (2006) suggests that other SDB such as substance use and binge eating can also serve this experiential avoidance function, and that people who engage in NSSI may also engage in other SDBs as a means of avoiding undesirable internal experiences. These undesirable experiences can include cognitions, memories, and physiological sensations, but in the context of NSSI are thought to primarily consist of unwanted emotions. Chapman et al. (2006) suggests that individuals who are more reactive to emotional experience, have lower distress tolerance, or have fewer alternative emotion regulation strategies may be more likely to enact maladaptive behaviours for the purpose of escaping aversive internal states. The reduction of these undesirable affective states then leads to negative reinforcement of these experiential avoidant behaviours, resulting in repeated use of the behaviour over time.

Emotional cascades.

Building on a model proposed by Linehan (1993) and drawing from Chapman and colleagues' (2006) experiential avoidance model, Selby & Joiner (2009) proposed the emotional cascades model of behavioural dysregulation to explain the high rates of SDBs in people with borderline personality disorder (BPD). However, the model has also been applied to explain the occurrence of SDBs outside of a BPD diagnosis (Selby, Anestis, & Joiner, 2008; Selby,

Kranzler, Panza, & Fehling, 2015; Jungmann, Vollmer, Selby, & Witthöft, 2016). The emotional cascades model posits that rumination on negative thoughts or emotions leads to an increase in negative affect, which leads to greater attention to negative emotional stimuli. Attention to emotional stimuli then increases rumination, creating a cycle of escalating negative thoughts and feelings. In order to escape this cycle, the individual turns to dysregulated behaviours such as NSSI, substance use, or binge eating as a way of drawing their attention towards the physical sensations associated with the behaviour, and thus away from the negative emotional experience, allowing negative affect to dissipate.

Four-function model.

Nock and Prinstein's (2004) four-function model of NSSI also has some utility in understanding other SDBs. The model theorizes that NSSI is maintained through the addition or removal of internal (automatic or intrapersonal) and/or social (interpersonal) consequences. The first function, *automatic negative reinforcement*, involves NSSI being reinforced through the alleviation or dampening of a negative affective state. NSSI may also be reinforced through *automatic positive reinforcement*, wherein the self-injury is used to generate desired sensations or emotions, often to end feelings of emotional numbness. *Social positive reinforcement* occurs when NSSI elicits a desired response from others, such as attention or support, while *social negative reinforcement* occurs when engaging in NSSI allows relief from unwanted interpersonal demands, such as undesired bids for connection. NSSI is thought to be reinforced through this removal of undesired automatic or social consequences and the addition of desired automatic or social consequences, thus leading to repetition of the behaviour in the future. Wedig and Nock (2010) subsequently hypothesized that this four-function model could also be applied to binge eating and purging behaviour, which was supported by the results of a confirmatory factor

analysis of a self-report measure of functions of bingeing and purging behaviour. This four-function model also closely resembles the four-factor motivational model of alcohol use (Cooper, 1994), which similarly suggested that drinking behaviours could be reinforced through generating positive internal states, reducing negative internal states, generating positive social consequences, or reducing negative social consequences (e.g., exclusion or social judgement). The commonality of these functions across several forms of SDBs suggests that these behaviours might be enacted to meet similar intra- and interpersonal needs, supporting their frequent co-occurrence.

Stress models.

Nock's (2010) integrated model of NSSI suggests that distal risk factors such as a genetic predisposition for emotional reactivity and environmental exposures such as childhood maltreatment result in intrapersonal (e.g. low distress tolerance) and interpersonal (e.g. poor communication skills) vulnerabilities that reduce effectiveness in responding to stressful life events (Nock, 2009; Nock, 2010). As a result, when encountering a stressor, the individual may turn to NSSI or other maladaptive behaviours to regulate their affective states (Nock, 2010). Consistent with this model, meta-analytic results have demonstrated that high life stress is associated with greater odds of NSSI (Liu, Cheek, & Nestor, 2016). However, much of the research that has assessed the relation between stress and NSSI has considered only between-person differences in life stressors or perceived stress (Liu et al., 2016). While this can account for the population-level risk for NSSI associated with experiencing high stress levels relative to other individuals, it does not capture the time-varying within-person associations between distress and NSSI that are core to the four-function and experiential avoidance models.

Some researchers have suggested that such person-centered approaches may be more appropriate for identifying risk factors associated with NSSI than between-person comparisons because they can account for time-varying changes that may relate to variability in NSSI engagement over time (Hamza & Willoughby, 2013). Thus, it is important that research also consider the role of higher-than-usual stress (i.e. periods of high stress, relative to a person's own typical stress level) in NSSI. Miller and colleagues (2019) investigated these within-person associations using samples of adolescent girls and young adult women. In a longitudinal study of adolescent girls measured at three-month intervals for eighteen months, higher-than-usual stress (but not average stress) was associated with the occurrence of NSSI during the same wave (Miller et al., 2019). Similarly, in a fourteen-day daily diary study of young adult women, higher-than-usual stress (but not average stress) was associated with the same-day likelihood of reporting thoughts of NSSI and NSSI acts (Miller et al., 2019). From these findings, the authors suggested a stress-threshold model of NSSI, wherein exceeding one's own usual level of stress confers risk for NSSI. This is consistent with the theories that have previously been outlined, which suggest self-injury and other SDBs are used as a way of alleviating immediate, intolerable levels of distress (Nock & Prinstein, 2004; Chapman et al., 2006; Selby & Joiner, 2009).

Pragmatic Hypothesis.

In the pragmatic hypothesis of NSSI, Nock (2010) suggested that NSSI may be selected over other SDBs that could also serve to relieve distress because it can be quickly implemented with little planning or required preparation. Nock (2010) suggested this may be most pertinent in adolescence, as adolescents are less likely to have access to some types of SDBs, such as alcohol and drugs. Similarly, while self-injury can be quickly and discretely performed in a private setting (e.g., in a bedroom or bathroom; Nock, 2010), disordered eating behaviours may also be

less easily enacted during adolescence. For instance, parents may be more apt to notice and monitor their child's eating behaviour (Martinson, Esposito-Smythers, & Blalock, 2016) and are considerably more involved in food purchase and preparation when their child lives at home, while behaviours such as bingeing and restricting may be more accessible when living away from parents. These developmental changes, along with the population-level declines seen in NSSI (Plener et al., 2015), suggest that the transition to adulthood may be an especially important period to examine SDBs, as young adults may find themselves with fewer barriers to alternative types of maladaptive behaviours as their independence increases. Given the culture of heavy alcohol and substance use and the increased responsibility for selecting and preparing meals in undergraduate populations, SDBs involving food, alcohol, and drug intake may become drastically more available, and more socially acceptable substitutions for NSSI. Thus, when experiencing distress, these behaviours may emerge as alternatives to NSSI during young adulthood.

This possible transition from NSSI to other SDBs is consistent with the developmental psychopathology concept of heterotypic continuity, which suggests that underlying vulnerabilities are expressed through different symptoms within the same individual throughout the lifespan (Angold, Costello, & Erkanli, 1999). NSSI and other SDBs share a number of common distal and proximal risk factors, including emotion dysregulation (Hasking & Claes, 2019), alexithymia (Hasking & Claes, 2019), impulsivity (Hasking & Claes, 2019), and self-criticism (Zelkowitz & Cole, 2018). Indeed, some research suggests that clinical populations may “shift” between symptoms of self-injury, disordered eating, and substance use over time, perhaps because of these shared underlying vulnerabilities (Garke, Sörman, Jayaram-Lindström, Hellner, & Birgegård, 2019). It may be that individuals who stop engaging in NSSI turn to other

maladaptive strategies to cope with a shared underlying vulnerability, such as emotion regulation difficulties. Within literature on borderline personality disorder, a diagnosis associated with high rates of SDBs, it has also been suggested that some individuals may switch from one harmful behaviour to another (e.g., desisting from alcohol misuse but developing an eating disorder) in a process called *symptom substitution* (Sansone & Sansone, 2007).

In the context of NSSI, heterotypic continuity suggests that when some individuals cease engaging in NSSI, they may replace self-injury with other SDBs that may serve similar functions (Selby & Joiner, 2009; Nock, 2010). Given that young adults with recent and distal histories of NSSI both demonstrate similar deficits in emotion regulation and distress tolerance relative to peers with no history of NSSI (Anderson & Crowther, 2012; Duggan, Heath, & Hu, 2015; Horgan & Martin, 2016), it appears that individuals with distal histories of self-injury may retain an emotional vulnerability that could increase risk for SDBs such as heavy alcohol use, substance abuse, and disordered eating (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Mars et al., 2014; Borschmann et al., 2017; Hasking & Claes, 2019). However, since these SDBs also carry risk of harm, identifying behavioural transitions is relevant to understanding long-term emotion regulation, coping, and wellbeing following NSSI cessation, and thus making these behavioural transitions relevant to a holistic conceptualization of recovery from NSSI.

Unfortunately, only limited research has examined how other SDBs are used as an emotion regulation strategy in conjunction with NSSI or following NSSI cessation (Muehlenkamp, Peat, Claes, & Smits, 2012; Turner et al., 2016; Wang, Pisetsky, Skutch, Fruzzetti, & Haynos, 2018).

The Present Study

At a population level, NSSI declines in prevalence during the transition to adulthood, suggesting this is a time when many people cease engaging in NSSI (Plener et al., 2015).

Considerable research has focused on understanding when or why some people are able to cease self-injuring, but only limited research has examined long-term outcomes for people with a history of NSSI (Lewis & Hasking, 2019). Cross-sectional research suggests that people with distal histories of NSSI continue to report difficulties with emotion regulation relative to those who have never self-injured (Anderson & Crowther, 2012; Horgan & Martin, 2016), suggesting that cessation of NSSI may not be indicative of a full, holistic recovery of wellbeing. Given that emotion regulation difficulties are a known risk factor for both NSSI and other forms of SDBs (Andover & Morris, 2014; Buckholdt et al., 2015; Hasking, & Claes, 2019; Wong et al., 2013; You et al., 2018), and that individuals with a history of NSSI are more likely to engage in SDBs (Mars et al., 2014; Riley et al., 2015, Serras et al., 2010), it is possible that people who have a history of NSSI retain a vulnerability to engage in other SDBs even after they have ceased self-injuring. Considering that the transition to university is marked by the introduction of many novel stressors, such as changes in peer networks, increased academic pressure, financial strain, and newfound independence (Towbes & Cohen, 1996), the first year of post-secondary education may be an especially vulnerable period for maladaptive coping behaviours.

Prominent theoretical models of NSSI and other SDBs suggest that individuals who struggle to manage distress or reduce negative emotions may engage in SDB as a method of altering their emotional experiences (Chapman, Gratz, & Brown, 2006; Nock & Prinstein, 2004, Selby & Joiner, 2009). For this reason, individuals who engage in NSSI may also use other forms of SDBs to regulate their emotions (Andrews, Martin, & Hasking, 2012; Buckholdt et al., 2015). Additionally, those who have ceased engaging NSSI, who may continue to struggle with emotion regulation (Anderson & Crowther, 2012; Horgan & Martin, 2016), may employ other forms of SDBs in place of NSSI (Gelinias & Wright, 2013) to serve an emotion regulation function.

Although research has begun to explore the prevalence of SDBs in people with a history of NSSI (Mars et al., 2014; Riley et al., 2015, Serras et al., 2010), no quantitative research has yet examined whether these behaviours seem to persist as an alternative, maladaptive emotion regulation strategy. Specifically, no previous research has investigated whether people with a distal history of NSSI are more likely than those without a history of NSSI to engage in SDBs when experiencing elevated distress, or explored the role of emotion regulation difficulties in the persistence of SDBs in those with a distal history of NSSI. The present study aimed to address these gaps by investigating the relative likelihood of engaging in binge drinking, binge eating, and illicit substance use in students with recent NSSI history, distal NSSI history, or no history of NSSI during the first academic year of post-secondary education (Aim 1). Given that proximal stress is an antecedent to SDB (Miller et al., 2019), and that those with either a recent or distal history of NSSI experience difficulties managing distress relative to those without a history of NSSI (Anderson & Crowther, 2012; Duggan et al., 2015; Horgan & Martin, 2016), this study also investigated whether students with a recent or distal history of NSSI engage in SDBs more frequently when experiencing elevated stress relative to students with no history of NSSI (Aim 2). Further, the present study examined whether between-person differences in emotion regulation difficulties contribute to the association between higher-than-usual stress and SDB frequency (Aim 3).

Aim 1.

Given previous research on SDBs, psychological functioning, and emotional dysregulation in young adults with NSSI history (e.g. Mars et al., 2014; Anderson & Crowther, 2012), I expected that students with either recent (i.e., past year) or distal (i.e., lifetime, but not in the past year) histories of NSSI would differ in their reported frequency of SDB (binge drinking,

binge eating, and illicit substance use) engagement from students without a history of NSSI (Hypothesis 1a). Additionally, I expected that students with a recent history of NSSI would differ from those with distal NSSI histories in their rates of engagement in SDBs (Hypothesis 1b).

Aim 2.

I further expected that students with either recent or distal histories of NSSI would differ from those with no NSSI history in the strength of the association between higher-than-usual stress and same-month SDB frequency (Hypothesis 2a). Again, I hypothesized that students with recent NSSI history would also differ from those with distal NSSI history in this respect (Hypothesis 2b).

Aim 3.

Next, since past research has demonstrated cross-sectional differences in emotion regulation abilities based on NSSI history (Anderson & Crowther, 2012; Horgan & Martin, 2016), and because emotion regulation difficulties are associated with engaging in SDBs (Hasking, & Claes, 2019), I expect that emotion regulation difficulties would moderate the strength of the association between higher-than-usual stress and SDB frequency (Hypothesis 3).

Methods

Participants

Participants in the present study were 540 first-year undergraduate students at a mid-sized Canadian university ($M_{\text{age}} = 17.98$, 75.7% female). Participants were recruited in September 2017 and September 2018 through the university's online psychology research participation portal (SONA), flyers around campus, online advertisements, and in-person canvassing at student welcome events. Data collection took place from September 2017 to April 2018 (Cohort 1) and September 2018 to April 2019 (Cohort 2). To be eligible for the study, participants were required to be: (a) enrolled in a minimum of 3.0 academic units (equivalent to two standard courses) at the University of Victoria, (b) aged 17-25 years old, and (c) in their first semester of post-secondary study. To be included in the analyses for this study, participants had to complete both the baseline testing session as well as at least one follow-up survey.

Procedure

Eligible and interested participants enrolled in the study by signing up through either the online psychology research participation portal (SONA) or an online screening survey. Baseline testing sessions occurred in the month of September (i.e., within the first 30 days of students' first semester of university) and lasted approximately 2-2.5 hours in length. Baseline sessions took place with groups of 5-38 students in campus computer labs. After providing informed consent, participants completed six computerized behavioural tasks designed to measure propensity for risk-taking and risky decision-making. For the remainder of the session, participants completed a battery of self-report questionnaires measuring demographics, personality, mental health, and history of SDBs.

For the remainder of the academic year (October through April), participants were emailed a link to complete follow-up surveys at approximately 30-day intervals for seven months. Follow-up surveys were completed through the Qualtrics online survey platform on participants' own devices and took an estimated 30-60 minutes to complete. The follow-up surveys consisted of measures of mental health, personality, and SDBs over the previous 30 days. Any participant who reported suicidal ideation within the past month received follow-up communication (by phone or email) from a member of the research team in order to assess and mitigate risk to safety. Participants were compensated on a prorated basis for completed follow-up surveys with their choice of partial course credit and financial compensation (to a maximum of 14.0 SONA credits plus \$46 in Cohort 1, or 15.0 SONA credits plus \$40 in Cohort 2) or financial compensation only (to a maximum of \$106 in Cohort 1 or \$100 in Cohort 2). The present study used a subset of measures drawn from this larger study.

Baseline Measures

Self-Injurious Thoughts and Behaviors Interview – Nonsuicidal Self-Injury

Subscale (SITBI-NSSI; Nock, Holmberg, Photos, & Michel, 2007). The SITBI-NSSI is a validated interview screening measure that assesses history, frequency, severity, and methods of NSSI. Although the SITBI-NSSI was originally developed to be administered as an interview, the measure was administered as a self-report questionnaire in this study, consistent with the approach taken in past research (e.g., Franklin et al., 2016; Kleiman et al., 2017; Zetterqvist, Lundh, Dahlström, & Svedin, 2013). Previous research has demonstrated that the measure shows strong agreement with other screening measures of NSSI ($K=.87$; Nock et al., 2007). For the purposes of this study and consistent with past research (e.g., Anderson & Crowther, 2012; Brown, Williams, & Collins, 2007; Rotolone & Martin, 2012), I used the SITBI-NSSI to classify

participants into three groups: (1) no history of NSSI (i.e., responded “no” to the NSSI screening item “*Have you ever physically hurt yourself on purpose, but without wanting to die [for example, cutting or burning yourself]?*”; N=386), (2) recent NSSI history (i.e., responded “yes” to the NSSI screening item, and reported at least one instance of NSSI on the item “*On how many days in the past year have you hurt yourself physically without wanting to die?*”; N=63), and (3) distal NSSI history (i.e., responded “yes” to the NSSI screening item, reported 0 instances of NSSI in the past year; N=91). Participants who responded “prefer not to say” to the NSSI screening item were excluded from analyses (N=33).

Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). The DERS is a 36-item scale measuring emotion regulation difficulties in the domains of non-acceptance of emotional responses, goal-directed behaviour while distressed, impulse control while distressed, emotional awareness, access to emotion regulation strategies, and emotional clarity. Participants are asked to rate how often each item applies to them, with responses rated on a 5-point likert scale ranging from “almost never (0-10%)” (1) to “almost always (91-100%).” Example items include “*when I’m upset, my emotions feel overwhelming*” and “*I have difficulty making sense out of my feelings.*” Responses are summed across all items to create a total score, with higher scores signifying greater emotion regulation difficulties. The measure has shown excellent test-retest reliability ($r = .88$) in past validation research and had high internal consistency (Cronbach’s $\alpha = .94$) in the present study.

Follow-Up Measures

Self-Damaging Behaviours. At each follow-up, participants were asked about their engagement in several SDB within the past 30 days using modified screening items from established measures. One item, adapted from the Eating Disorders Diagnostic Scale (Stice,

Telch, Rizvi, 2000), assessed frequency of binge eating, defined as “eat[ing] an objectively large amount of food in a manner that felt out of control,” with response categories indicating this behaviour occurred “Never” (0), “Only once” (1), “2-3 times” (2), “4 or more times” (3), or “prefer not to say” (coded as missing). One item assessed frequency of binge drinking, defined as consuming “five or more alcoholic drinks in a row” (Bulloch, Williams, Lavorato, & Patten, 2016), with response categories indicating this behaviour occurred “Never” (0), “Only once” (1), “2-3 times” (2), “4 or more times” (3), or “prefer not to say” (coded as missing). Illicit substance use was assessed with an item from the Drug Use Disorders Identification Test (DUDIT; Berman, Bergman, Palmstierna, & Schlyter, 2003) that asked “*During the past 30 days, on how many days did you use drugs other than alcohol, marijuana, and tobacco?*” The response options included “Never, 0 times” (0), “1 day” (1), “2-4 days” (2), “5-8 days” (3), “9-12 days” (4), “More than 12 but less than 30 days” (5), “Every day” (6), and “prefer not to say” (coded as missing). Due to very low frequency rates of illicit substance use in the sample, responses were recoded to a binary variable, where a value of 0 indicated no past-month instances of illicit substance use, and a value of 1 indicated that the participant reported using illicit substances one or more days in the past month.

College Chronic Life Stress Survey (CCLSS; Towbes & Cohen, 1996). Participants were asked to rate their exposure and reactions to common stressful events for postsecondary students, including stressors related to academics, employment, peers, and family, at each follow-up to assess perceived stress over the previous 30 days. The measure has shown high test-retest reliability and validity, with self-report scores correlating highly with other-rater reports completed by students’ close friends (Towbes & Cohen, 1996). The present study administered 52 of the original 54 CCLSS items. The items “*academic performance*” and “*amount of sex with*

lover” were omitted from the survey due to an administrative error. The measure showed excellent internal consistency in the present study (Cronbach’s $\alpha = .90$). For each stressor that participants reported experiencing, they rated how bothered they were by the experience on a scale of “Just a little bothered” (1), “Bothered me a moderate amount” (2), or “Bothered me very much” (3). Responses were summed to create a total stress impact score at each month, with possible scores ranging from 0 to 156. Although the questionnaire includes items assessing stressors in a number of domains (interpersonal, academic, etc.), a factor analysis of the original scale did not support the creation of domain-specific subscales, and thus the stress impact score represents the total effect of all stressful experiences included in the measure (Towbes & Cohen, 1996).

Data Screening

Participants were monitored by research assistants during the in-person baseline testing sessions for signs of low effort or inattention (e.g., completing the session substantially faster than the majority of other participants; appearing distracted or off-task). No participants were excluded due to observable poor effort. The baseline questionnaire included two “attention check” items embedded in other survey measures, which prompted participants to provide a specific response (e.g., “choose ‘almost never’ for this item”) to indicate that they were reading and understanding the survey items. Participants who responded incorrectly to either of these items were excluded from analyses (Cohort 1: $N=39$, Cohort 2: $N=34$). All responses were screened on the basis of per-item response times and no significant outliers were detected.

For the follow-up surveys, which were completed online and therefore participants could not be directly monitored, a more rigorous data screening procedure was employed to detect low effort and inattentive responding, using recommendations from Huang and colleagues (2012).

Criterion 1: Variability of responses.

To assess response variability, we selected five survey measures that were administered in all seven follow-up points across both cohorts. The five surveys we used were: The Brief COPE (Carver, 1997; 28 items and 14 subscales); the Depression Anxiety Stress Scale (DASS-21; Lovibond & Lovibond, 1995; 21 items and 3 subscales); the Domain Specific Risk-Taking (DOSPERT; Blais & Weber, 2006; 30 items with 2 scales and 10 subscales); the College Student Subjective Wellbeing Questionnaire (CSSWQ; Renshaw & Bolognino, 2016; 16 items and 4 subscales), and Compulsive Buying Scales (adapted from Valence, d'Astous, & Fortier, 1988). A participant was considered to have an invariable response for a measure if they responded identically to all items on that measure for the DASS-21, CSSWQ, DOSPERT or CBS or responded identically to at least 24 of the 28 items of the COPE (given the higher number of subscales). Data for follow-up surveys in which a participant showed a pattern of invariable responding on three or more of these five measures were excluded from analyses, as this pattern is an indicator of low effort responding.

Criterion 2: Completeness of response.

Completeness of responding was assessed to identify participants who provided very little valid data (i.e., skipped several entire measures within a given month) or who appeared to be only responding to items that appeared to require low effort to answer. We considered a questionnaire to have been completed if sufficient responses had been provided to calculate at least one subscale score for the COPE, CSSWQ, and DASS-21 and sufficient information to calculate a total score for the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), the Self-Defeat and Entrapment Scale (Griffiths et al., 2015), and the CBS (adapted from Valence, d'Astous, & Fortier, 1988). Any participant who provided insufficient

data to calculate subscale or total scores for four or more of these six scales was excluded from analyses for that follow-up survey.

Criterion 3: Speed of Responding

Speed of responding was assessed within each follow-up survey to identify participants who completed the survey at a pace of two seconds per item or less, based on recommendations provided by Huang et al., 2012 and our own visual inspection of the data. To create a time-per-item score, we first calculated the total number of items that had been completed by each participant, excluding consent, compensation-related, free-text entry and checklist-type items. We added a uniform scalar (+ 65) to each participant's total to account for checklist type items contained in the survey (where a non-response is considered non-endorsement of an item). Next, we divided the time it took each participant to complete each follow-up survey by the total number of items completed in that survey. Any participant with an average time-per-item of less than 2 seconds was excluded from analyses for that month, as this indicated that a participant may not have properly read items before responding.

Criterion 4: Attention

Consistent with the procedures employed for screening of the baseline survey data, follow-up surveys from the second cohort of data collection included two attention-check questions to ensure that participants were reading each item carefully and understood the response scales. Any participant who failed to correctly answer both attention-check questions was excluded from analyses for the corresponding follow-up survey.

Planned Analyses

Given that the present study used longitudinal data in which multiple observations arose from the same participants, multilevel models with maximum likelihood estimation were

employed to account for the nested structure of the data and missing follow-up data. Multilevel modeling accounts for non-independence in the data that is expected to be systematically associated with the participant in order to differentiate within-participant variance over time from between-person variability. Maximum likelihood estimation techniques employ all available data without participant deletion, which maximizes power of the analyses when data missingness is unavoidable (e.g., participant drop out in longitudinal designs).

Multilevel linear modelling was employed for dependent variables that approximated a normal distribution (binge drinking and binge eating frequency), while Bernoulli (logistic) multilevel models were employed for the dependent variable of illicit substance use, which was recoded as a binary value. All analyses were interpreted with robust standard errors to account for model misspecifications (e.g., non-normality in the dependent variables). Analyses were carried out with HLM 8.1 statistical software.

As an initial step, I computed the intraclass correlation (ICC; see Equation 1 and 2 below) from a fully unconditional model (Model 1; i.e., a model without any independent variables) for each of the three SDBs (binge eating, binge drinking, and illicit substance use) to determine the amount of the variability that exists at the within-person level (i.e., the extent to which SDB frequency differs within the same person from month to month) and between-person level (i.e., the extent to which SDB frequency differs from person to person).

Model 1: Fully Unconditional (Null) Model

$$\text{SDB Frequency} = \beta_{0i} + e_{ij}$$

Equation 1 (Linear Models): $\text{ICC} = \tau_{00}/(\tau_{00} + \sigma^2)$

τ_{00} = Level 2/between-person variance, σ^2 = Level 1/within-person variance

Equation 2 (Binary Model): $ICC = \text{var}(u_{0j}) / [\text{var}(u_{0j}) + (\pi^2 / 3)]$

$\text{var}(u_{0j})$ = Level 2/between-person variance

The ICC was used to calculate the design effect (see Equation 3 below), which is an indicator of how strongly the non-independence of observations has biased the estimates of standard errors for the observed data, and thus the extent to which multilevel modelling is warranted (Peugh, 2010). A design effect > 2.0 is generally recommended to support the use of multilevel modelling, a minimum threshold that is commonly met in longitudinal nested data (Peugh, 2010).

Equation 3: Design Effect = $1 + (n_c - 1)ICC$

n_c = average number of level-1 observations (i.e., completed monthly surveys) per participant

To compare students with recent NSSI, distal NSSI history, and no NSSI history in terms of their engagement in SDBs (Hypothesis 1a and 1b), paired associations of higher-than-usual stress and SDB frequency (Hypothesis 2a and 2b), and the moderating effect of emotion dysregulation in this association (Hypothesis 3), subsequent multilevel models used each of the three SDBs as dependent variables and dummy-coded NSSI groups as independent variables. A linear effect of time was included as a covariate in all substantive multilevel models to account for the possibility of linear change in the dependent variables over the course of the year. Time was centred at the first follow-up survey (administered in October, one month after the baseline assessment of NSSI history) as this was the first time that the dependent variables were measured, with one “unit” of time representing the time between each of the seven monthly surveys (i.e. 0=October, 1=November, 2=December, etc). Male gender and sexual minority (SM)

status (i.e., identifying as non-heterosexual) were found to significantly differ across levels of NSSI history and were therefore included as covariates in all subsequent models.

Aim 1.

To test Hypotheses 1a and 1b, model 2 compared the average monthly frequency of each form of SDB across levels of NSSI history.

Model 2: Frequency of SDB by NSSI History Group

Level 1:

$$\text{SDB Frequency} = \beta_{0i} + \beta_{1i}(\text{Time}) + e_{ij}$$

Level 2:

$$\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Recent NSSI}) + \gamma_{02}(\text{Distal NSSI}) + \gamma_{03}(\text{Gender[Male]}) + \gamma_{04}(\text{SM Status}) + u_{0i}$$

$$\beta_{1i} = \gamma_{10} + u_{1i}$$

Aim 2.

Next, to determine if there are NSSI history group differences in the association between higher-than-usual stress and SDBs, successive models were built upon the initial fully unconditional SDB models (Model 1). An intermediary coupling model (Model 3) was computed to first determine whether there is a significant association between SDB frequency and higher-than-usual levels of stress. The coupled model included both a level-1 predictor of monthly stress scores that have been centred around each person's own mean, which represent the extent to which an individual is deviating from their own average level of stress in any given month, and a level-2 predictor of person-mean stress centred around the grand-mean, which represents the extent to which an individual differs in average stress levels from other participants. By including stress at both levels, this accounts for both the within-person effect of stress (the effect of experiencing higher stress relative to one's own usual level) and the between-person effect of stress (the effect of being a high-stress person relative to others in the sample) on SDB

frequency. This approach is consistent with past research using multilevel modelling to examine the relationship between stress and SDBs (Miller et al., 2019).

Model 3: Stress and SDB coupled relationship

Level 1:

$$\text{SDB Frequency} = \beta_{0i} + \beta_{1i}(\text{Person-Mean Centred Monthly Stress}) + \beta_{2i}(\text{Time}) + e_{ij}$$

Level 2:

$$\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Gender}[\text{Male}]) + \gamma_{02}(\text{SM Status}) + \gamma_{03}(\text{Grand-Mean Centred Person-Average Stress}) + u_{0i}$$

$$\beta_{1i} = \gamma_{10} + u_{1i}$$

$$\beta_{2i} = \gamma_{20} + u_{2i}$$

To test Hypothesis 2a and 2b (i.e., the recent, distal, and no NSSI history groups will differ in their association between higher-than-usual stress and SDB frequency), a moderated model was built upon the intermediate coupling model (Model 3) to include the dummy-coded NSSI history groups as moderators of the coupled relationship between higher-than-usual stress and SDB frequency (Model 4). The NSSI history groups were also included as moderators of the model intercept to control for overall group differences in SDB frequency so that the moderation of the coupling parameter purely reflects group differences in the relationship between higher-than-usual stress and SDB.

Model 4: Differences in NSSI History Groups in the Coupled Relationship Between Stress and SDB:

Level 1:

$$\text{SDB Frequency} = \beta_{0i} + \beta_{1i}(\text{Person-Mean Centred Monthly Stress}) + \beta_{2i}(\text{Time}) + e_{ij}$$

Level 2:

$$\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Gender}[\text{Male}]) + \gamma_{02}(\text{SM Status}) + \gamma_{03}(\text{Grand-Mean Centred Person-Average Stress}) + \gamma_{04}(\text{Distal NSSI}) + \gamma_{05}(\text{Recent NSSI}) + u_{0i}$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}(\text{Distal NSSI}) + \gamma_{12}(\text{Recent NSSI}) + u_{1i}$$

$$\beta_{2i} = \gamma_{20} + u_{2i}$$

Aim 3.

To test Hypothesis 3 (i.e., emotional dysregulation will moderate the association between stress and SDB engagement), a final moderated model was built upon Model 4 to include the moderating effect of emotion regulation difficulties on the association between higher-than-usual stress and SDB frequency. Emotion regulation difficulties, measured by the DERS, were included as a level-2 moderator at both the intercept (to account for overall differences in SDB frequency as a result of emotion regulation difficulties) and the slope of the association between higher-than-usual stress and SDB frequency (to account for the effect of emotion regulation difficulties in managing high levels of distress).

Model 5: Emotion Dysregulation in the Coupled Relation Between Stress and SDB

Level 1:

$$\text{SDB Frequency} = \beta_{0i} + \beta_{1i}(\text{Person-Mean Centred Monthly Stress}) + \beta_{2i}(\text{Time}) + e_{ij}$$

Level 2:

$$\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Gender}[\text{Male}]) + \gamma_{02}(\text{SM Status}) + \gamma_{03}(\text{Grand-Mean Centred Person-Average Stress}) + \gamma_{04}(\text{Distal NSSI}) + \gamma_{05}(\text{Recent NSSI}) + \gamma_{06}(\text{Emotion Regulation Difficulties}) + u_{0i}$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}(\text{Distal NSSI}) + \gamma_{12}(\text{Recent NSSI}) + \gamma_{13}(\text{Emotion Regulation Difficulties}) + u_{1i}$$

$$\beta_{2i} = \gamma_{20} + u_{2i}$$

Competing nested models were assessed for fit using chi square tests of model deviance and by examining pseudo R^2 , which compares the amount of variability explained by each model.

Results

Preliminary Analyses

As an initial step, I examined the distribution of each of the dependent variables using descriptive statistics and histograms. Tabachnick and Fidell (2013) suggest that parameter estimates are robust to small to medium violations of the assumptions of normality (e.g., skew and kurtosis) in sample sizes over 200 participants. Others have specifically suggested that linear models are appropriate in large samples where skewness does not exceed three and kurtosis does not exceed ten (Kline, 2012). The dependent variables of binge drinking and binge eating frequency, which were scored on a 4-point ordinal scale, were found to be relatively normally distributed, within these suggested ranges and depicted in Table 1. If interpreted with robust standard errors, multilevel linear models are considered to be appropriate with variables with this type of distribution in large sample sizes, such as the present study (Maas & Hox, 2004).

Illicit substance use frequency, which was measured using a 7-point ordinal scale, severely violated assumptions of normality due to a very low rate of observations in the upper values of the scale. Given that this data could not be appropriately tested using a linear multilevel model, data was recoded to a binary variable, with a value of 0 indicating that the participant did not report any instances of illicit substance use in a given month, and a value of 1 indicated that a participant reported one or more instances of illicit substance use. Logistic multilevel models were utilized to predict engagement (vs. non-engagement) in illicit substance use in any given month. Results were interpreted for unit-specific models with robust standard errors.

Table 1*Distributions of dependent variables*

Variable	Min.	Max.	Mean	SD	Skewness		Kurtosis	
					Statistic	SE	Statistic	SE
Binge Drinking	0	3	0.63	0.93	1.23	0.05	0.21	0.09
Binge Eating	0	3	0.27	0.69	2.57	0.05	5.63	0.09
Illicit Substance Use	0	6	0.07	0.40	8.87	0.05	100.76	0.09

Missing Data

As part of my data screening strategy, participants who failed to complete at least four of six measures within a follow-up survey were excluded from analyses for that month. Missing data at the scale level was minimal and was handled with maximum likelihood estimation. Follow-up data was treated as missing for any month where a participant did not complete the follow up survey or was excluded due to low-quality or inattentive responding. Retention rates for follow-up surveys were very good, with participants completing an average of 5.3 of the 7 surveys and 41.5% of participants completing every monthly follow up. A breakdown of completion rates for follow-up surveys is presented in Table 2.

Table 2*Number of monthly follow ups completed by participants in sample*

Number of monthly surveys completed	N(%)
1	28(5.2)
2	42(7.8)
3	47(8.7)
4	47(8.7)
5	59(10.9)
6	93(17.2)
7	224(41.5)

For item-level missing data on the DERS, prorated scores were calculated where at least 80% of items were completed on each subscale. In order to be included in the present study, participants had to provide a valid response to both the initial baseline survey as well as at least one follow-up survey. Missing values analysis revealed no evidence of systematic missingness in scale data. Little's MCAR was not significant ($\chi^2 = 18.42$, $df=12$, $p = .104$), and therefore the null hypothesis that data are missing at random was retained and data were assumed to be missing at random.

Descriptive statistics were calculated for the 540 participants who contributed data to the present study. Chi squared analyses revealed significant group differences in gender and sexual orientation between the no NSSI, distal NSSI, and recent NSSI groups. Those who had never engaged in NSSI were more likely to be male ($X^2 (2, N=540) = 23.91$, $p < .001$) and less likely to identify as a sexual minority (SM; e.g., lesbian, gay, or bisexual; $X^2 (2, N=540) = 22.60$, $p < .001$). There were no significant group differences in whether participants identified as a member

of a racial minority group ($X^2(2, N=540) = 3.00, p = .22$). An analysis of variance (ANOVA) test did not reveal significant differences in age between the groups ($F(2, 534) = .018, p = .98$). Thus, male gender and SM identity were included as covariates in all models in order to avoid conflating the effects of gender or sexual minority status with differences in the effects of NSSI history.

Table 3

Descriptive statistics for the study sample (540 Participants)

	<i>Total sample N(%)</i>	<i>No NSSI History</i>	<i>Distal NSSI History</i>	<i>Recent NSSI History</i>
Mean Age (SD)	17.98(0.78)	17.98(0.78)	17.97(0.60)	17.97(0.82)
Gender				
<i>Female</i>	409(75.7)	271 (70.2)	81 (89)	57 (90.5)
<i>Male</i>	129(23.9)	114 (29.5)	10 (11)	5 (7.9)
<i>Transgender/Agender/Non-Binary</i>	2(0.4)	1 (0.3)	0(0)	1(1.6)
Sexual Minority (SM)	101 (18.7)	48 (12.4)	24 (26.4)	29(46)
Race/Ethnicity				
<i>White</i>	432(80)	303(78.5)	79(86.8)	50(79.4)
<i>East Asian</i>	48(8.9)	36(9.3)	8(8.8)	4(6.3)
<i>Southeast Asian</i>	35(6.5)	26(6.7)	5(5.5)	4(6.3)
<i>South Asian</i>	27(5.0)	23(6.0)	2(2.2)	2(3.2)
<i>Hispanic, Latina, Latino</i>	12(2.2)	9(2.3)	2(2.2)	1(1.6)
<i>First Nations, Metis</i>	13(2.4)	8(2.1)	2(2.2)	3(4.8)
<i>Black, African, Caribbean</i>	7(1.3)	6(1.6)	0(0)	1(1.6)
<i>Middle Eastern</i>	10(1.9)	6(1.6)	1(1.1)	3(4.8)
<i>Other</i>	15(2.8)	9(2.3)	4(4.4)	2(3.2)
<i>Multi-ethnic</i>	57(10.6)	38 (9.8)	12(13.2)	7(11.1)

Nested structure of the data.

To evaluate the appropriateness of multilevel modelling for the data I calculated the intraclass correlation (ICC) for the outcome variables that were determined to approximate a normal distribution (i.e., binge eating and binge drinking frequency). To obtain the ICC, “null” multilevel models (Model 1) were computed with no predictor variables for each of the two outcomes. The purpose of this is to determine the amount of variability in the dependent variable that occurs at the within-person (i.e., variability within the same individual across measurement points) and between-person level.

For binge drinking, the unconditioned model revealed that 60% of the variability occurred at the between-person level, leaving 40% of the variability left to be explained at the within-person level. For binge eating, 43% occurred at the between-person level, while 57% of the variability occurred at the within-person level. Significance of the random effects (both $p < .001$) indicated that there was significant within-person variability to be explained, which justified the use of multilevel modelling with these data. Design effects were also calculated for each of these outcomes. The design effect for binge drinking was 4.60 while the design effect for binge eating was 3.68. Both of these exceed the threshold of 2, which indicates that multilevel modelling techniques are needed to account for the nested structure of this data.

Using the method recommended by Sommet and Morslli (2017), the ICC for illicit substance use was calculated as 0.44 (i.e., 44% of the variability occurred at the between-person level and 56% occurred at the within-person level). The random effect for the null model was also significant ($p < .001$) and the design effect was 3.64. Thus, multilevel logistic modelling was also deemed to be the most appropriate method for analyzing monthly engagement in illicit substance use.

Primary Analyses

Aim 1

Aim 1 was to investigate between-group differences in the frequency of binge eating and binge drinking or odds of engagement in illicit substance use for students with no history of NSSI, a distal history of NSSI, or a recent history of NSSI (Model 2). Hypothesis 1a predicted that students with distal or recent NSSI history would differ from those with no NSSI history in terms of their engagement in SDBs, while hypothesis 1b proposed that students with distal and recent NSSI history would also differ from each other. Table 4 presents the results of the base models, where students with no history of NSSI were dummy-coded as the reference group. Table 5 presents the probed simple intercepts of SDB engagement for each of the NSSI groups, as well as differences between the distal and recent NSSI history groups. Male gender, sexual minority status, and time were included as covariates in all models.

Students with either a distal history ($p = .17$) or recent history ($p = .28$) of NSSI did not differ with respect to binge drinking compared to students who had never self-injured. Binge drinking frequency also did not differ between those with distal or recent NSSI history ($p = .94$). Similarly, students with a distal ($p = .07$) or recent ($p = .94$) history of NSSI did not differ in terms of binge eating frequency compared to students without a history of NSSI, nor did they differ from each other ($p = .10$).

Participants with either a distal ($p < .001$) or recent ($p = .01$) history of NSSI were significantly more likely to report using illicit substances in any given month than students who had never self-injured. Students with a distal NSSI history were 3.28 times more likely to report using illicit substances than students with no NSSI history, while students with a recent NSSI history were 3.21 times more likely to have engaged in illicit substance use than their peers who

had never self-injured. Students with a recent history of NSSI were no more likely to report past-month illicit substance use than students with a distal history of NSSI (OR= 0.98, $p=.96$).

Table 4

Monthly engagement in SDBs across levels of NSSI history

Fixed effects	Binge Drinking			Binge Eating			Illicit substance Use				
	β	<i>SE</i>	<i>p</i>	β	<i>SE</i>	<i>p</i>	β	<i>SE</i>	<i>OR</i>	95% <i>CI</i>	<i>p</i>
Intercept β_{00}	0.672	0.050	<.001	0.422	0.038	<.001	-4.351	0.24	0.01	(0.008, 0.021)	<.001
Distal NSSI β_{01}	0.122	0.088	.17	0.141	0.078	.07	1.187	0.33	3.28	(1.706, 6.298)	<.001
Recent NSSI β_{02}	0.132	0.122	.28	-0.005	0.062	.94	1.166	0.41	3.21	(1.436, 7.168)	.01
Male Gender β_{03}	0.247	0.091	.007	-0.181	0.036	<.001	1.026	0.35	2.79	(1.408, 5.530)	.003
SM status β_0	0.008	0.092	.93	-0.181	0.055	.49	0.274	0.34	1.32	(0.671, 2.577)	.42
Time β_{10}	-0.041	0.007	<.001	-0.049	0.006	<.001	-0.016	0.05	0.98	(0.891, 1.086)	.75
Random effects	Variance	<i>SD</i>	<i>p</i>	Variance	<i>SD</i>	<i>p</i>	Variance	<i>SD</i>	<i>p</i>		
Intercept	0.750	0.866	<.001	0.387	0.622	<.001	2.106	1.45	>.50		
Time	0.010	0.099	<.001	0.009	0.095	<.001	0.003	0.06	>.50		
Residual	0.316	0.562	-	0.221	0.470	-	-	-	-		

Table 5*Simple Intercepts of SDB engagement across levels of NSSI history*

Fixed effects	Binge Drinking			Binge Eating			Illicit Substance Use				
	β_{00}	<i>SE</i>	<i>p</i>	β_{00}	<i>SE</i>	<i>p</i>	β_{00}	<i>SE</i>	<i>OR</i>	95% <i>CI</i>	<i>p</i>
Distal NSSI	0.80	0.09	<.001	0.56	0.08	<.001	-3.16	0.32	0.04	(0.02, 0.08)	<.001
Recent NSSI	0.80	0.12	<.001	0.42	0.06	<.001	-3.19	0.38	0.04	(0.02, 0.09)	<.001
Distal vs Recent NSSI	-0.01	0.14	.94	0.15	0.09	.10	0.02	0.43	1.02	(0.44, 2.40)	.96

Aim 2

To determine the role of stress and emotion regulation in SDB frequency, three nested models were computed for each dependent variable. Results of these models are depicted in Table 6 for binge drinking, Table 7 for binge eating, and Table 8 for illicit substance use.

The first of these nested models (model 3) sought to determine whether there was a coupled association between person-centred stress levels and SDB engagement, such that as stress levels increased or decreased within a participant (relative to their own average level of stress), their likelihood of engaging in SDBs would change concurrently, regardless of NSSI history. Male gender, sexual minority status, person-average stress (centred at the grand mean), and time were included as covariates in all models.

Analyses revealed a significant coupled association between within-person changes in stress and binge drinking frequency ($p = .01$). For every 1-unit increase in stress, binge drinking frequency increased by 0.003 units. Likewise, a 1-unit increase in stress was associated with a 0.005 unit increase in binge-eating frequency in the overall sample ($p < .001$). Within-person increases in stress were also associated with an increased likelihood of illicit substance use. For

every 1-unit increase in stress, participants were 1.04 times more likely to report using illicit substances ($p < .001$).

To determine whether the strength of the association between stress and SDBs varied across levels of NSSI history (Hypothesis 2a and 2b), subsequent models (Model 4) were run to include NSSI history status as a moderator of both overall SDB frequency and the slope of stress on SDB frequency. Although the coupled association between within-person stress and binge drinking remained significant ($p = .03$), the strength of this association did not differ among students with a distal ($p = .56$) or recent ($p = .71$) NSSI history relative to students with no NSSI history, nor did they differ from each other ($p = .46$).

The same pattern was observed for binge eating frequency. Students with a distal ($p = .53$) or recent ($p = .12$) history of NSSI did not differ from students with no NSSI history in the strength of the association between person-centered stress and binge eating frequency. Students with distal and recent NSSI histories also did not differ from one another in the strength of this association ($p = .32$).

Model 4 additionally showed that participants with either a distal ($p = .003$) or recent ($p = .01$) history of NSSI remained more likely to engage in illicit substance use overall than students without a history of NSSI. However, after including these group differences in the model, within-person variations in stress were no longer significantly associated with odds of engaging in illicit substance use ($p = .11$). The strength of the association between stress and illicit substance use also did not differ for students with either a distal history ($p = .17$) or recent history ($p = .69$) relative to students who had never self-injured.

Aim 3

A final model (Model 5) was computed to assess hypothesis 3 by evaluating whether emotional dysregulation moderated the coupled association between stress and SDB engagement. Emotion dysregulation scores were included as a moderator at the intercept and as an interaction with within-person stress to assess these affects. Results of these models are included in Table 6, Table 7, and Table 8. Male gender, sexual minority status, person-average stress (centred at the grand mean), and time were included as covariates in all models. NSSI history and emotional dysregulation were included as covariates at the intercept to account for the effects of these variables on overall rates of SDB engagement.

Emotion dysregulation was unrelated to overall binge drinking frequency ($p = .16$) as well as to the association between stress and binge drinking ($p = .61$), regardless of NSSI history. The association between within-person stress and binge drinking frequency remained significant ($p = .03$).

In contrast, emotional dysregulation was related to increased overall binge eating frequency ($p = .006$). A 1-unit increase in emotion dysregulation was associated with a 0.003 unit increase in binge eating in average month. However, emotion dysregulation did not moderate the association between stress and binge eating frequency ($p = .31$).

Emotion dysregulation was unrelated to overall likelihood of using illicit substances in any given month ($p = .52$), nor did it moderate the non-significant association between stress and illicit substance use ($p = .85$).

Examining Model Fit

Model fit was examined for the linear models (binge drinking and binge eating frequency) by calculating a Log Likelihood test to compare the amount of variability explained in the dependent variable across sequential nested models. Because HLM 8.1 estimates logistic

multilevel models using a penalized quasi-likelihood approach, deviance statistics are not provided, and thus Log Likelihood tests cannot be performed.

Model deviance values for the binge drinking and binge eating models are included in Table 6 and Table 7. Results of Log Likelihood tests are reported in Table 9 and Table 10. Model comparisons revealed that models 4 and 5 did not significantly improve upon model 3 in predicting binge drinking frequency. Given that neither model 4 or 5 included any additional significant predictors, this makes sense. Thus, model 3 can be considered the most parsimonious model for predicting binge drinking frequency. For predicting binge eating frequency, although model 4 was not a significant improvement over model 3, model 5 fit the data significantly better than either model 3 or 4. Thus, model 5 is considered to be the best fitting model for predicting binge eating frequency.

Table 6

Binge Drinking Model Summaries

	Fixed Effect	SE	<i>p</i>	Random Effect	SD	<i>p</i>	Deviance (Parameters)
Model 1:							6378.63 (3)
Intercept Y00	0.667110	0.03432	<.001	0.54994	0.74	<.001	
Residual				0.36512	0.60		
Model 3:							6204.15 (13)
Intercept Y00	0.686451	0.04611	<.001	0.74220	0.86	<.001	
Male Gender Y01	0.25330	0.09066	.01				
SM status Y02	0.02966	0.09102	.75				
Person-Average Stress Y03	0.00345	0.00218	.11				
Person-Centred Stress Y10	0.00345	0.00137	.01	0.00009	0.01	.02	
Time Y20	-0.03371	0.00722	<.001	0.00814	0.01	<.001	

Residual				0.30836	0.56		Pseudo R ² = .1554
							6201.23
Model 4:							(17)
Intercept Y00	0.65343	0.04986	<.001	0.73815	0.86	<.001	
Male Gender Y01	0.27572	0.09189	.003				
SM status Y02	-0.00436	0.09195	.96				
Person-Average Stress Y03	0.00327	0.00219	.14				
Distal NSSI Y04	0.10728	0.08896	.23				
Recent NSSI Y05	0.13355	0.12117	.27				
Person-Centred Stress Y10	0.00364	0.00168	.03	0.00009	0.01	.01	
Distal NSSI Y11	-0.00198	0.00343	.56				
Recent NSSI Y12	0.00141	0.00387	.72				
Time Y20	-0.03310	0.00721	<.001	0.00808	0.09	<.001	
Residual				0.30835	0.56		Pseudo R ² = .1555
							6198.87
Model 5:							(19)
Intercept Y00	0.66710	0.05183	<.001	0.73424	0.86	<.001	
Male Gender Y01	0.27025	0.09214	.004				
SM status Y02	-0.02766	0.09362	.77				
Person-Average Stress Y03	0.00208	0.00231	.37				
Distal NSSI Y04	0.08812	0.08801	.32				
Recent NSSI Y05	0.09057	0.13159	.49				
Emotion Dysregulation Y06	0.00229	0.00162	.16				
Person-Centred Stress Y10	0.00364	0.00169	0.03	0.00009	0.01	.01	
Distal NSSI Y11	-0.00181	0.00352	.61				
Recent NSSI Y12	0.00216	0.00406	.59				
Emotion Dysregulation Y13	-0.00003	0.00005	.61				
Time Y20	0.033573	0.00722	0.001	0.00808	0.09	<.001	
Residual				0.30830	0.56		Pseudo R ² = .1556

Intercept Y00	0.38995	0.03532	<.001	0.2925	0.54	<.001	
Male Gender Y01	-0.09028	0.03833	.02				
SM status Y02	0.00325	0.05202	.95				
Person-Average Stress Y03	0.00934	0.00213	<.001				
Distal NSSI Y04	0.10128	0.07255	.16				
Recent NSSI Y05	-0.04061	0.06169	.51				
Emotion Dysregulation Y06	0.002888	0.00105	.01				
Person-Centred Stress Y10	0.00338	0.00142	.02	0.0002	0.01	.04	
Distal NSSI Y11	0.001528	0.00322	.63				
Recent NSSI Y12	0.00602	0.00513	.24				
Emotion Dysregulation Y13	0.00006	0.00006	.31				
Time Y20	-0.03750	0.00620	<.001	0.0066	0.08	<.001	
Residual				0.2075	0.46		Pseudo R ² = .2414

Table 8*Illicit Substance Use Model summaries*

	Fixed Effect	SE	Odds Ratio	95% CI	<i>p</i>	Random Effect	SD	<i>p</i>
Model 1								
Intercept Y00	3.6293	0	0.0265	(0.020, 0.035)	<.001	2.5349	1.59	<.001
Model 3								
Intercept Y00	4.1276	0	0.0161	(0.011, 0.025)	<.001	2.7598	1.66	>.5
Male Gender Y01	0.7427	7	2.1017	(1.100, 4.017)	.03			
SM status Y02	0.5310	6	1.7007	(0.901, 3.209)	.10			
Person-Average Stress Y03	0.0048	8	1.0049	(0.990, 1.020)	.52			
Person-Centred Stress Y10	0.0362	3	1.0369	(1.017, 1.057)	<.001	0.0008	0.03	>.5

Time Y20	0.0510 7	0.0513	1.0524	(0.951, 1.164)	.32	0.0009	0.03	>.5
Model 4								
	-							
Intercept Y00	4.5580 2	0.2505	0.0105	(0.006, 0.017)	<.001	2.6636	1.63	>.5
Male Gender Y01	1.0699 3	0.3505	2.9152	(1.464, 5.804)	.002			
SM status Y02	0.2493 8	0.3429	1.2832	(0.654, 2.517)	.47			
Person-Average Stress Y03	0.0036 8	0.0082	1.0037	(0.988, 1.020)	.66			
Distal NSSI Y04	1.0701 1	0.3571	2.9157	(1.445, 5.882)	.003			
Recent NSSI Y05	1.1059 3	0.4263	3.0221	(1.308, 6.984)	.01			
Person-Centred Stress Y10	0.0232 8	0.0144	1.0236	(0.995, 1.053)	.11	0.0006	0.03	>.5
Distal NSSI Y11	0.0302 9	0.0218	1.0308	(0.988, 1.076)	.17			
Recent NSSI Y12	0.0081 9	0.0205	1.0082	(0.968, 1.050)	.69			
Time Y20	0.0521 0	0.0527	1.0535	(0.950, 1.168)	.32	0.0008	0.03	>.5
Model 5								
	-							
Intercept Y00	4.5471 9	0.2532	0.0106	(0.006, 0.017)	<.001	2.6756	1.64	>.5
Male Gender Y01	1.0735 9	0.3489	2.9259	(1.474, 5.808)	.002			
SM status Y02	0.2079 5	0.3484	1.2312	(0.621, 2.441)	.55			
Person-Average Stress Y03	0.0011 2	0.0089	1.0011	(0.984, 1.019)	.90			
Distal NSSI Y04	1.0408 6	0.3664	2.8316	(1.378, 5.817)	.01			
Recent NSSI Y05	1.0306 8	0.4653	2.8030	(1.123, 6.993)	.03			
Emotion Dysregulation Y06	0.0045 0	0.0070	1.0045	(0.991, 1.018)	.52			
Person-Centred Stress Y10	0.0232 1	0.0148	1.0235	(0.994, 1.054)	.12	0.0006	0.03	>.5
Distal NSSI Y11	0.0298 9	0.0210	1.0001	(0.999, 1.001)	.16			

Recent NSSI Y12 Emotion Dysregulation Y13	0.0061 6	0.0220	1.0303	(0.989, 1.074)	.78			
	0.0000 6	0.0003	1.0062	(0.964, 1.051)	.85			
Time Y20	0.0526 3	0.0529	1.0540	(0.950, 1.169)	.32	0.0008	0.03	>.5

Table 9

Comparison of fit for binge drinking models

Model comparison	Degrees of Freedom	X^2	p
Model 1 vs Model 3	10	174.48	<0.001
Model 3 vs Model 4	4	2.905	>0.5
Model 4 vs Model 5	2	2.363	>0.25
Model 3 vs Model 5	6	5.277	>0.25

Table 10

Comparison of model fit Binge Eating

Model comparison	Degrees of Freedom	X^2	p
Model 1 vs Model 3	10	382.35	<.001
Model 3 vs Model 4	4	8.698	>.05
Model 4 vs Model 5	2	8.704	<.05
Model 3 vs Model 5	6	17.402	<.01

Discussion

The present study had 3 aims: 1) to examine rates of engagement in SDBs (binge drinking, binge eating, and illicit substance use) in first-year students with a distal history, recent history, or no history of NSSI, 2) to investigate the relation between fluctuations in stress and engagement in SDBs in each of these groups, and 3) to determine the role of emotional dysregulation in the association between stress and SDBs. The results reveal three key findings. First, students with either a distal or recent history of NSSI were more likely to engage in illicit substance use than students who had never self-injured. Second, students engaged in binge drinking and binge eating more frequently when experiencing elevated stress (relative to their own average), but this association was unrelated to NSSI history. Third, emotional dysregulation did not moderate the association between stress and SDBs, such that students who reported more difficulties with regulating their emotions were no more likely to engage in SDBs when encountering stress than students with stronger emotion regulation skills. Below, each of these findings are explored.

First, analyses revealed that while students with either distal or recent NSSI history did not engage in binge drinking or binge eating any more frequently than students who had never self-injured, they were more likely to report using illicit substances in any given month. This is consistent with past research that has identified increased rates of substance use in people with a history of self-harm (Borschmann et al., 2017; Brausch & Boone, 2015; Giletta et al., 2012; Mars et al., 2014; Moran et al., 2014; Serras et al., 2010). Odds of engaging in illicit substance use did not differ significantly between those with a recent history of NSSI and those with a distal history. However, these findings diverge from previous findings suggesting elevated rates of problem drinking and disordered eating in people who have engaged in self-injury (Riley et al.,

2015; Serras et al., 2010; Turner et al., 2015; Xin et al., 2017). Notably, some past research has observed more robust associations between NSSI and SDBs when specifically examining high-frequency SDB (Serras et al., 2010) or more clinically severe forms of SDB (Riley et al., 2016), which may partially account for these non-significant results.

The second aim of this study was to investigate the role of within-person changes in stress on rates of engagement in SDBs across these three groups. In a number of theoretical models, SDBs are hypothesized to serve an emotion regulation function, such that they are sometimes enacted to relieve feelings of distress or increase positive emotions by individuals who struggle to regulate their emotions through less extreme means (Chapman et al. 2006; Nock & Prinstein, 2004; Selby & Joiner, 2009). Thus, I hypothesized that the strength of the association between stress and SDB engagement would vary across levels of NSSI history. Partially consistent with this hypothesis, when participants experienced higher-than-usual levels of stress, they reported engaging in binge drinking and binge eating more frequently. However, students with either a distal or recent history of NSSI were no more likely to engage in SDBs during high-stress periods than students who had never self-injured, nor did they differ from one another in terms of their engagement in SDBs when experiencing increased stress. Within-person changes in stress were also unrelated to illicit substance use after accounting for NSSI history.

The third aim of this study was to examine the role of emotion regulation in the relation between stress and SDB engagement. Given that individuals with either a distal or recent history of NSSI likely experience more difficulty regulating their emotions than peers who have never self-injured and are therefore thought to enact SDBs as an emotion regulation strategy (Anderson & Crowther, 2012; Chapman et al. 2008; Duggan et al., 2015; Horgan & Martin, 2016; Selby & Joiner, 2009), it was predicted that emotional dysregulation would moderate the association

between stress and SDB engagement. This hypothesis was not supported for any of the three SDBs. Individuals with more emotional dysregulation were no more likely to engage in binge drinking, binge eating, or illicit substance use when experiencing elevated stress than peers with less emotional dysregulation. Emotion dysregulation was related to overall likelihood of engaging in binge eating, such that individuals who had more difficulties with regulating their emotions engaged in binge eating more frequently in any given month than peers with lower levels of dysregulation. This pattern was not observed for either binge drinking or binge eating frequency or for likelihood of engaging in illicit substance use.

Altogether, these findings suggest that, as expected, when an individual experiences levels of stress that exceed their own typical level, they engage in more SDB (binge drinking and binge eating more frequently, using illicit substances more often) than in less stressful periods. This is consistent with theoretical models of SDBs such as the experiential avoidance (Chapman et al., 2006) and emotional cascades (Selby & Joiner, 2009) models that suggest that SDBs are enacted when an individual is experiencing heightened distress. Specifically, these models suggest that SDBs interrupt undesirable internal states and thus act as an emotion regulation strategy. Therefore, individuals who struggle to regulate their emotions through more adaptive methods may be especially likely to enact these behaviours when experiencing conditions of distress.

Individuals with a history of NSSI are thought to be more likely to engage in SDBs due to persistent difficulties with emotion regulation and low distress tolerance, which are thought to render them more sensitive to elevations in stress than their peers with no NSSI history (Nock, 2009; Nock, 2010). However, this study did not find any differences in reactivity to stress (in terms of engagement in SDBs) across levels of NSSI history. Further, difficulties with emotion

regulation did not moderate the association between elevated stress and SDB engagement, regardless of NSSI history. This indicates that individuals who struggle to regulate their emotions are no more likely to enact SDBs when stressed than students with well-developed emotion regulation skills. Thus, the results of this study do not suggest that SDBs are functioning as a risky emotion regulation strategy for individuals who struggle to regulate their responses to stress through less extreme means. Rather, it appears that binge eating and binge drinking are behaviours that are more commonly enacted during times of elevated stress (and perhaps therefore with the intention of reducing negative emotional states), but that this association is equally strong across students, regardless of their NSSI history or emotional dysregulation.

While previous research has shown that individuals with a history of NSSI are at elevated risk for high-risk drinking behaviour, this study did not find any differences in rates of binge drinking between people with or without a history of NSSI. This may be because binge drinking, defined in this study as consumption of 5 or more alcohol drinks on a single occasion, occurs at a fairly high frequency in first-year student populations, with as many as 20% of first-year students reporting binge drinking in the past two weeks (White et al., 2006). Some other studies that have observed higher rates of alcohol misuse in people with a history of self-harm have done so by measuring drinking behaviours that are more clinically significant than those measured in this study. For instance, Mars and colleagues (2014) linked adolescent NSSI to future harmful alcohol use (defined as a clinically significant score on the Alcohol Use Disorders Identification Test), while Moran and colleagues (2014) linked adolescent self-harm to adult heavy binge drinking (defined as >11 drinks in a week for women and >20 drinks in a week for men) or clinical alcohol dependence (based on DSM-IV criteria). In a post-secondary student sample, Serras and colleagues (2010) observed that frequent binge drinking (defined as three or more

instances in a two-week period) was associated with a recent history of NSSI, while having any history of binge drinking in the past two weeks was not. Given that the dependent variable for binge drinking in the present study did not distinguish between binge drinking frequency at a rate greater than four instances per month, it may be that the truncation of this scale masked a possible association between NSSI history and high-frequency binge drinking behaviour. Others have also suggested that, given the high rates of binge drinking in this developmental window, the quantity of alcohol consumed in a single occasion (which may significantly exceed the 5-drink threshold employed for this study) may be a better indicator of high-risk drinking behaviour (Jackson et al., 2008). The present study also did not take into account drinking-related harms, which are key to assessing clinical severity of problem drinking behaviour. It may be the case that NSSI history only predicts alcohol use at a higher level of clinical severity or only heavy drinking behaviour that persists beyond what might be a developmentally typical period for experimenting with heavy alcohol use (Chassin et al., 2002).

It is possible that a similar pattern applies to disordered eating behaviour. For instance, Serras and colleagues (2010) also observed no association between NSSI history and binge eating in a post-secondary student sample. Similarly, Riley and colleagues (2015) found that NSSI history was linked to greater probability of purging onset, but not binge eating onset, in first-year undergraduates. While binge eating is a much more common disordered eating symptom in undergraduates, purging is often considered more clinically severe and is associated with poorer mental health outcomes (Serra et al., 2020). In an undergraduate sample, Serra and colleagues (2020) observed that students who reported binge eating were about four times more likely than those who reported no binge/purge symptoms to have a history of NSSI, but students who engaged in both bingeing and purging were 18 times as likely to report past NSSI than those

with no binge/purge symptoms. Taliaferro and Muehlenkamp (2015) observed that NSSI history was associated with a diagnosed eating disorder or “extreme” weight control behaviours in undergraduate students. While binge eating was hypothesized to be a relevant disordered eating behaviour among students with NSSI history due to its function as an emotion regulation behaviour (Wedig & Nock, 2010), it may be the case that other, more clinically severe behaviours such as purging or restriction are more closely linked with NSSI.

In line with the results of this study, the association between NSSI history and substance use appears to be the most consistently replicated across the extant literature (Borschmann et al., 2017; Brausch & Boone, 2015; Giletta et al., 2012; Mars et al., 2014; Moran et al., 2014; Serras et al., 2010; Taliaferro & Muehlenkamp, 2015). Notably, illicit substance use was the least commonly reported of the SDBs measured in this study, but may also be associated with the highest risk of harm.

This study hypothesized that rates of SDB engagement would differ across levels of NSSI history due to a possible shared emotion regulation function across each of these behaviours. However, given that the data do not support the hypothesis that individuals with a history of NSSI employ SDBs as an alternative emotion regulation strategy, there may be a more appropriate theoretical model to explain why higher rates of illicit substance use behaviour were observed in individuals with NSSI history in this study and others (Borschmann et al., 2017; Brausch & Boone, 2015; Giletta et al., 2012; Mars et al., 2014; Moran et al., 2014; Serras et al., 2010; Taliaferro & Muehlenkamp, 2015), and why other past research has identified a link between NSSI and more severe SDBs. One possibility that has yet to be sufficiently explored is acquired capability. Originally proposed by Joiner (2005) as part of the interpersonal theory of suicide, acquired capability is the conditioned mental state associated with fearlessness and decreased

sensitivity to pain that may allow an individual the capacity to carry out suicidal behaviours. Repeated “painful and provocative” events (e.g., NSSI) are thought to increase capacity for suicidal behaviour by desensitizing the individual to the fear and pain associated with severe self-harm and potentially lethal actions. SDBs such as substance use (Cheek et al., 2016), disordered eating (especially restriction and purging; Favaro, 1997, Riley et al., 2016), and heavy drinking (Wolford-Clevenger et al., 2015) have also been proposed to develop capability for suicide (Joiner, 2005; Turner et al., 2013). Some research has also suggested that engagement in multiple forms of SDBs (e.g., NSSI and disordered eating) is associated with higher rates of acquired capability than engaging in only one form of SDB (Brausch & Perkins, 2018).

Although acquired capability is typically used to explain the process of erosion of barriers to suicidal behaviours (i.e., fear and pain avoidance; Joiner, 2005), some researchers have suggested a broader model of acquired capability for self-harm, wherein experience with one form of self-harmful behaviour (e.g., NSSI) may generate capability to tolerate other forms of self-harm (Riley et al., 2015). For instance, repeated engagement in NSSI may erode an individual’s response to pain, which may lead them to be more able to engage in purging (which is considered one of the most severe and aversive forms of disordered eating; Claes & Muehlenkamp, 2014) than other individuals who have never engaged in NSSI (Riley et al., 2015). Likewise, fearlessness (highly associated with impulsivity) may make an individual more likely to engage in substance use without concern for potential detrimental effects or legal consequences (Walters, 2014). However, other less-severe forms of SDBs that are more common in the general student population (i.e., binge drinking, binge eating; Kwan et al., 2013; Serra et al., 2020) may not require the same erosion of barriers to be enacted and may therefore be less closely linked to a history of NSSI. Consistent with this possibility, Riley and colleagues

(2015) found that binge eating (a less-aversive form of SDB) did not predict subsequent onset of either purging or NSSI onset in first-year university students, while purging (a more aversive behaviour) predicted the subsequent onset of NSSI, and vice versa.

Notably, Joiner (2005) proposed that once it is established, acquired capability persists over time. Thus, individuals with a distal history of NSSI would be hypothesized to be equally capable of future self-harmful behaviours as individuals with a more recent history. One cross-sectional study investigating the role of NSSI cessation in suicide capability actually found that levels of acquired capability were higher among individuals who had desisted from NSSI longer ago, compared to those who had self-injured more recently (Kittleman, 2014). Since acquired capability is hypothesized to be stable once acquired, this could also explain why rates of SDBs remain elevated long after NSSI has stopped. Taken together, these findings may suggest that individuals with either a distal or recent NSSI history are specifically vulnerable to high-barrier or more clinically severe presentations of SDBs, while other less-aversive SDBs may be equally accessible regardless of NSSI history.

Recently, NSSI researchers Lewis and Hasking (2021) have proposed a person-centred framework of NSSI recovery. Importantly, this model emphasizes that recovery from NSSI is a multifaceted process that continues long after cessation of NSSI. Two key components of this NSSI recovery process are the importance of developing alternatives to NSSI and addressing adversities that underlie the behaviour. The present study hypothesized that SDBs may function as an alternative emotion regulation behaviour in individuals with either recent or historical self-injury. If individuals with a history of NSSI engage in SDBs to fulfill a similar function (emotion regulation or otherwise) to NSSI, this person-centred framework would emphasize the need for fostering less harmful alternatives to replace both NSSI and other SDBs while fulfilling the same

need. Although not suggested by the results of this study, qualitative research with individuals who have lived experience of recovering from NSSI has suggested that this is the case for at least some people with a history of NSSI (Gelinias & Wright, 2013). Thus, future research should consider the functions of reported SDBs among people with and without a history of NSSI to better understand how and why SDBs might be substituted for NSSI, and how more adaptive alternatives can be introduced.

Past research has demonstrated that a number of underlying vulnerabilities, such as emotional dysregulation, low distress tolerance, internalizing pathology, and body dissatisfaction persist even after NSSI has stopped (Anderson & Crowther, 2012; Duggan et al., 2015; Horgan & Martin, 2016). This corroborates Lewis and Hasking's (2021) model by suggesting that the need for support and intervention does not disappear when an individual stops engaging in NSSI. The results of this study and others suggest that individuals with a history of NSSI remain vulnerable to certain types of SDBs after NSSI has stopped (Brown et al., 2007; Glenn & Klonsky, 2011) and even well into adulthood (Mars et al., 2014; Moran et al., 2014). Whether this occurs due to stable vulnerabilities in traits such as emotion dysregulation or internalizing pathology or is due to an acquired vulnerability such as the erosion of barriers (e.g. fear and pain) that might deter engagement in other SDBs, it is clear that individuals with a history of NSSI remain at risk of indirect self-harm even after desisting from NSSI.

Clinically, it may be warranted for mental health professionals to consider the role of other SDBs in the NSSI recovery process. While clinicians are beginning to move away from a sole focus on cessation and take into account other domains of functioning in the NSSI recovery process (Lewis & Hasking, 2021), less focus has been placed on SDBs specifically. Given that some individuals report substituting other SDBs for NSSI (Gelinias & Wright, 2013), clinicians

should monitor this risk in clients who are transitioning away from NSSI behaviour. It may be necessary to adopt a coordinated treatment approach that can target both NSSI and other emergent SDBs by addressing underlying vulnerabilities and developing more adaptive alternative behaviours. Further, just as history of suicidality is routinely assessed in clinical practice, clinicians may consider screening for a history of NSSI in their clients and considering whether NSSI history may be an indicator of risk for other SDBs in the future. However, additional research is needed to clarify which types of SDBs persist in individuals with a history of NSSI, and to prevent or treat the co-occurrence of SDBs across the lifetime.

Limitations

There are a number of important limitations that should be considered when understanding the results of this study. First, although the first year of post-secondary study is a high-risk time for SDBs, the results of this study may not generalize well to non-student populations. Rates of certain SDBs, especially substance use, would be expected to be higher in a community sample of individuals of approximately the same age (Health Canada, 2010; Kwan et al., 2013). Given the low frequency of illicit substance use in the present study, illicit substance use frequency was treated as a binary variable measuring engagement or non-engagement in illicit substance use in any given month. Although this dichotomous approach has been taken in a number of previous studies with student populations (e.g., Serras et al., 2010), it disallows a more nuanced understanding of how the frequency at which an individual engages in illicit substance use relates to their fluctuations in stress, NSSI history, and emotional dysregulation. Further, this approach made it more difficult to compare the association of each of these variables and illicit substance use engagement to their associations with binge drinking and binge eating frequency, which were assessed using a different metric and model specification. Thus, it

is possible that the differences observed across these outcome variables is in part due to differences in the statistical approach.

Similarly, binge drinking and binge eating frequency were assessed using an ordinal scale with a maximum value of “four or more times” in one month rather than a true frequency count. If NSSI history is associated with a higher frequency of these behaviours, as has been suggested by at least one other study of NSSI and binge drinking in university students (Serras et al., 2010), the truncation of this scale may have masked a true association between these variables. Further, for the purpose of this study, binge drinking was defined as consumption of 5 or more alcoholic drinks, regardless of gender. While this definition has been adopted in past large-scale health research projects (Bulloch et al., 2016), other agencies suggest that a definition of 4 or more drinks for women and 5 or more drinks for men is preferable (Allen & Wilson, 2003). Thus, the present study may have provided a less sensitive assessment of binge drinking in women. Similarly, the single-item measure of binge eating used in this study may also have limitations. Although the item assessed for two key features associated with clinical binge eating episodes (consuming a large quantity of food and loss of control APA, 2013), other features such as eating rapidly, eating until uncomfortably full, eating when not hungry, eating alone due to embarrassment, and feelings of depression or shame following eating were not assessed. Additionally, participants may have differed in their evaluation of what constitutes an “objectively large amount of food,” which may have led to less consistency among responses.

Although a strength of this study was a relatively high number of measurement intervals over the span of many months, this one-month measurement interval may have also been subject to recall bias, wherein participants might more readily recall their more recent experiences of stress and SDB engagement while not providing responses that accurately reflect the entire past

month. Thus, recall bias may have introduced additional error into the data that may have been avoided by surveying participants at more frequent intervals. Additionally, this measurement interval may not have been sensitive enough to discrete changes in levels of distress that might lead an individual to engage in an SDB. By measuring stress only once per month, it may be the case that distinct instances of emotional distress that may have been linked with SDB engagement were masked. For instance, if a participant experienced an intense but short-lived stressor that corresponded to an instance of SDB engagement (e.g., binge drinking after a stressful exam or interpersonal conflict), this acute stressful experience may not have altered their total monthly stress level enough to influence the statistical association between overall stress levels and monthly rate of SDB engagement.

Emotion regulation theories of SDB (e.g., Chapman et al., 2006; Selby & Joiner 2009) typically focus on the association between proximal experiences of distress that are rapidly followed by a discrete instance of SDB. Thus, this research question may be better addressed by a study utilizing experience sampling methods wherein participants complete multiple brief reports as they go about their daily lives in order to capture momentary changes in emotions and the behaviours that precede or follow them. Real-time measurement offers the notable advantages of minimizing bias associated with retrospective recall and maximizing ecological validity (Trull & Ebner-Priemer, 2009). It may be the case that individuals with distal or recent histories of NSSI are more likely than their peers to enact SDBs as an emotion regulation strategy following an acute rise in distress, rather than being more likely to engage in SDBs as an emotion regulation strategy during a longer high-stress period such as the one-month interval employed in this study. Thus, further research testing the association between NSSI history, SDBs, and emotional states using novel experience sampling techniques is warranted.

Conclusion

The results of the present study contribute to a growing body of literature suggesting that individuals with a history of NSSI may be at greater risk of engaging in certain types of SDBs such as illicit substance use (Borschmann et al., 2017; Brausch & Boone, 2015; Giletta et al., 2012; Mars et al., 2014; Moran et al., 2014; Serras et al., 2010). The present study expands on previous findings by establishing that relative to peers who have never self-injured, elevated risk for illicit substance use persists for both those who have recently self-injured, and for those who have not self-injured for at least one year. This finding can be interpreted as consistent with a person-centred framework of NSSI recovery (Lewis & Hasking, 2021), which suggests that the NSSI recovery process continues long after an individual stops self-injuring and that cessation of NSSI is not a sole indicator of a holistic mental health recovery. Specifically, this finding reinforces the importance of fostering long-term adaptive coping skills that offer an alternative to SDB engagement and addressing underlying vulnerabilities that may render an individual at risk to future self-harmful behaviours. These results may also offer support to an acquired capability model of self-harm (Joiner, 2005; Riley et al., 2015) by suggesting that engaging in one form of self-harmful behaviour may erode barriers to engaging in other harmful behaviours.

These results also differ from emotion regulation models of SDBs by suggesting that although some SDBs such as binge drinking and binge eating may be enacted under conditions of distress, individuals with emotion regulation difficulties or those who have engaged in NSSI in the past may not be any more likely to demonstrate this pattern. Rather, binge drinking and binge eating may be more widely accessible behaviours that can be enacted by an individual when experiencing conditions of stress that exceed their own typical levels.

Taken together, these findings suggest that the relation between NSSI history, SDBs, and emotion regulation may be more complex than previously hypothesized. Rather than a broad association between NSSI and all other behaviours that pose a risk of harm to self, this transdiagnostic vulnerability may be more pertinent to behaviours of a higher level of clinical severity. Thus, future research examining the association between NSSI and specific forms of SDB and the mechanisms that link them is warranted.

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