EMOTION IN NON-SUICIDAL SELF-INJURY: A CONTRADICTION BETWEEN GLOBAL SELF-REPORTS AND REAL-TIME RESPONSES

BY

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Abstract

People who engage in non-suicidal self-injury (NSSI) report doing so largely to manage overwhelming emotions. Prominent theories of NSSI argue that an amplified emotional response system creates the context in which a person chooses to regulate their emotions by engaging in NSSI. In line with these theories, people who engage in NSSI consistently report greater global emotion reactivity and emotion dysregulation than do controls. These global self-reports of emotional functioning also predict the onset and cessation of NSSI, demonstrating their considerable utility in understanding the behaviour. However, global self-reports provide an overall evaluation of one's average affective experience and so are ill-suited to isolating precise alterations in emotional responding.

I first establish how best to assess NSSI (Study 1a and 1b). I then leverage experimental affective science and individual differences methodologies to test whether NSSI is characterised by a more reactive and intense emotional response to challenge, and/or whether factors that help to create, modify, and later recall the emotional response are altered in those who engage in NSSI compared with controls. Study 2 compared how young adults with a past-year history of NSSI and controls subjectively and physiologically reacted to, and recovered from, acute stress. Study 3 compared how young adults with a past-year history of NSSI and controls subjectively reacted to both explicit and more ambiguous social exclusion.

Consistent with a wealth of research, across both Studies 2 and 3 people with a past-year history of NSSI reported considerably greater global emotion reactivity and emotion dysregulation than did controls. However, counter to predictions, both the NSSI and Control groups showed similar patterns of real-time emotional responding to both acute stress (Study 2) and social exclusion (Study 3), providing no evidence that NSSI is characterised by an amplified response to emotional challenge. In addition, we found no evidence that emotional recovery, emotion regulation strategy use, memory of emotional experience, or appraisal—all factors that shape the emotional response—operate differently in those who engage in NSSI. Focusing on how people make global self-reports, exploratory reanalysis of Study 2 and 3 suggests that people with no history of NSSI draw from their real-time experiences of acute (but not mild) emotional challenge when making judgements about their global emotion dysregulation. In contrast, people who engage in NSSI appear to rely on different channels of information when reporting their global emotion dysregulation.

Overall, this thesis demonstrates that, despite reporting considerably poorer global emotional functioning, people who engage in NSSI show largely typical responses to real-

time emotional challenges. Given that global self-reports of emotional functioning appear to be critical for understanding NSSI onset and cessation, the discrepancy between global self-reports and measures of real-time responding highlights the complexity of the relationship between emotion and NSSI. To advance our understanding of emotional responding in NSSI, research should: a) establish the conditions (if any) under which people who engage in NSSI show amplified emotional responding, and b) isolate the psychological processes that underlie the experience of poorer global emotional functioning reported by people who engage in NSSI.

Publications During Candidature

Publications included in this thesis

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Other publications

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Kaess, M., Hooley, J., Klimes-Dougan, B., Koenig, J., Plener, P. L., Reichl, C., **Robinson, K.,** Schmahl, C., Sicorello, M., Westlund-Schreiner, M., & Cullen, K. (2021). Advancing a temporal framework for understanding the biology of nonsuicidal self-injury: An expert review. *Neuroscience and Biobehavioural Reviews, 103,* 228-239. https://doi.org/10.1016/j.neubiorev.2021.08.022

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> *"…I needed some other way of dealing with the pain and hurt, so I started cutting instead. It is a way of gaining temporary relief. As the blood flows down the sink, so does the anger and the anguish. It's a way of transferring the scars and wounds inside onto a visible object, … it's easier to deal with it on the outside and it's a way of communicating the pain within"* (participant quoted in Harris, 2000, p. 167).

Despite powerful psychobiological drives to protect our bodies, one in four young people deliberately and directly injure themselves without suicidal intent (Gillies et al., 2018; Muehlenkamp et al., 2012; Swannell et al., 2014). This non-suicidal self-injury (NSSI) represents a significant mental health concern. NSSI is concurrently associated with psychological distress. Compared to those with no history of NSSI, people who engage in NSSI report poorer psychosocial wellbeing (Giletta et al., 2012; Muehlenkamp et al., 2013; Rotolone & Martin, 2012) and greater psychopathology (Nock et al., 2006). NSSI also *prospectively* predicts psychological distress—longitudinal analyses demonstrate that engaging in NSSI subsequently predicts poorer socio-emotional functioning (Andrews et al., 2014; Gandhi et al., 2017; Robinson et al., 2019), new instances of psychiatric disorders (Wilkinson et al., 2018), and suicidal thoughts and behaviours (Guan et al., 2012; Ribeiro et al., 2016). Given the clinical significance of self-injury, a comprehensive understanding of the mechanisms underlying the behaviour is needed to inform effective prevention and intervention strategies.

Functional analysis of NSSI highlights the ubiquity of unwanted emotional experiences in instances where people engage in NSSI. As captured in the quote above, people typically self-injure in order to down-regulate or manage intense emotions (for review, see Edmondson et al., 2016)—the so called 'affective engine' of NSSI (Hooley & Franklin, 2018). As such, theories primarily conceptualise NSSI as a strategy for regulating unwanted emotions (e.g., the Experiential Avoidance Model: Chapman et al., 2006; the Cognitive–Emotional Model: Hasking et al., 2016; the Integrated Theoretical Model: Nock, 2009). These theories argue that individual differences in how people respond to emotional challenge are critical for understanding the development and maintenance of NSSI. In this thesis, I leverage affective science and individual differences methodologies to better isolate the precise role that the emotional response plays in NSSI. This chapter provides a brief

overview of the rationale and aims of the thesis. A more detailed review and discussion of the evidence presented here is provided in Chapter 2.

Current evidence for the role of emotional responding in NSSI

Emotions represent the coordinated activity of subjective, physiological, and behavioural systems that prepare us to deal with challenges, filtered through our appraisal of the situation and in light of our personal histories (Feldman Barrett, 2009; Scherer, 2009). Emotional responses are dynamic processes that rise and fall. At first, we may respond to a person, object, event, or recollection. But then, we may also respond to our own response—our racing heart, our stab of anger, our clenched fists—to move our emotional experience more in line with how we want to feel, how we believe we 'should' feel, or how we want to seem to those around us. Within the NSSI literature, individual differences in the emotion *generation* process are typically measured using self-reports of global emotion reactivity, defined as a person's emotional sensitivity, intensity, and persistence (Emotion Reactivity Scale; Nock et al., 2008). Similarly, individual differences in the emotion *regulation* process are typically measured by self-reports of global emotion dysregulation; maladaptive ways of responding to emotional challenge, including a lack of awareness, nonacceptance of emotions, and the inability to flexibly engage in situationally appropriate emotion regulation strategies, or control behaviours when distressed (Difficulties in Emotion Regulation Scale; Gratz & Roemer, 2004). These global self-reports ask participants to summarise their emotional experience across contexts in order to report their typical experience (e.g. global emotion reactivity: *'My emotions go from neutral to extreme in an instant'*; Nock et al., 2008; global emotion dysregulation: *'When I'm upset, I believe that there is nothing I can do to make myself feel better'*; Gratz & Roemer, 2004).

Global self-reports of emotion reactivity and dysregulation offer considerable utility in understanding NSSI. Meta-analyses demonstrate that greater self-reported emotion reactivity and emotion dysregulation are robustly associated with engagement in NSSI (You et al., 2018), and longitudinal studies find that poorer self-reported global emotion regulation subsequently predicts NSSI within both adolescent (Robinson et al., 2019) and adult samples (Ewing et al., 2019). Therapeutic interventions that focus on emotion regulation are particularly effective in reducing self-injury. Dialectical Behaviour Therapy for Adolescents—which is designed in part to scaffold distress tolerance and emotion regulation skills—has demonstrated success in reducing self-injury across randomised controlled trials (Kothgassner et al., 2020), and may be most beneficial for those who initially report greater

emotion dysregulation (Adrian et al., 2019). Taken together, evidence from cross-sectional, longitudinal, and clinical research suggests that NSSI is characterised by greater global emotion reactivity and emotion dysregulation.

The problem

Global self-reports provide an overall evaluation of one's average affective experience but are ill-suited to isolating precise alterations in emotional responding for two reasons. First, it is unclear the extent to which global self-reports map on to the moment-to-moment dynamics of the subjective response to real-time emotional challenges. In particular, retrospective judgements of experience rely on heuristics which can introduce bias to reports, such as being influenced by current experiences and emphasising some experiences over others (e.g., Kahneman et al., 1993; Mayer et al., 1995). Second, global emotion dysregulation and reactivity capture only *subjective* aspects of emotion, leaving it unclear how physiological and behavioural channels of emotion operate in people who self-injure. Isolating which (if any) emotional response channel(s) show greater reactivity and impaired recovery in NSSI is critical to our empirical understanding of NSSI. In addition, identifying the emotional response channel(s) which are altered in NSSI is of great clinical importance. The psychological skills and strategies that alter the physiological emotional response (e.g., diaphragmatic breathing) differ from those that alter the subjective emotional response (e.g., cognitive reappraisal). Isolating where alterations do (or do not) lie allows clinicians to develop more precise and effective therapeutic targets.

To capture the underlying cause(s) of these differences in global emotional functioning we see in NSSI, multi-modal assessments of real-time emotional responding are needed. To date, limited research has assessed how people who self-injure subjectively *and* physiologically respond to emotional challenge in real-time. The findings of these studies are mixed; some have found a difference in subjective and/or physiological responding to emotional challenge by self-injury status (e.g., Crowell et al., 2005, 2008; Kaufman et al., 2019; Nock & Mendes, 2008), whereas others have not (e.g., Allen et al., 2019; Davis et al., 2014; Glenn et al., 2011; Kaess et al., 2012; Tatnell et al., 2018). These mixed results across and within subjective and physiological response channels may reflect differences in mood induction methods or how NSSI was operationalised (e.g., 'lifetime NSSI history' compared to 'past-year history'; Nock & Mendes, 2008; Tatnell et al., 2018). However, they may also reflect a common reliance on small sample sizes with limited power to detect significant effects and an increased likelihood of spurious findings. In addition, few studies have

assessed how people who self-injure respond to emotional challenge across multiple measures of physiological responding (for exceptions, see Crowell et al., 2005; Kaess et al., 2012), despite evidence that different physiological measures may not cohere (Levenson, 2014). Although people who self-injure consistently report experiencing greater global emotion reactivity and emotion dysregulation, it is currently unclear which elements of the emotional response might be altered in NSSI. Emotions are complex and dynamic processes influenced by our experiences, and global self-reports aggregate across all of these processes. Therefore, it is not clear, from global self-reports, which components of the emotional response are altered in NSSI, impeding our ability to target therapeutic interventions.

The solution

Our solution to this problem is to assess emotional responding *as it unfolds* in real-time among people with and without a history of NSSI. Real-time, multi-channel assessment of emotional reactivity and recovery allows for unique insight into the dynamic emotional response, and experimental manipulation of emotion using well-established emotional challenges allows for precise statistical control. My thesis describes a research programme using experimental methods to induce emotional responding in real-time to test two broad possibilities for *why* we consistently see large differences in global self-reports of emotion reactivity and emotion dysregulation between people with and without a history of NSSI.

The first branch of this thesis tests what I have called the *amplified emotional response account*. Namely, whether the large differences we consistently see in global reports of emotion reactivity and emotion dysregulation by NSSI status are the downstream consequences of a more reactive and intense emotional response among people who engage in NSSI compared to controls. If this is the case, then people who engage in NSSI should show greater increases in measures of physiological and subjective channels of emotion in response to real-time emotional challenges compared to those without a history of NSSI.

Many additional factors play a considerable role in generating and shaping our emotional response. Thus, the second branch of this thesis tests whether factors that play a role in creating, modifying, and later remembering the emotional response can explain the elevated global emotion dysregulation and reactivity we see by NSSI status. In this thesis I test whether, compared to controls, people who engage in NSSI: (i) are more likely to interpret an ambiguous event negatively, (ii) take longer to subjectively and physiologically recover from emotional challenge, (iii) choose to engage in different emotion regulation strategies, and/or (iv) are better able to remember their emotional experiences. Taken

together, the two branches of this thesis provide a comprehensive description of how people who engage in NSSI respond to real-time emotional challenges and tests the hypothesis that NSSI is marked by alteration(s) in responding to emotional events.

The structure of this thesis

The next chapter of this thesis draws from the NSSI and affective science literatures to provide a detailed overview of current theoretical and empirical understanding of the role of emotional responding in NSSI. Given that precise measurement is a foundation for all scientific investigation and that previous studies have used different operationalisations of NSSI engagement to identify participants, Chapter 3 then presents two studies (Study 1a and Study 1b) assessing the best way to measure NSSI for subsequent studies. Chapter 4 describes Study 2 which measures how young adults with and without a history of NSSI subjectively and physiologically respond to, and recover from, a well-established acute stress manipulation. I also explore whether people with and without NSSI differ in the extent to which they spontaneously engage in emotion regulation strategies and how they later remember the emotional experience. Chapter 5 focuses on the subjective response to emotional challenge in NSSI, describing an online study (Study 3) in which people with and without NSSI took part in either an explicit or a more ambiguous social emotional challenge. Chapter 6 takes a complimentary individual differences approach using data from Study 2 and 3 to assess how well real-time emotional responding maps on to global self-reports, and whether this association is moderated by NSSI status. Chapter 7 summarises the contributions of my thesis, integrates my findings with the extant literature on emotional responding in NSSI, and identifies the implications and future directions of these findings for both NSSI and affective science fields. Finally, in Chapter 8 I provide a brief reflection on the process of doing this thesis.

Chapter 2: General introduction

Chapter 1 provided a brief snapshot of the theoretical and empirical foundations of this thesis, highlighting the current limitations in this field, and providing an overview of the thesis aims and overarching questions. This chapter presents a more detailed literature review; beginning with an overview of presentation characteristics and key theories of NSSI, moving to consider emotion, emotion regulation, and emotion *dys*regulation, and ending with a summary of the current research, theory, and commentary on the interface between emotion and NSSI.

What is non-suicidal self-injury?

Self-injury research is plagued by the lack of a standardized language. Terms such as *deliberate self-harm*, *parasuicide*, *self-mutilation*, and *self-inflicted injury* encapsulate self-injurious behaviours, both with and without suicidal intent, and assume that such behaviours fall along a continuum. In contrast, *non-suicidal self-injury* makes a categorical distinction between behaviours with and without suicidal intent. Establishing a standardized nomenclature is further complicated by growing evidence that self-injury that occurs explicitly *without* suicidal intent is a risk factor for the development of subsequent suicidal ideation, suicide attempts, and death by suicide (Castellví et al., 2017; Chesin et al., 2013; Dhingra et al., 2016; Hamza et al., 2012; Ribeiro et al., 2016; Siddaway et al., 2018). Given the robust relationship between NSSI and suicidal thoughts and behaviours (Kiekens et al., 2018a; Mars et al., 2019; Robinson et al., 2021), some researchers have argued that distinguishing between suicidal and non-suicidal thoughts and behaviours creates a false dichotomy (Kapur et al., 2013). Nevertheless, NSSI can be distinguished from suicidal self-injury by characteristics such as severity, behavioural frequency, number of methods, antecedent cognitive states, and interpersonal and intrapersonal consequences (Muehlenkamp & Kerr, 2010).

Within this thesis I conceptualise *self-injurious thoughts and behaviours* using Nock's (2010) classification system. In this system, self-injurious thoughts and behaviours are separated into two superordinate clusters: *Suicidal Phenomena,* and *Non-Suicidal Phenomena.* Suicidal Phenomena are further separated into *Suicidal Ideation*, *Suicide Plans*, and *Suicide Attempts*. Non-Suicidal Phenomena are further separated into *Non-Suicidal*

Thoughts/Ideation, *Non-Suicidal Self-Injury*, and *Suicide Threats/Gestures*.[1] Given the heterogeneity of self-injury terms and definitions, within this thesis I use the term '*Non-Suicidal Self-Injury'* (and its abbreviation, NSSI) to refer specifically to instances of deliberate and direct self-injury which occur expressly without suicidal intent and for reasons which are not socially or culturally sanctioned (Lloyd-Richardson et al., 2007; Nock, 2010). In contrast, I use *'self-injury*' as an umbrella term to encompass self-injurious acts with or without suicidal intent (Hawton et al., 2002), particularly when describing previous research which grouped together suicide attempts and NSSI, or which did not assess the intent of the behaviour.

A (pragmatic) review of non-suicidal self-injury

Given the proliferation of NSSI research since the field of inquiry began in the 1970's and 1980's (Favazza & Conterio, 1988; Toch, 1975), a comprehensive review is beyond the scope of this thesis (but see, Nock, 2014; Washburn, 2019). Instead, I provide a brief overview of NSSI, focusing on the presentation characteristics and the emotional causes and consequences of the behaviour.

Presentation characteristics

NSSI is a widespread, highly heterogeneous behaviour. Although first documented in clinical and forensic settings (Crabtree, 1967; Toch, 1975), NSSI is common among community adolescents and adults (Hasking et al., 2013; Plener et al., 2016; Whitlock et al., 2006). Meta-analyses estimate that between 18-23% of community adolescents and 6% of adults report a lifetime history of NSSI (Gillies et al., 2018; Muehlenkamp et al., 2012; Swannell et al., 2014), with evidence that, at least among adolescents, the prevalence of lifetime self-injury has increased between 1990 and 2015 (Gillies et al., 2018). More recently, the ongoing global COVID-19 pandemic has created substantial loss of life and widespread socioeconomic disruption, leading to predictions that the stressors created and exacerbated by COVID-19 will result in increased risk of NSSI onset and escalation (Fegert et al., 2020; Hasking et al., 2021). However, given the recency and ongoing nature of the COVID-19 pandemic, the psychological sequela remains to be seen.

[1] Defined as instances in which a person leads others to believe they want to kill themselves when they have no such intention (Nock & Kessler, 2006). Although 'suicide threats/ gestures' is the most common and precise term in recent suicidology research (e.g., Fox et al., 2020; Guan et al., 2012), the term has been used historically to refer pejoratively to self-injury behaviour or communications judged to be instrumental or malingering (and thus dismissed as 'not genuine'), leading to calls to abandon the term (Heilbron et al., 2010). I use the term here to maintain consistency with Nock's (2010) classification system.

NSSI typically manifests as cutting, scratching, or burning of the skin, or banging the body (Garisch & Wilson, 2010; Lloyd-Richardson et al., 2007; Whitlock et al., 2011), with many people engaging in multiple forms of NSSI (Anestis et al., 2015; Robinson et al., 2021; Whitlock et al., 2011). Notably, common NSSI methods vary across cultures (Gholamrezaei et al., 2017) and by gender (Bresin & Schoenleber, 2015). People who self-injure typically do so on their upper and lower arms, wrists, thighs, and/or stomach (Whitlock et al., 2011; Williams & Hasking, 2010)—areas of the body easier to conceal from public view. Indeed, NSSI is often a private behaviour. In university student samples, between 22.6% and 40.1% of students who self-injure reported that no one knew about their NSSI (Muehlenkamp et al., 2013; Whitlock et al., 2011), and only 16.9% reported disclosing their NSSI to a mental health professional (Whitlock et al., 2011).

Engagement in NSSI is highly variable. Some people engage in NSSI once or twice, others engage sporadically, and still others engage in the behaviour chronically over time (Klonsky & Olino, 2008; Whitlock et al., 2011; Wilkinson et al., 2018). Adolescence represents a developmentally critical period for self-injury (Wyman, 2014). NSSI usually begins between 12-15 years of age and peaks around 15-16 years old, before declining in early adulthood (Plener et al., 2015). More recently, the transition to university has been identified as a second peak in the onset of NSSI (Kiekens et al., 2019).

NSSI is a transdiagnostic behaviour. Among a United States of America (USA) adolescent clinical inpatient sample who had engaged in NSSI in the past year, 87.6% met criteria for one or more Diagnostic and Statistical Manual 4th edition (DSM-IV) diagnoses; 51.7% presented with an internalizing disorder, 62.9% with an externalizing disorder, and 59.6% with a substance use disorder (Nock et al., 2006). In addition, 67.3% of participants met criteria for a DSM-IV personality disorder, most commonly Borderline Personality Disorder (BPD; 51.7%)[2] and Avoidant Personality Disorder (31.0%; Nock et al., 2006). Among university students with a history of NSSI, 35.5% met screening criteria for one or more mental disorders in the past year, most commonly major depressive disorder (21.1%) and generalized anxiety (17.6%; Kiekens et al., 2018b). Greater past-year NSSI frequency has also been associated with greater likelihood of suicide attempts, substance use, and disordered eating (Brausch & Boone, 2015).

[2] The high comorbidity between BPD and NSSI is perhaps unsurprising given that, since the inclusion of BPD in the DSM-III, NSSI has been a diagnostic criterion for BPD (American Psychiatric Association, 1980, 2013).

NSSI within Aotearoa New Zealand

Given the specific cultural context in which this research was conducted, I briefly consider aspects of NSSI that are unique to Aotearoa New Zealand. Several lines of research indicate a higher prevalence of NSSI in Aotearoa New Zealand than in many other countries with similar ethnic and economic characteristics. Within the general population, 0.9% of USA adults selected through random-digit dialling reported a past-year history of NSSI (Klonsky, 2011). In contrast, 14% of the Dunedin Multidisciplinary Health and Development Study[3] reported a past-year history of NSSI at age 26 (assessed in 1998–1999; Coppersmith et al., 2017). NSSI prevalence amongst adolescent and young adult samples also appears higher in Aotearoa New Zealand compared to international rates. Meta-analyses estimate that 18–23% of community adolescents and young adults have engaged in NSSI at least once in their lifetime (Gillies et al., 2018; Muehlenkamp et al., 2012; Swannell et al., 2014). In comparison, 26% and 49% of two samples of Aotearoa New Zealand adolescents (Garisch & Wilson, 2015; Robinson et al., 2021), and 38% of students attending a New Zealand university reported a lifetime history of NSSI (Fitzgerald & Curtis, 2017). Focusing on past-year NSSI incidence, 6.8% of USA university students (Whitlock et al., 2011) and 7.5% of USA adolescents (Hilt et al., 2008) had engaged in NSSI in the past year. Within Aotearoa New Zealand, 12.9% of a university student sample (Fitzgerald & Curtis, 2017) and 7.9% of a nationally representative sample of adolescents (Chan et al., 2018) had engaged in NSSI in the past year. Moving beyond prevalence rates, the presentation characteristics of NSSI within Aotearoa New Zealand largely mirror those documented in the USA, Canada, Australia, and Western Europe described above (Fitzgerald & Curtis, 2017; Garisch & Wilson, 2015; Robinson et al., 2017, 2021).

Initial research has considered NSSI among indigenous communities in New Zealand. Among university students, Māori[4] and Pākehā/New Zealand European emerging adults were more likely to report a history of NSSI than people of other ethnicities, but Māori students were no more or less likely to report a history of NSSI than Pākehā (Fitzgerald & Curtis, 2017). Qualitative research demonstrates that Māori and Pasifika[5] understand self-injury within a holistic framework of wellbeing. Pasifika mental health professionals included deliberate disconnection from spiritual faith as a form of self-injury, alongside directly (e.g., cutting and scratching) and indirectly harmful behaviours (e.g., alcohol and drug misuse;

[3] A longitudinal birth cohort study following people born between 1st April 1972 and 31st March 1973 in Dunedin, Aotearoa New Zealand.
[4] Māori are the indigenous peoples of Aotearoa New Zealand.
[5] Pasifika are the indigenous peoples of the Pacific Islands.

Dash et al., 2017). Among rangatahi and their whānau[6], disregarding cultural traditions and protocol for tattooing, drinking and driving with self-injurious intent, and unprotected sex were considered to be forms of NSSI in addition to behaviours like cutting (Kingi et al., 2017). I return to consider the research implications of individual differences in conceptualisations of NSSI in Chapter 3. For a comprehensive exploration of self-injury in rangatahi see Kingi and colleagues (2017).

Theories of non-suicidal self-injury

Next, I provide a brief overview of three prominent models of NSSI. Although there are several other models of NSSI (e.g., the Benefits and Barriers Model: Hooley & Franklin, 2018; the Emotional Cascade Theory: Selby & Joiner, 2009; and the Opioid Deficiency Model: Stanley et al., 2010), here I focus on three which share the assertion that an amplified response to emotional challenge and impaired regulation of that response creates the context in which an individual may choose to manage their emotional experiences with NSSI. Models are presented chronologically for clarity.

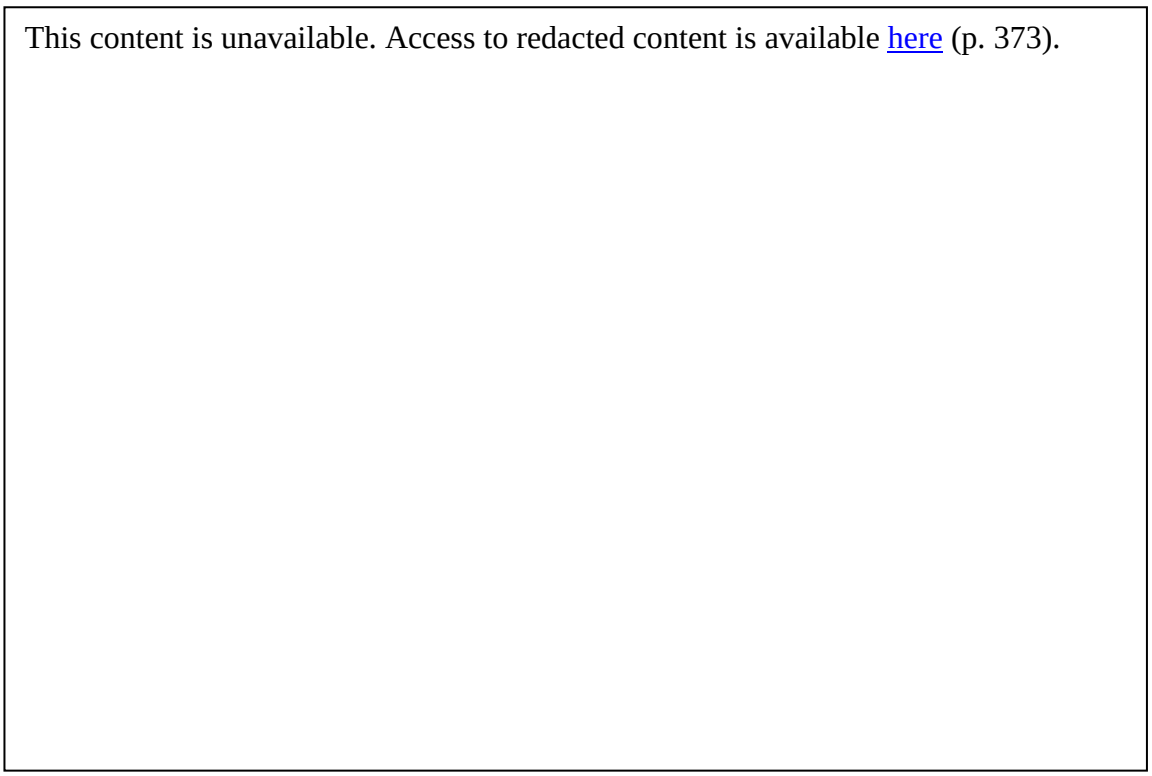
The Experiential Avoidance Model

The Experiential Avoidance Model (Chapman et al., 2006) is the original model that influenced my thinking in this thesis. In this model, individual differences in emotional functioning are key components which create the context in which a person self-injures. As demonstrated in Figure 1, when a person encounters an emotional challenge, individual risk factors such as high emotion intensity and a deficit in emotion regulation skills create an overwhelming emotional response which the person is then motivated to end. Self-injury is one way to escape or avoid these unwanted emotional experiences, and the act of self-injuring provides temporary relief. This escape from aversive states then negatively reinforces the behaviour, so that the person is more likely to self-injure in future emotional contexts.

[6] Te Reo Māori is an official language of Aotearoa New Zealand and so this thesis will use te reo words where appropriate, with definitions provided the first time a word is used. Rangatahi refers to Māori youth, and whānau refers to families.

Figure 1

The Experiential Avoidance Model of Deliberate Self-Injury (Chapman et al., 2006)



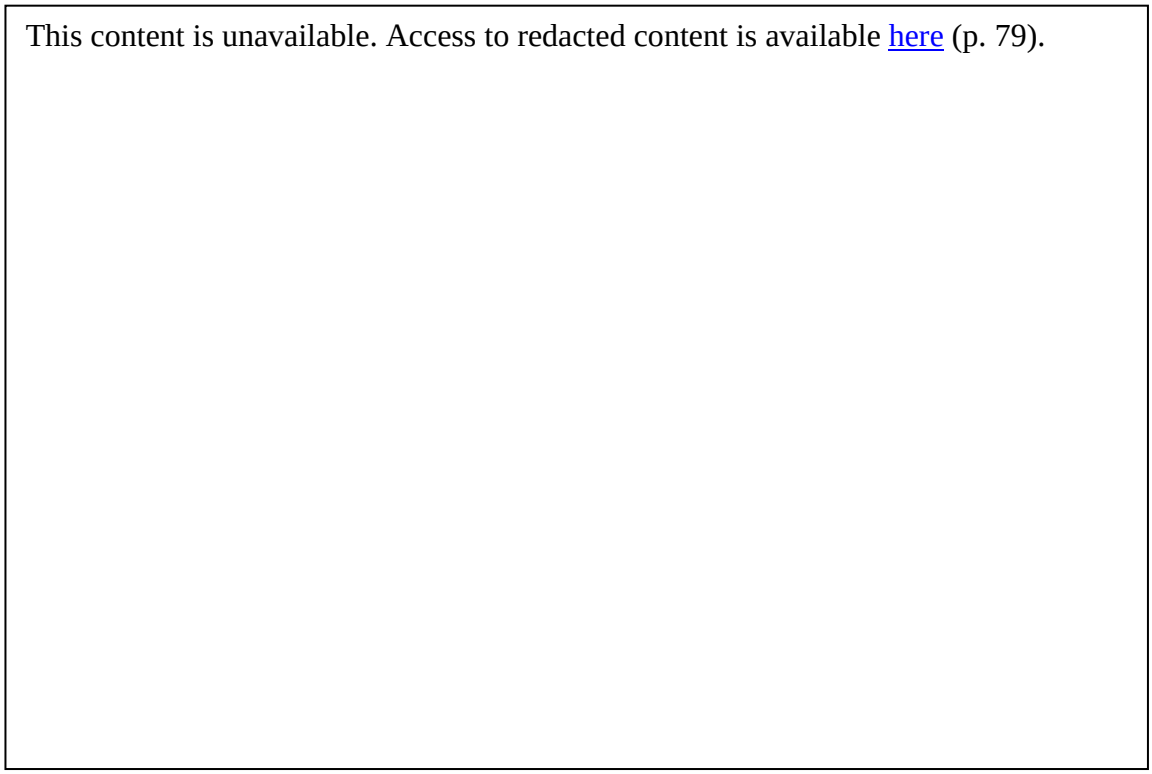
The Integrated Theoretical Model

The Integrated Theoretical Model of NSSI (Nock, 2009; see Figure 2) retains several aspects of the Experiential Avoidance Model. Again, individual differences in emotional functioning (e.g., high emotion reactivity, a greater tendency to experience highly aversive emotions), in combination with poor regulation skills (e.g., poor social problem solving and distress tolerance) creates the context for NSSI. The combination of distal risk factors (e.g., genetic contributions to reactivity) and intra- and interpersonal vulnerability factors create an altered emotional response to challenge. Again, as in the Experiential Avoidance Model, engaging in NSSI allows an individual to regulate this stress response, with the Integrated Theoretical Model distingushing between regulation of affective[7] and social domains. In comparision to the Experiential Avoidance Model, the Integrated Theoretical Model includes the ability for NSSI to both up *and* down-regulate experiences, and offers greater

[7] Affect is an umbrella terms for a broad range of psychological states involving a positive/negative valuation such as stress responses, short-term emotions (e.g., anger), and longer-term mood states (e.g., feeling grumpy; Gross, 2015a).

Figure 2

The Integrated Theoretical Model of Non-Suicidal Self-Injury (Nock, 2009)



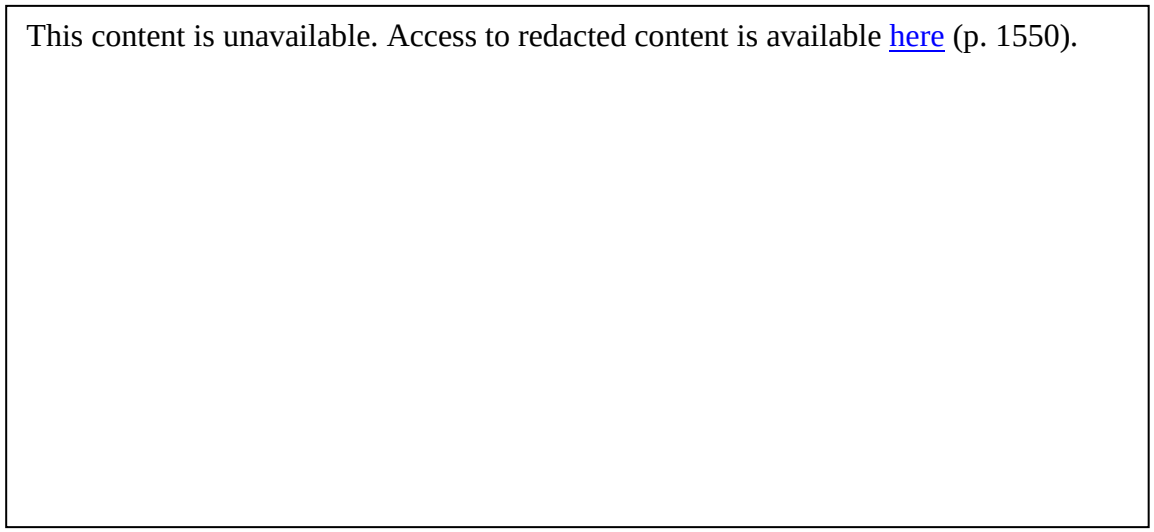
consideration of the factors which may lead an individual to choose NSSI over other emotion regulation strategies.

The Cognitive–Emotional Model

The final model of NSSI that I describe here is the Cognitive–Emotional Model of NSSI (Hasking et al., 2016; see Figure 3). Like both previous models, the Cognitive–Emotional Model proposes that individual differences in emotion reactivity interact with other risk factors (e.g., NSSI-related cognitions and representations of the self) to create the context for NSSI. Again, during emotional challenge, poorer emotion regulation skills (e.g., less engagement in cognitive reappraisal, greater engagement in expressive supression, fewer alternative emotion regulation strategies) creates the context in which an individual engages in NSSI to regulate their experiences. Over and above emotional responding, the Cognitive–Emotional Model emphasises the importance of cognitions and beliefs about both NSSI (e.g., ‘I expect that NSSI will help me feel better’) and the self (e.g., ‘I become out of control when I’m upset’).

Figure 3

The Cognitive–Emotional Model of Non-Suicidal Self-Injury (Hasking et al., 2016)



NSSI as an emotion regulation strategy

Although there are many ways in which NSSI may operate as an emotion regulation strategy (see also, Mckenzie & Gross, 2014), most of the empirical research in this area has focused on understanding the ability of NSSI to repair negative mood. Experience sampling studies tracking NSSI in daily life have demonstrated that NSSI episodes are often preceded by highly negative emotional states, particularly guilt, anger, and shame, which dissipate in the hours following NSSI (Armey et al., 2011; Kiekens et al., 2020; Muehlenkamp et al., 2009; Nock et al., 2009).[8]

Taking a more mechanistic approach, laboratory studies have investigated the impact of experimental proxies for NSSI, such as cold, heat, or pressure pain, on immediate mood and cognition. Several studies have demonstrated that the *offset* of a painful stimulus reduces negative affect (Bresin & Gordon, 2013; Franklin et al., 2014), particularly for people who report greater self-criticism (Fox et al., 2017) and greater global emotion reactivity (Bresin et al., 2010). Notably, this decrease in negative affect following pain offset has been observed among people with and without a history of NSSI (Bresin & Gordon, 2013; Bresin et al., 2010; Franklin et al., 2010; Fox et al., 2017), suggesting that the affect regulatory function of

[8] The functionality of NSSI has, in part, led to calls to move away from describing NSSI as a 'maladaptive coping strategy' (Hasking et al., 2018, Hasking, Lewis & Boyes, 2019). NSSI is effective at helping people cope in the short term and may occur in instances where other strategies are unknown or inaccessible. Thus, labelling NSSI as 'maladaptive' ignores the context in which the behaviour takes place. Indeed, the broader field of emotion continues to debate whether *any* isolated emotion regulation strategy can be termed 'adaptive' without taking into account the context in which it occurs (for discussion, see Aldao et al., 2010, 2015; Tamir, 2011).

NSSI operates through a generalised mechanism shared among people with and without psychopathology. Taken together, experience sampling and experimental manipulations of NSSI-proxies demonstrate the effectiveness of NSSI as a strategy for regulating affective states.

A wealth of research has also considered the reasons people give for engaging in NSSI. Systematic reviews and meta-analyses of the self-reported functions of NSSI typically differentiate functions into two superordinate classes; intrapersonal functions and interpersonal functions (Klonsky, 2007; Klonsky & Glenn, 2009; Taylor et al., 2018). Intrapersonal functions describe patterns of self-focused NSSI reinforcement, specifically: regulating affect; enacting self-punishment motivations; preventing dissociation; preventing suicidal thoughts and behaviours; marking distress; and self-care (Klonsky & Glenn, 2009). In contrast, interpersonal functions describe patterns of social reinforcement, specifically: demonstrating autonomy; marking interpersonal boundaries; interpersonal influence; bonding with peers; enacting revenge motivations; sensation-seeking; and demonstrating toughness (Klonsky & Glenn, 2009). These functions are typically assessed with the Inventory of Statements About Self-Injury (Klonsky & Glenn, 2009; Klonsky et al., 2015).

Emotions are a central theme across both superodinate 'families' of NSSI functions. Intrapersonal functions focus on the role of NSSI in regulating internal states in general, and emotional states in particular. The affect regulation function of NSSI—at face value, the function most closely aligned with emotion regulation—focuses on NSSI as a strategy for *down*-regulating emotions (e.g., *'When I self-injure, I am calming myself down'*; Klonsky & Glenn, 2009). In contrast, the anti-dissociation function focuses on NSSI as a strategy for *up*-regulating emotions (e.g., *'When I self-injure, I am trying to feel something [as opposed to nothing] even if it is physical pain'*; Klonsky & Glenn, 2009). Other intrapersonal functions focus on NSSI as a behavioural expression of negative affect in general (marking distress function, e.g., *'When I self-injure, I am signifying the emotional distress I'm experiencing'*; Klonsky & Glenn, 2009) or negative self-focused affect in particular (self-punishment function, e.g., *'When I self-injure, I am expressing anger towards myself for being worthless or stupid'*; Klonsky & Glenn, 2009). Thus, the intrapersonal functions of NSSI can serve to up-regulate, down-regulate, or express affective states.

The interpersonal functions of NSSI work to modify the social situation of the individual. These social modifications often serve emotional goals and have flow-on effects for the person's emotional world. A perceived disconnect between real and desired interpersonal states is an emotional challenge in general, and interpersonal functions

represent attempts to reduce this disconnect. For instance, the peer bonding function focuses on NSSI as a strategy for up-regulating social connections and expectations (e.g., *'When I self-injure, I am creating a sign of friendship or kinship with friends or loved ones'*; Klonsky & Glenn, 2009). In contrast, the interpersonal boundaries function focuses on NSSI as a strategy for down-regulating social connections and expectations (e.g., *'When I self-injure, I am establishing a barrier between myself and others'*; Klonsky & Glenn, 2009). Lastly, the revenge function focuses on NSSI as a strategy to achieve a specific emotional goal *for others* (i.e., using the aversiveness of NSSI in an attempt at co-regulation, e.g., *'When I self-injure, I am getting back at someone'*; Klonsky & Glenn, 2009). Thus, emotion and emotion regulation are themes that run through both intrapersonal and interpersonal 'families' of NSSI functions.

Given the importance of emotion and emotion regulation in understanding NSSI, I now provide a pragmatic review of emotion, emotion regulation, and emotion dysregulation in order to ground this thesis in the broader field of affective science.

What are emotions?

Emotions represent the coordinated activity of subjective, physiological, and behavioural systems that prepare us to deal with challenges; filtered through our appraisal of the situation and reflecting our personal histories (Feldman Barrett, 2009; Scherer, 2009). Emotions interrupt and capture our attention (for review, see Okon-Singer et al., 2013), motivating us to action and enabling us to respond to evolutionarily critical stimuli in our environment (Bradley & Lang, 2007). That is, emotions are functional—they provide us with a useful channel of information about ourselves in the world.

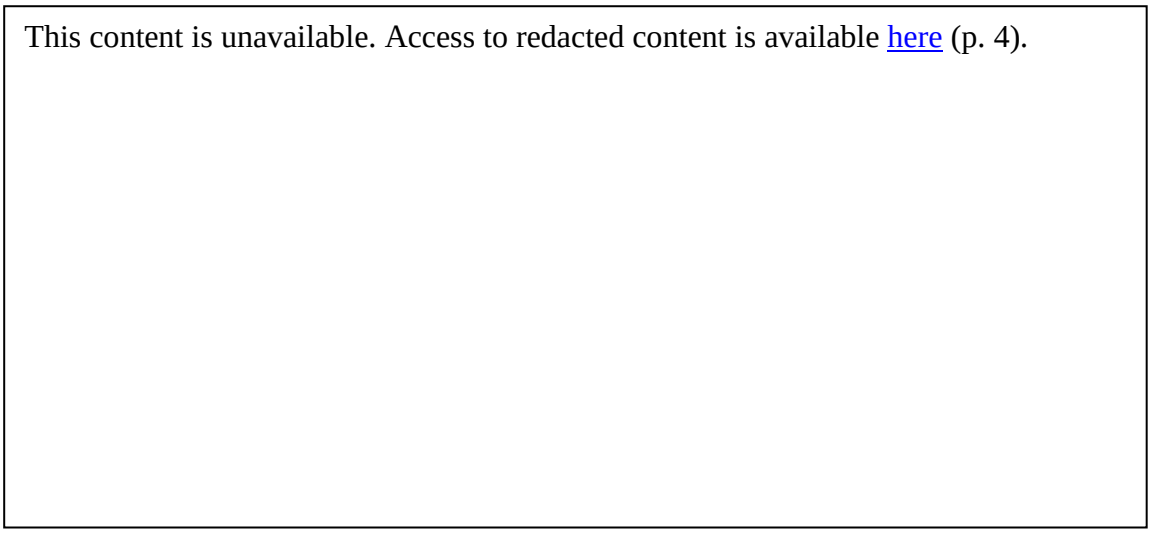
Emotion generation

Emotions are inherently biological phenomena orchestrated by a range of unique and shared neurological mechanisms (for reviews, see Hajcak et al., 2010; Ochsner et al., 2014; Phillips et al., 2003). In this thesis, I conceptualise emotions from an appraisal perspective (as opposed to basic emotion, psychological construction, or social construction perspectives of emotion, for review see Gross & Feldman Barrett, 2011). The appraisal perspective proposes that emotions are generated when a person attends to a stimulus (whether external or internal), appraises it as relevant to their goals, which then creates an emotional response (see Panel A of Figure 4; Gross et al., 2011; Gross & Thompson, 2007; Moors et al., 2013). This emotional response may then create or modulate the situation (whether external or internal),

Figure 4

The Modal Model of Emotion (A), demonstrating how the emotion generation process may unfold and influence itself over time (B; Gross, 2015a)

A **B**



which may then start a second cycle of emotion generation (see Panel B of Figure 4). Critically, the emotional response is multi-modal and occurs across subjective, physiological, and behavioural channels.

Subjective channels. Subjective channels of emotion comprise the experiential 'feeling' of an emotion, for instance, of anger, joy, or belligerence. Subjective experiences of emotion are typically assessed using questionnaires (e.g., the Positive and Negative Affect Scale; Watson et al., 1988) or visual analogue scales which ask an individual to report the extent to which they experienced a specific mood (e.g., anger) or dimension (e.g., arousal) of subjective affect. Subjective experiences are typically conceptualised along two dimensions; arousal which refers to the perceived energy of the experience and range from activated to deactivated, and valence which refers to the hedonic nature of the experience and ranges from pleasant to unpleasant (Russell, 1980). However, analysis of the relationships between subjective ratings of more than two thousand video clips found 27 distinct varieties of emotional experiences (Cowen & Keltner, 2017), suggesting that the structure of emotional experiences is complex and more nuanced than can be easily captured in two dimensions.

Physiological channels. Physiological channels of emotion comprise changes in the activity of the autonomic nervous system and its effect on bodily functions, such as heart rate,

digestion, and respiratory rate. The autonomic nervous system has two branches: the sympathetic nervous system which broadly functions to activate bodily resources, and the parasympathetic nervous system which broadly functions to conserve bodily resources (for a comprehensive review of the anatomy, physiology, and pharmacology of the autonomic nervous system, see Wehrwein et al., 2016). Both branches of the autonomic nervous system work in tandem to maintain homeostasis—allowing our body to respond optimally in the specific environment (Levenson, 2014).

Self-injury research typically assesses autonomic functioning using measures of skin conductance, heart rate, and heart rate variability (specifically, respiratory sinus arrhythmia; RSA). Measures of skin conductance capture the change in the electrical conductivity of the skin due to sweat gland secretion which is activated by the sympathetic nervous system. Skin conductance is sensitive to emotional arousal, but not valence (Bradley et al., 2001). In contrast, heart rate reflects the dual influence of both the parasympathetic and sympathetic branches of the autonomic nervous system. Heart rate typically accelerates in response to emotional challenge such as stress (Kreibig, 2010). Heart rate variability and RSA are two additional measures of cardiovascular functioning. Heart rate variability captures moment-to-moment changes in the interval between heart beats (i.e., heart rate) and is influenced by both the sympathetic and parasympathetic nervous system. The sympathetic nervous system produces slow changes in heart rate (and therefore low frequency heart rate variability), whereas the parasympathetic nervous system produces rapid changes to calibrate cardiac output precisely to match metabolic demands (therefore measured in high frequency heart rate variability). RSA provides one measure of high frequency heart rate variability and captures the fluctuation in heart rate that occurs with the inhalation and exhalation cycle of respiration. RSA is thought to be a biological marker of emotion dysregulation (Beauchaine, 2015b; Beauchaine & Thayer, 2015), with lower tonic RSA indexing less cardiac responsivity to momentary changes (i.e., less potential for regulation).

In addition to the autonomic nervous system, the hypothalamic–pituitary–adrenal (HPA) axis plays a key role in physiological responding to emotional challenge. In general, the HPA axis functions to coordinate physiological and behavioural responses to, and recovery from, stress; notably through the secretion of glucocorticoids such as cortisol. Basal cortisol and changes in cortisol in response to emotional challenge thus provide an index of HPA axis functioning. Atypical HPA axis functioning (either hyperreactivity or hyporeactivity) has been linked to psychopathology, including depression (e.g., Lopez-Duran

et al., 2009), posttraumatic stress disorder (Yehuda et al., 2002), and a history of suicide attempts (O'Connor et al., 2016).

Behavioural channels. Lastly, behavioural channels of emotion comprise changes in behaviour. For instance, when angry a person may frown, cross their arms, and lean back in their chair. Within the affective science field, measures of behavioural responding tend to be less common than subjective and physiological measures (e.g., Webb et al., 2012). Within the NSSI field, research investigating behavioural channels of emotion typically focus on facial behaviour using either observers' ratings of facial behaviour or facial electromyography (EMG). Observer ratings use established coding systems (e.g., Facial Action Coding System; Ekman & Rosenberg, 1997) to assess the frequency of either facial movement in general, or of specific facial behaviours. Facial EMG is largely localised to measuring activity in the zygomatic muscle which raises of the corners of the lips, and the corrugator supercilii which draws the eyebrow downward and medially. Both muscles are sensitive to emotional valence; zygomatic activity increases with the pleasantness of stimuli, whereas corrugator activity increases with the unpleasantness of stimuli (for a review, see Mauss & Robinson, 2009).

Functional models of emotions (e.g., Ekman, 1992; Levenson, 2014) argue that emotional concordance, the synchronization and coordination of subjective, behavioural, and physiological channels of emotion, allows us to more effectively respond to emotional challenges in our internal or external environment. However, counter to predictions of an integrated emotional response, divergence across and within response channels appears to be the rule rather than the exception (Hollenstein & Lanteigne, 2014; Lougheed et al., 2021; Mauss et al., 2005; Tooley et al., 2017). Given the lack of coherence across channels of emotion, multi-channel assessments are needed to develop a more complete understanding of the emotional response.

Emotion regulation

The emotional response is highly malleable through emotion regulation processes—defined as the behaviours, skills, and strategies, whether automatic or effortful, which function to modulate, inhibit, and enhance emotional experiences and expressions (Gross, 1998; Gross et al., 2011; Tamir, 2011). Although evidence from neuroscience demonstrates that emotion generation and emotion regulation are separable cognitive processes (for review, see Ochsner & Gross, 2005), it is worth emphasising that often (but not always) these

processes occur in parallel and so may not be temporally distinguishable (for review, see Gross et al., 2011).

The emotional response is dynamic, and the Process Model of Emotion Regulation (Gross, 1998, 2015b) emphasises that cognitive and behavioural regulation strategies can be employed at different time points to alter different aspects of the emotion-generation process. Figure 5 shows the types of emotion regulation strategies that can be implemented at different stages of the emotion generation process. For instance, distraction is an attentional deployment strategy that operates on the attention component of the generation process and involves the individual moving their focus to different internal or external stimuli. In contrast, cognitive reappraisal is a strategy which operates at the appraisal component of the generation process and involves the reinterpretation of an emotional stimulus. Whereas expressive suppression is a response modulation strategy which operates at the response component of the emotion generation process and involves restraining and concealing the expression and experience of emotion. Consider for instance, a person wanting to reduce their fear during airplane travel. The person could choose to read through the inflight magazine to distract themselves (distraction). Or they could remind themselves of the numerous incredible feats of human endeavour which have allowed humans the ability to fly in order to change their experience from fear into awe (cognitive reappraisal). Or instead, they could make their face blank and act as if they are not afraid (expressive suppression).

Figure 5

The Process Model of Emotion Regulation, demonstrating how emotion regulation strategies can be implemented at different stages of the emotion generation process (Gross, 1998, 2015a)

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Emotion regulation is typically assessed in one of three ways. First, and most commonly, emotion regulation is assessed via global self-report measures of the extent to which a person habitually engages in specific strategies (typically, cognitive reappraisal and expressive suppression; e.g., Ford, Feinberg, et al., 2018; Gross & John, 2003; Hasking et al., 2010). Second, taking advantage of the recent advances in smartphone technology, experience sampling methods capture subjective reactivity and regulation as it unfolds in daily life (e.g., Kiekens et al., 2020; Koval et al., 2013; Scott et al., 2020). Finally, experimental manipulations of emotional challenge allow researchers to assess either the regulation strategies a participant spontaneously implements, or how emotional responding changes following instructions to engage in a specific emotion regulation strategy (e.g., Davis et al., 2014; Hajcak & Nieuwenhuis, 2006; Ray et al., 2010). Intriguingly, recent evidence demonstrates that global self-reports of habitual reappraisal use only partly cohere with self-reported reappraisal use captured with experience sampling methods (Koval et al., 2020), suggesting that methods of assessing emotion regulation should not be used interchangeably. I return to this problem regarding the 'level' of inquiry in Chapter 6.

Emotion regulation strategies are implemented to reach a goal. It stands to reason that not all strategies may be equally effective at reaching this goal. Typically, strategy efficacy is assessed as the extent to which emotional responding changes following emotion regulation.[9] In a meta-analysis of 306 experimental comparisons, emotion regulation strategies differed in their effectiveness across different channels of emotion (Webb et al., 2012). For instance, within the subjective channel, reappraisal impacted subjective feelings (d = 0.45), whereas attentional deployment and expressive suppression strategies did not (Webb et al., 2012). Focusing on the physiological response, meta-analysis demonstrates that reappraisal and suppression instructions during emotional challenge manipulations show small and highly inconsistent effects within physiological response channels (Zaehringer et al., 2020). For instance, cognitive reappraisal resulted in a small decrease (d = -0.09) in heart rate but had no effect on other measures of cardiovascular functioning (e.g., heart rate variability, finger pulse transit time; Zaehringer et al., 2020). These results demonstrate that emotion regulation strategies differentially impact the emotional response, with a high degree of variability across, and within, channels of emotion.

[9] Recently, Daniel and colleagues (2019) argued that assessments of the efficacy of emotion regulation should include the extent to which the individual judges that the strategy has allowed them to meet their regulatory goals. Using experience sampling methods over two weeks, social anxiety severity was negatively associated with *perceived* emotion regulation efficacy but was unrelated to *actual* mood repair (Daniel et al., 2019). This suggests that perceived and actual emotion regulation should not be used interchangeably, but instead offer different insights into the relationship between emotion regulation and psychopathology.

Although researchers tend to examine the efficacy of a single emotion regulation strategy in isolation, in daily life people often use multiple emotion regulation strategies concurrently or sequentially to achieve emotional goal(s) during an emotional event (Ford et al., 2019). Consider the example above in which a person works to downregulate their fear during flying. First, during taxiing and take-off the person may choose to distract themselves by reading a book to provide quick relief from fear. Once the plane is at cruising altitude and the intensity of their fear has reduced, they may transition to a reappraisal strategy. The combination of the 'quick-relief' of distraction paired with the 'long-term relief' of reappraisal may work synergistically to achieve emotion goals more effectively (Ford et al., 2019). Preliminary evidence that the combination of emotion regulation strategies matters for managing mood comes from an experience sampling study assessing mood and emotion regulation among university students three times per day over ten days (Southward & Cheavens, 2020). Students who used more engagement strategies (e.g., reappraisal, acceptance, and problem-solving) both in general, and in the moment, reported improved mood, whereas those who used more *dis*engagement strategies (e.g., denial, expressive suppression, substance use) both in general, and in the moment, reported worse mood (Southward & Cheavens, 2020). Thus, both the *type* of emotion regulation strategy and *how many* emotion strategies an individual used influences their mood.

Emotion regulation strategies and psychopathology

Moving beyond affect dynamics, specific emotion regulation strategies are associated with psychological wellbeing. In a 30-day daily diary study, university students who reported engaging in distraction, cognitive reappraisal, and problem-solving during the day were less likely to report evening substance use (Weiss et al., 2017). Intriguingly, evening substance use also predicted greater odds of next-day avoidance, and lower odds of next-day cognitive reappraisal (Weiss et al., 2017), suggesting a cyclical relationship between emotion regulation strategies and poorer psychological functioning. Habitual use of emotion regulation strategies over extended periods of time is also associated with psychological functioning. Meta-analysis has demonstrated that global self-report measures of habitual emotion regulation strategies are differentially associated with psychopathology (Aldao et al., 2010). In particular, people who habitually engaged in cognitive reappraisal (r = -.14) and problem solving (r = -.31) had lower rates of psychopathology, whereas those who habitually engaged in avoidance (r = .38), rumination (r = .49), and expressive suppression (r = .34) had greater rates of psychopathology (Aldao et al., 2010). Thus, in addition to the short-term

impacts on moment-to-moment affect, habitual use of regulation strategies impacts our psychological functioning.

Emotion dysregulation

Moving outward from specific emotion regulation processes, I now take a broader approach to consider *patterns* of emotion regulation dynamics that contribute to maladaptive emotional functioning. Emotion *dys*regulation is defined as "a deficit in the implicit (e.g., through physiological homeostatic mechanisms) or explicit (e.g., through effortful strategies) regulation of the emotion system that hampers the individual's ability to engage in effective goal- or value-oriented behaviour" (Chapman, 2019, pg. 1145). That is, emotion dysregulation constitutes a pattern of more prolonged or intense emotional responding than typical, along with a reduced capacity to effectively regulate emotions (Beauchaine, 2015a; Cole et al., 2019). This pattern of responding violates sociocultural standards for emotional behaviour and communication, and interferes with well-being goals (Beauchaine, 2015a; Cole et al., 2019). Emotion dysregulation is thought to arise from an interaction between inherited biological risk for impulsivity and high-risk family environments that creates emotional lability and poorer emotion regulations skills (Beauchaine, 2015a).

Theoretical and empirical work has begun to disentangle what it means to be 'emotionally dysregulated'. Emotion dysregulation may result from an individual failing to engage in regulation strategies when it would be helpful for them to do so (i.e., emotion regulation failures), or because they choose to implement emotion regulation strategies that are poorly suited to that specific situation (i.e., emotion mis-regulation; Gross & Jazaieri, 2014). Together, these failures may result in problems in the intensity, duration, frequency, or type of emotion—as always, relative to the situation in which the emotion occurs (Gross & Jazaieri, 2014).[10] For instance, it is reasonable to expect an individual to experience sadness following the death of a beloved pet. In contrast, an expression of anger in this instance would constitute a problematic type of emotion, and thus emotion dysregulation. That is, emotional dysregulation is more than just poor regulation.

Emotion dysregulation is argued to be a transdiagnostic hallmark of psychopathology (Beauchaine, 2015a; Beauchaine & Zisner, 2017; Gross & Jazaieri, 2014). To date, research typically assesses emotion dysregulation using a global self-report scale. The Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) measures six components of

[10] Gross and Jazaieri (2014) emphasise that emotion dysregulation is only one factor which may cause problems in emotional functioning.

emotion dysregulation: lack of emotional clarity, lack of emotional awareness, difficulties engaging in goal-directed behaviour when upset, difficulties controlling impulses when upset, limited access to effective emotion regulation strategies, and nonacceptance of emotional responses (Gratz & Roemer, 2004). Meta-analyses have documented positive associations between global emotion dysregulation and psychopathology, such as attention deficit/hyperactivity disorder (Beheshti et al., 2020), posttraumatic stress symptoms (Seligowski et al., 2015), and NSSI (Wolff et al., 2019; You et al., 2018). Moving beyond the limitations of cross-sectional data, a longitudinal study of community adolescents found that global emotion dysregulation (a latent variable comprised of emotion understanding, rumination, and dysregulated expressions of anger and sadness) predicted increased anxiety, aggressive behaviour and disordered eating over seven months (McLaughlin et al., 2011). In contrast, adolescent psychopathology was unrelated to change in emotion dysregulation over time (McLaughlin et al., 2011). That is, emotion dysregulation appears to be a *predictor* of psychopathology, rather than a *consequence* of living with psychopathology.

Current evidence for the role of emotion in NSSI

Next, I provide an overview of the research investigating the role of emotion in NSSI. I begin by considering the wealth of research on global self-reports of emotional functioning, before considering the limitations of these global measures, moving to focus on studies that track emotions as they unfold in daily-life, and ending with an overview of studies which assess responses to experimental manipulations of emotional challenge.

Global emotional functioning in NSSI

Within the NSSI literature, global emotional functioning is typically measured with self-reports of emotion reactivity and emotion dysregulation. Emotion reactivity describes the sensitivity to emotional stimuli, threshold, intensity, peak, and duration of an emotion (Davidson, 1998; Nock et al., 2008).[11] Global emotion reactivity is typically assessed with the Emotion Reactivity Scale (ERS; Nock et al., 2008) which includes items such as *'I tend to get very emotional very easily'* and *'When I experience emotions, I feel them very strongly/intensely'*. As described above, global emotional dysregulation is typically assessed with The Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) which includes items such as *'When I'm upset, I believe that I will remain that way for a long time'* and *'When I'm upset, I become out of control'*.

[11] Note that emotional dysregulation incorporates greater emotion reactivity. I use both global emotion reactivity and global emotion dysregulation in this thesis to maintain consistency with the wider NSSI literature.

A wealth of research has established that global self-reports of emotional functioning hold considerable utility in understanding NSSI. Across two meta-analyses, both global self-reports of emotion reactivity (odds ratio [OR] = 2.46) and dysregulation (OR = 3.03) showed strong associations with NSSI (Wolff et al., 2019; You et al., 2018). In addition, all six dimensions of the DERS were associated with NSSI, although limited access to emotion regulation strategies, non-acceptance of emotional responses, and impulse control difficulties showed the strongest associations (Wolff et al., 2019; You et al., 2018). In particular, emotion dysregulation in NSSI seems to be localised to negatively-valenced emotional experiences; compared to young women with no history of NSSI, those with a recent NSSI history reported greater global difficulties regulating negative affect (e.g., anger), but no difference in regulating positive affect (e.g., joy; Mettler et al., 2021). Moving beyond cross-sectional studies, a meta-analysis of six longitudinal samples found that affect dysregulation prospectively predicted NSSI, although the effect size was weak (OR = 1.05; Fox et al., 2015). More recently, longitudinal studies have also documented evidence for the inverse relationship; engaging in NSSI predicted subsequently poorer emotional functioning with adolescent (Robinson et al., 2019) and adult samples (Ewing et al., 2019). Together, this suggests that poorer global emotional functioning creates the context for NSSI, and that engaging in NSSI subsequently impacts global emotional functioning.

A growing body of research has also demonstrated that improvements in global self-reports of emotional functioning may lead to reductions in NSSI. Given prominent theoretical models of NSSI (as reviewed above), many therapeutic treatments for reducing NSSI focus on reducing emotion dysregulation (e.g., Emotion Regulation Group Therapy, Gratz & Tull, 2011; Dialectical Behaviour Therapy, Rathus & Miller, 2015). In particular, Dialectical Behaviour Therapy for Adolescents (DBT-A), which is designed in part to scaffold distress tolerance and emotion regulation skills, has demonstrated success in reducing self-injury in two meta-analyses of randomised control trials and controlled clinical trials (Kothgassner et al., 2020, 2021). Secondary analysis of a DBT-A randomized control trial demonstrated that reductions in global emotion dysregulation mediated the relationship between DBT-A treatment and reduced self-injury, highlighting emotion dysregulation as a treatment target (Asarnow et al., 2021). In addition, DBT-A may be most beneficial for those who report greater emotion dysregulation prior to intervention (Adrian et al., 2019). Thus, evidence from cross-sectional, longitudinal, and clinical intervention research suggests that NSSI is characterised by greater global emotion reactivity and dysregulation.

The limitations of global self-reports.

As valuable as global self-reports of emotional functioning are for our understanding of NSSI, they are not without four critical limitations. First, global self-reports provide an overall evaluation of an individual's *average* affective experience, but emotions are dynamic and show considerable variation over both short (i.e., minutes) and long (i.e., days) timescales. Second, global self-reports are retrospective judgements that rely, in part, on heuristics that introduce bias. For instance, people in a happy mood are better able to recall positive information while people in a sad mood are better able to recall negative information (i.e., mood-congruent memory effects; Ebner-Priemer et al., 2006; Mayer et al., 1995). Agreement between real-time changes in subjective mood and retrospective recall is only slight (κ range from < .01 to .04; Solhan et al., 2009), suggesting that real-time and retrospective reports should not be used interchangeably. Third, global self-reports of emotional functioning capture only subjective channels of emotion, leaving unclear how physiological and behavioural channels—critical aspects of emotion—respond in people who self-injure. Finally, global self-reports are likely confounded by the frequency and intensity of emotional challenges in an individual's life. This is particularly problematic for group comparisons of global emotion functioning by self-injury status, as people who engage in NSSI are disproportionately more likely to experience adverse life events that generate intense emotional experiences (e.g., childhood maltreatment, peer bullying, trouble with parents) than those with no history of NSSI (Brown et al., 2018; Kaess et al., 2019). Greater *frequency* of intense negative emotions may then be (mis)interpreted as greater reactivity and/or dysregulation. These limitations mean that global self-reports of emotional functioning are unable to disentangle precise alterations in emotional responding.

Emotions in daily life

One approach that tests for differences in emotional responding in NSSI uses experience sampling methods to track how mood unfolds in daily life. One such study assessed momentary affect in hourly intervals over two weekends among adolescent young women who had engaged in five or more incidents of NSSI in the past year, and an age and gender-matched control group with no history of NSSI (Santangelo et al., 2017). Compared to the Control group, the NSSI group reported greater variability in their mood (i.e., greater affective instability; Santangelo et al., 2017).[12] In a similar manner, past-year NSSI behaviour

[12] It is worth noting that 73% of the NSSI group in this study met the diagnostic criteria for BPD (Santangelo et al., 2017). As a diagnostic group, people with a BPD diagnosis show greater affective instability in daily life

predicted greater amplitude and variability in negative affect among young women who reported their momentary affect in response to seven survey prompts per day, over a 3-week period (Victor et al., 2021). Taken together, preliminary evidence from experience sampling studies suggests that people who engage in NSSI experience greater affective instability in daily life.

However, experience sampling methods are poorly suited to test whether the emotion response system is altered in NSSI for two reasons. First, the methods for concurrently assessing physiological responding in daily life are still under development (e.g., Kleiman et al., 2019; Van Doren et al., 2021). Thus, current well-established experience sampling procedures capture only subjective channels of emotion. Second, assessing emotional responding in daily life provides no control over the nature or intensity of emotional challenges an individual may experience. As discussed above, people who engage in NSSI are disproportionately more likely to experience adverse life events than those with no history of NSSI (Brown et al., 2018; Kaess et al., 2019).[13] Without the control provided by experimental manipulation, it is difficult to establish whether people who engage in NSSI experience emotional challenges of the same nature and intensity as people without a history of NSSI.

Responding to emotional challenge manipulations

Experimental studies allow for multi-modal assessment of real-time emotional responding and provide precise control over the nature and frequency of emotional challenge, making them well suited to stringently test whether NSSI is characterised by alterations in emotional responding. As in all experiments, the choice of manipulation is an important one. Given that people typically engage in NSSI to downregulate unpleasant experiences (Edmondson et al., 2016; Klonsky & Glenn, 2009) and report global emotion dysregulation largely when experiencing unpleasant emotions (Wolff et al., 2019; You et al., 2018), the majority of research in this area has focused on responding to emotional challenges (although see, Boyes et al., 2020; Mettler et al., 2021). Given that there are only 14 studies which assess emotional responding in NSSI, I made the pragmatic decision to also include in this review

compared to control, depressive disorder, and bipolar disorder groups (Ebner-Priemer et al., 2015; Houben & Kuppens, 2020; Mneimne et al., 2016). Indeed, in this study the number of BPD criteria each participant met was positively correlated with their affective instability (Santangelo et al., 2017), leading Hooley and Franklin (2018) to suggest that the difference in affective dynamics by NSSI status may be due to the high degree of BPD symptoms in this group.

[13] It is also worth noting that adverse life events and psychopathology have bidirectional effects (for review, see Hammen, 2006)—engaging in NSSI may also create additional adverse life events for an individual.

studies which conceptualised self-injury as deliberate self-injury (i.e., including suicide attempts and NSSI within the same category). I decided against including experiments focused on participants with a BPD diagnosis, unless NSSI or self-injury was an inclusion criterion (e.g., Gratz et al., 2019), because a BPD diagnosis does not necessarily indicate a history of self-injury (e.g., Nock et al., 2006).

Unfortunately, not all studies which experimentally induced emotion among people with and without a history of self-injury are able to inform our understanding of emotional responding in self-injury. First, several studies failed to include a baseline measure of emotion, either in general (Kim et al., 2015), or for a specific emotional channel (e.g., behavioural responding; Kaufman et al., 2019; Nock & Mendes, 2008). Without a baseline comparison, it is unclear whether any difference by self-injury status is due to a difference in *reactivity* to emotion or a greater basal level response in general. Group-level differences have been observed in subjective and physiological channels of emotion (e.g., Crowell et al., 2005; Kaufman et al., 2019; Plener et al., 2017). For instance, Kaufman and colleagues (2019) found that people with a history of self-injury reported higher negative affect and lower positive affect on arrival to the laboratory compared to controls. Although these group-level differences tell us about overall emotion, they can tell us little about emotion reactivity or recovery because they do not capture changes in emotion over time. A second difficulty arises because some studies report that their physiological measures of responding were not sensitive to the emotional challenge manipulation. For instance, although Gratz and colleagues (2019) found that negative affect increased from baseline following an audio-guided imagined social-rejection, the emotional challenge did not influence skin conductance responses or heart rate variability. Within these studies, these measures are unable to shed light on emotional responding in self-injury, because there was no emotional response with which to compare the Control and Self-Injury groups. Thus, evidence of altered reactivity or recovery in self-injury comes only from an *interaction* between self-injury status and emotional challenge.

Given these difficulties, I focus here on the published studies which: i) included both a Self-Injury group and a Control group with no history of self-injury; ii) manipulated emotional challenge; iii) assessed emotional reactivity and/or recovery across subjective, physiological, and/or behavioural channels; iv) assessed responding both pre-, during, or post-emotional challenge; and v) demonstrated that the emotional challenge was effective (for each measure). See Table 1 for an overview of the design charactertics and key findings

of the 19 studies that met these criteria. [14] In the next section of this chapter, I provide a narrative review of this research.

Single channel assessments of real-time emotional reactivity

A third (37.8%, $k = 7$) of studies in this area has focused exclusively on how people who self-injure subjectively react to emotional challenge. Evidence for an amplified emotional response in these studies is mixed. Young adults with a lifetime history of NSSI as well as current BPD experienced greater increases in negative affect to imagined social rejection than the No NSSI group (Gratz et al., 2019). In the same study, young adults with a lifetime history of NSSI *without* BPD did not differ in their subjective reactivity to the emotional challenge compared to both the comorbid NSSI and BPD group or the No NSSI group (Gratz et al., 2019). Other research has failed to find any differences in subjective responding to emotional challenge. In two studies using a computerised social exclusion ball-tossing game, both people with a lifetime history of NSSI (compared to those with no lifetime history; Schatten et al., 2015) and people with both depression and recent NSSI (compared to a depression only group and a healthy control group; Groschwitz et al., 2016) failed to find any evidence of differences in reactivity. Other research has found no difference in how people who self-injure subjectively respond when asked to write about a time in which they became extremely angry (Weinberg & Klonsky, 2012), or to personalised scripts detailing interpersonal distress (Gratz et al., 2011) or criticism from a loved one (Allen et al., 2019). In one study, young adults with a lifetime history of NSSI reported *less* subjective reactivity when writing about a personal failure than did those without a history of NSSI (Bresin & Gordon, 2013).

[14] Search concluded 1st June 2021.

Table 1

Overview of the studies (k = 19) which experimentally assessed how people who self-injure respond to emotional challenge

Study	Recruitment setting	*N* (Self-injury *n*)	Self-injury status criteria	Age *M* (*SD*)	% Female	Emotional challenge	Emotional channel (measure)	Reactivity/ recovery	Evidence for altered reactivity or recovery
Allen et al. (2019; Study 1)[a]	USA community	64 (33)	*NSSI:* Lifetime NSSI. *Control:* No history of NSSI, suicidal self-injury, psychiatric illness, or treatment.	*NSSI:* 22.45 *Control:* 23.71	*NSSI:* 75.8% *Control:* 67.7%	Iowa Gambling Task modified to include regular verbal criticism, ostensibly from a loved one.	Subjective (Negative affect)	Reactivity	No evidence.
Boyes et al. (2020)[b]	Australian undergraduates	214 (76)	*NSSI:* Lifetime NSSI. *Control:* No NSSI history.	21.33 (5.49)	73.8%	Sadness film clip	Subjective (Sadness ratings)	Reactivity and recovery	*Reactivity:* NSSI group responded less intensely to the emotional challenge than did the Control group. *Recovery:* NSSI group showed less recovery from emotional challenge than did Control group.
Bresin and Gordon (2013)	USA undergraduates	115 (59)	*NSSI:* Lifetime NSSI. *Control:* No NSSI history.	19.48 (2.53)	56.5%	Write about a specific personal failure.	Subjective (Negative affect)	Reactivity	Control group showed greater subjective reactivity than did the NSSI group.
Crowell et al. (2005)	USA inpatient, outpatient, and community	46 (23)	*DSH:* ≥3 DSH behaviours in past 6 months, or ≥5 lifetime DSH events. *Control:* No lifetime DSH, current substance or alcohol abuse/dependence disorders, psychotropic medications, or lifetime Axis I disorder.	15.3 (1.1)	100%	Sadness film clip	Physiological (EDR, RSA) (NB. PEP not sensitive to emotional challenge).	Reactivity & recovery	*Reactivity:* DSH group showed greater RSA reductions during emotional challenge than the Control group. No evidence in EDR. *Recovery:* No evidence in RSA or EDR.

Continued…

Study	Recruitment setting	*N* (Self-injury *n*)	Self-injury status criteria	Age *M* (*SD*)	% Female	Emotional challenge	Emotional channel (measure)	Reactivity/ recovery	Evidence for altered reactivity or recovery
Davis et al. (2014; Study 1)	USA community	111 (25)	*DSH:* Lifetime DSH. *Healthy control:* low depression and anxiety symptoms, no DSH history. *Depression control*: matched to DSH group on depression and anxiety symptoms, no DSH history.	*DSH:* 39.5 (9.3) *Depression Control:* 43.5 (10.2) *Healthy Control:* 42.2 (10.9)	*DSH:* 36.0% *Depression Control:* 42.9% *Healthy Control*: 45.9%	Sadness film clip	Subjective (Negative affect; sadness)	Reactivity & instructed recovery	*Reactivity:* No evidence. *Recovery:* DSH did not reduce their negative emotion following reappraisal instructions, whereas the Healthy Control and Depression Control groups did.
Glenn et al. (2011)	USA undergraduates	78 (41)	*NSSI:* Lifetime NSSI. *Control:* No NSSI history.	19.98 (1.99)	73.2%	Emotional images	Behaviour (Startle eye blink)	Reactivity	No evidence.
Gratz et al. (2011)	USA community	47 (21)[b]	*NSSI:* Past-year NSSI. *Control:* No NSSI history.	*NSSI:* 19.30 (1.73) *Control:* 20.04 (1.73)	71.6%	Personalised interpersonal distressing script	Subjective (Negative affect)	Reactivity	No evidence.
Gratz et al. (2019)	USA and Canadian community	64 (NSSI + BPD: 21; NSSI - BPD: 18)	*NSSI + BPD:* Lifetime NSSI with threshold or subthreshold BPD. *NSSI - BPD:* Lifetime NSSI without threshold or subthreshold BPD. *No NSSI:* A lifetime psychiatric disorder or psychological treatment history, with no NSSI history.	23.94 (4.79)	72.0%	Audio-guided imaged social-rejection scenario	Subjective (Negative affect) (NB. Neither SCR nor HRV measures were sensitive to emotional challenge).	Reactivity	NSSI + BPD group demonstrated greater subjective emotional reactivity than the No NSSI group. The NSSI - BPD group did not differ in subjective reactivity from both groups.

Continued…

Study	Recruitment setting	*N* (Self-injury *n*)	Self-injury status criteria	Age *M* (*SD*)	% Female	Emotional challenge	Emotional channel (measure)	Reactivity/ recovery	Evidence for altered reactivity or recovery
Groschwitz et al. (2016)	German inpatient and outpatient	43 (14)	*Depression + NSSI:* Major depression diagnosis, ≥5 NSSI acts in past year. *Depression:* Major depression diagnosis, no NSSI within past year. *Healthy Controls:* No lifetime history of psychiatric disorder.	*Depression + NSSI:* 15.4 (1.9) *Depression:* 15.9 (1.6) *Healthy Controls:* 14.5 (1.7)	79.0%	Cyberball social exclusion ball-tossing game	Subjective (anger, frustration, content)	Reactivity	No evidence.
Kaess et al. (2012)	German inpatient, outpatient, and community	28 (14)	*NSSI:* Repetitive NSSI. *Control:* No current or previous psychiatric disorder, and no lifetime NSSI history.	*NSSI:* 16.6 (1.7) *Control:* 16.3 (2.2)	100%	Trier Social Stress Test	Subjective (Negative affect, Positive affect). Physiology (HR; Salivary cortisol)	Reactivity and recovery (for cortisol only)	NSSI group showed attenuated cortisol reactivity. No evidence in subjective mood or heart rate.
Kaufman et al. (2019)	USA outpatient, inpatient, community	60 mother-daughter dyads (30 dyads)	*DSH:* 3 or more instances of self-injury. *Control:* No current or previous psychiatric disorder and no lifetime DSH history.	*DSH:* 15.47 (1.48) *Control:* 14.77 (1.33)	100%	Conflict discussion with mother	Subjective (Negative affect, Positive affect) Physiology (RSA) (NB. Observers ratings of behaviour had no baseline measure)	Reactivity	DSH group reported more negative emotions and fewer positive emotions following conflict compared to Control group. No evidence in RSA.
Mayo et al. (2021)	Swedish community and patients at a psychiatric clinic	60 (30)	*NSSI:* ≥5 NSSI acts in past 6 months. *Control:* No past-year Axis I or II disorder and no lifetime NSSI history.	*NSSI:* 15.9 (0.8) *Control:* 16.4 (0.9)	100%	Picture viewing task (positive, negative, neutral)	Subjective (valence, arousal) Behaviour (facial EMG: corrugator, zygomatic)	Reactivity	No evidence in subjective ratings of arousal or valence. NSSI group showed greater corrugator reactivity to negative images, and greater zygomatic reactivity to positive images than did the Control group.

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Study	Recruitment setting	*N* (Self-injury *n*)	Self-injury status criteria	Age *M* (*SD*)	% Female	Emotional challenge	Emotional channel (measure)	Reactivity/ recovery	Evidence for altered reactivity or recovery
Mettler et al. (2021)[c]	Canadian undergraduates	70 (36)	*NSSI:* NSSI engagement in the past 2 years. *Control:* No lifetime NSSI history.	*NSSI:* 20.06 (1.51) *Control:* 20.15 (1.54)	100%	Sadness film clip	Subjective (positive mood, negative mood)	Reactivity and recovery	No evidence.
Nock and Mendes (2008)	USA outpatient and community	92 (62)	*NSSI:* Lifetime NSSI. *Control:* No NSSI lifetime history.	*NSSI:* 17.4 (1.8) *Control:* 16.7 (2.0)	*NSSI:* 79.7% *Control:* 73.3%	Card-sorting frustration task	Physiological (EDR) (NB no behavioural baseline).	Reactivity	NSSI group showed greater increases in EDR than Control group.
Plener et al. (2017)	German community	130 (21)	*DSH:* Lifetime self-injury. *Control:* No lifetime history of self-injury.	19	100%	Trier Social Stress Test	Physiology (Blood cortisol)	Reactivity and Recovery	No evidence.
Schatten et al. (2015)	USA undergraduates and community	120 (48)	*NSSI:* Lifetime NSSI. *Control:* No lifetime NSSI history.	21.94 (2.82)	64.2%	Cyberball social exclusion	Subjective (distress rating)	Reactivity	No evidence.
Tatnell et al. (2018; Study 2)	Australian undergraduates and community	78 (25)	*NSSI:* Lifetime NSSI. *Control:* No lifetime NSSI history.	20.05 (1.74)	66.6%	Trier Social Stress Test	Physiology (EDR)	Reactivity	No evidence.
Weinberg and Klonsky (2012)	Canadian or USA undergraduates	72 (39)	*NSSI:* Lifetime NSSI. *Control:* No lifetime NSSI history.	20.24 (2.22)	63.9%	Write about an incident in which they became extremely angry	Subjective (ratings of arousal and valence)	Reactivity [d]	No evidence.

Continued…

Study	Recruitment setting	*N* (Self-injury *n*)	Self-injury status criteria	Age *M* (*SD*)	% Female	Emotional challenge	Emotional channel (measure)	Reactivity/ recovery	Evidence for altered reactivity or recovery
Ziebell et al. (2020)	Canadian undergraduates	60 (30)	*NSSI:* Lifetime history of ≥ 5 instances of NSSI, with no history of a BPD diagnosis. *Control:* No lifetime NSSI history.	18.87 (1.31)	85.0%	Dynamic emotion expressions (from neutral to anger, disgust, fear, happiness, sadness, and surprise)	Behaviour (facial EMG: corrugator). NB zygomatic not sensitive to emotional challenge.	Reactivity	No evidence overall across all six expressions. Compared to the Control group, the NSSI group displayed a reduced mimicry response when observing angry and happy emotional expressions.

Note. BPD = Borderline Personality Disorder; DSH = deliberate self-harm; EDR = Electrodermal Responding; EMG = Electromyography; HR = Heart Rate; HRV = Heart Rate Variability; PEP = cardiac pre-ejection period; RSA = respiratory sinus arrhythmia; SCR = Skin Conductance Responses; USA = United States of America. [a] Study 2 of Allen and colleagues (2019) did not report data for Self-Injury Status by Emotional Challenge interaction. [b] Only the participants randomised to the emotional script. [c] Only the negative mood induction. [d] Only reactivity measures, as the recovery measures are taken following a pain manipulation.

Two studies have focused soley on electrodermal responding to emotional challenge as an index of sympathetic autonomic activity. In a large sample (NSSI n = 62, total n = 92), Nock and Mendes (2008) assessed how adolescents with and without a lifetime history of NSSI responded to a frustrating card-sorting task. Notably, the task extended up to 14 minutes—considerably longer than most other emotional challenges in this field. Compared to the Control group, the NSSI group showed greater increases in skin conductance during the emotional challenge, with these reactivity differences becoming more pronounced from approximately six minutes into the task. In contrast, other research using a ~13-minute interpersonal stressor to manipulate emotional challenge found no difference in skin conductance reactivity between young adults with and without a lifetime history of NSSI (Tatnell et al., 2018).

Three studies have considered how people who engage in NSSI behaviourally respond to emotional challenges in real-time (although see Crowell et al., 2008; Kaufman et al., 2019; Nock & Mendes, 2008, who did not include a behaviour baseline). Ziebell and colleagues (2020) recruited young adults who had engaged in NSSI five or more times in their lifetime, and those who had never engaged in NSSI, to take part in a passive viewing task in which face stimuli dynamically morphed from neutral to emotional expressions. Compared to the Control group, the NSSI group showed attenuated corrugator EMG activity when viewing angry and happy facial expressions (but no difference when viewing disgust, fear, sadness, or surprise facial expressions), suggesting impaired emotional mimicry of these emotional expressions (Ziebell et al., 2020). Among Swedish adolescents, those who had engaged in NSSI five or more times in the past month showed greater corrugator reactivity to negative images, and greater zygomatic reactivity to positive images than did the Control group, but arousal and valence ratings of the images did not differ by NSSI-status (Mayo et al., 2021). In a more direct emotional challenge, Glenn and colleagues (2011) found no difference by self-injury status in emotional modulation of the startle eye blink (an index of emotional reactivity). However, given the low intensity of emotional images stimuli, it is unclear whether viewing emotional images should be considered an emotional challenge.

Assessments of real-time emotional reactivity and recovery

Four studies have used sadness-specific emotional challenges to investigate whether self-injury is characterised by alterations in emotional reactivity and/or recovery. Within the subjective channel, Davis and colleagues (2014) found that adults with a lifetime history of self-injury experienced similar increases in negative mood to a sad film clip compared to both

a healthy control group and a depression-matched control group. Following reappraisal instructions, the self-injury group failed to reduce their negative affect, whereas both the Healthy Control and Depression Control groups showed mood repair (Davis et al., 2014). In contrast, Boyes and colleagues (2020) found that adults with a lifetime history of NSSI reported *reduced* sadness reactivity to a sad film clip compared to those with no history of NSSI, but also showed less recovery from the emotional challenge. Counter to both of these studies, Mettler and colleagues (2021) found that young adults with and without a lifetime history of NSSI showed similar patterns of subjective reactivity to, and recovery from, a sad film clip.

One study has used sadness inductions to assess physiological responding in self-injury. Crowell and colleagues (2005) found that adolescents with a recent or chronic history of self-injury showed greater RSA reductions during a sad film clip compared to a Control group but found no differences in electrodermal responding. Neither RSA nor electrodermal responding differed by self-injury status during recovery from emotional challenge (Crowell et al., 2005).

Given the importance of social relationships in self-injury, socially relevant emotional manipulations are commonly used to investigate emotional responding. Kaufman and colleagues (2019) compared subjective and physiological indices of emotional responding among adolescent young women with repetitive self-injury and those with no history of self-injury or psychiatric disorder during a conflict discussion with their mothers. Compared to the Control group, the Self-Injury group reported more negative mood and less positive mood following emotional challenge. No evidence was found of altered RSA responding across groups (Kaufman et al., 2019). Two studies have used the Trier Social Stress Test—a well-established paradigm that reliably induces stress using socially evaluative situations (Kirschbaum et al., 1993)—to investigate neuroendocrinological stress among those who engage in self-injury. In a small sample (NSSI n = 14, Control n = 14), young women with repetitive NSSI showed attenuated salivary cortisol reactivity and recovery to interpersonal stress, but no differences in heart rate or negative mood reactivity compared to young women without NSSI or psychiatric illness (Kaess et al., 2012). In a larger study (Self-Injury n = 21, Control n = 109), young women with a lifetime history of self-injury showed a blunted blood cortisol response to interpersonal stress *in general*, but no evidence of altered reactivity or recovery compared to the Control group (Plener et al., 2017).

Taken together, there is limited evidence for a systematic difference in how people with and without a history of self-injury respond to, or recover from, real-time emotional

challenge. Even studies which used similar manipulations and measures of responding report inconsistent findings (e.g., subjective responding to sadness films, Boyes et al., 2020; Davis et al., 2014; Mettler et al., 2021). Within studies, evidence for altered emotional responding differs both across (e.g., Kaess et al., 2012), and within (e.g., Crowell et al., 2005) emotional channels.

Limitations of the extant research

Drawing firm conclusions from these studies is difficult for four key reasons. First, there is considerable variability in how self-injury is conceptualised across studies. Four of the nineteen studies conceptualised self-injury as deliberate self-harm and included both NSSI and suicide attempts within the same category. Given that people with a history of NSSI, suicide attempt(s), and those with no history of self-injury differ from each other in their subjective ratings of stress (Kim et al., 2015), it is unclear the extent to which emotional responding in a broader self-injury group generalises to a NSSI-specific group.

Second, even within the studies that focused on NSSI, there is considerable variability in how eligibility was determined.[15] Two-thirds (64.3%, $k = 9$) of NSSI-specific studies recruited participants to the NSSI group on the basis of a lifetime history of NSSI (e.g., Allen et al., 2019; Bresin & Gordon, 2013; Glenn et al., 2011; Nock & Mendes, 2008), whereas others determined eligibility based on the number of lifetime instances of the behaviour (Ziebell et al., 2020), and still others based on the number of instances within a certain time period (e.g., Groschwitz et al., 2016; Mettler et al., 2021). Given the variability in NSSI engagement (e.g., Whitlock et al., 2011; Wilkinson et al., 2018), determining eligibility on the basis of a lifetime history of NSSI means that it is likely that many participants in the NSSI group no longer self-injure. This is problematic because it assumes that any potential underlying alterations in emotional responding persist even into recovery. Although this assumption remains untested, systematic review of studies comparing adolescents who have ceased NSSI to those who continue reveal differences in global self-reported emotion (dys)regulation (Mummé et al., 2017), and improvements in global self-reports of emotion dysregulation partially explain reductions in NSSI following treatment (Asarnow et al., 2021; Gratz et al., 2012).

Thirdly, just over two-thirds (68.4%, $k = 13$) of previous studies have included samples comprised of both men and women, with samples ranging from 36.0% to 85.0%

[15] It is also worth noting that eligibility criteria for the Control group also differed widely. Half (58.9%, $k = 11$) of studies determined eligibility for the Control group based on no lifetime history of self-injury, whereas others also required no history of psychiatric illness (Allen et al., 2019; Groschwitz et al., 2016), and still others a history of psychiatric illness without self-injury (Gratz et al., 2019).

women. Although both men and women engage in self-injury and NSSI, there are gender differences in the prevalence and presentation of both self-injury generally (e.g., Hawton et al., 2002), and NSSI in particular (e.g., Bresin & Schoenleber, 2015). In addition, there are differences between men and women in global self-reports of subjective emotional experiences (but not in real-time measures; Feldman Barrett et al., 1998), emotional expression (Chaplin & Aldao, 2013), and habitual use of emotion regulation strategies (Nolen-Hoeksema & Aldao, 2011).

Finally, much of the extant literature draws from small sample sizes, notably for the self-injury group, and particularly in studies that measure emotional responding across multiple channels. Across the 19 studies described in Table 1, the average number of participants in the Self-Injury group was 37.00 (*SD* = 16.53), perhaps reflecting the difficulties associated with recruiting a sample of people who self-injure. Taken together, the large variability in self-injury conceptualisation, NSSI behavioural criteria, and gender make-up coupled with low sample sizes means that it is likely that the extant literature is under-powered. This thesis will address these limitations by consistently using a stringent eligibility criteria of past-year NSSI behaviour, recruiting only young women, and conducting well-powered, pre-registered studies.

Although people who self-injure consistently report experiencing greater global emotion reactivity and emotion dysregulation, evidence for a systematic difference in emotional reactivity to, or recovery from, real-time emotional challenge is limited and mixed. As such, it remains unclear whether or not the elevated global emotional dysregulation and emotion regulation reported by people who engage in NSSI compared to people with no history of NSSI is the reflection of an amplified emotional response.

Untangling the mechanism(s) that underpin poorer global emotional functioning in NSSI is not merely an intellectual pursuit. Rather, this approach may offer critical insights to guide clinical intervention. Meta-analysis of the currently available therapeutic interventions for NSSI suggests that Dialectical Behaviour Therapy (DBT) approaches hold the most promise for reducing self-injury, although these treatment effects are typically small to moderate (DeCou et al., 2019; Kothgassner et al., 2020). DBT approaches work, in part, to scaffold the development of more effective use of adaptive emotion regulation strategies and improving flexibility in the choice regulation strategies (Miller et al., 2017; Rathus & Miller, 2015). Critically, the efficacy and specificity of these treatment interventions for reducing NSSI depends on the extent to which they mitigate or overcome the underlying mechanism(s) which create global emotion dysregulation. Emotion regulation strategies vary widely in

terms of their efficacy, ease, site of impact, and resource costs. For instance, diaphragmatic breathing carries a relatively low cognitive load and directly alters the cardiac channel of the physiological emotional response. In contrast, cognitive reappraisal carries relatively high cognitive load and acts first on the subjective interpretation of the emotional challenge. Situation modification strategies which prevent the generation of an emotional response before it even occurs often require greater resources (e.g., quitting a job which causes distress requires financial resources). A nuanced understanding of the precise mechanism(s) of global emotion dysregulation in NSSI creates the opportunity to develop more effective and targeted therapeutic interventions to reduce NSSI.

Moving forward

As outlined in Chapter 1, this thesis aims to test two possibilities for why we see poorer global emotional functioning among people who engage in NSSI. Across two experiments (Study 2 and 3), I test whether people who engage in NSSI generate and experience a more intense response to emotional challenge than controls, and investigate how factors that shape the emotional response, such as emotion regulation strategy use, differ by NSSI status. However, before I present these two studies assessing emotional responding in NSSI, given my need for robust selection criteria I next turn to consider how best to capture a critical variable in these experiments—how do I know if someone has engaged in NSSI?

Chapter 3: Measuring non-suicidal self-injury

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I acknowledge the useful feedback of two anonymous reviewers on the ideas presented in this chapter.

Defining and measuring what it is that we study is the foundation of any scientific inquiry. Thus, before I turn my focus to understanding the role of emotion in NSSI, I first step back to consider how best to reliably and robustly assess NSSI. In particular for this thesis, the aim of the current investigation was to isolate the 'best' way to assess NSSI history in large-scale, online pre-screening surveys in order to establish eligibility for participation in subsequent experiments investigating emotional responding in NSSI.

Engagement in NSSI is typically measured by retrospective self-report questionnaires. Research on other health-risk behaviours such as alcohol and drug use has demonstrated that self-report responses are affected by a variety of cognitive and situational factors such as length of the recall period (e.g., past-year engagement versus lifetime engagement) and social desirability (for review, see Brener et al., 2003). Although objective measures of behaviour (e.g., biochemical validation of drug use) can help prevent against these biases, for most health-risk behaviours—including NSSI[16]—there are currently no objective measures that provide a cost-effective, feasible, and ethical alternative to self-report (Brener et al., 2003). Some researchers have tried to avoid some of the biases inherent in self-reports by relying on 'other-reports' of self-injury from parents or medical records (Borschmann et al., 2017; Fisher et al., 2012). However, NSSI is a stigmatised behaviour (Heath et al., 2011; Lloyd et al., 2018). The majority of people who self-injure do so privately (Klonsky & Olino, 2008), and are hesitant to disclose the behaviour to friends and family (Hasking, Tatnell, et al., 2015; Klineberg et al., 2013) or seek support from mental health professionals (Hasking, Tatnell, et

[16] Burke et al. (2016) argue that the permanent scarring that may result from instances of NSSI "are objective physical indicators" (p. 79). However, NSSI is typically performed on areas of the body which are easy to conceal (e.g., upper and lower arms, wrists, thighs, and/or stomach; Whitlock et al., 2011; Williams & Hasking, 2010), and it is unlikely that all instances of NSSI will permanently scar. Most importantly, the *'self-inflicted'*, *'deliberate'*, and *'without suicidal intent'* aspects which define NSSI (Lloyd-Richardson et al., 2007) are unable to be assessed simply from inspection of scar tissue. Indeed, Burke and colleagues (2016) assessed for the presence of NSSI scars with a self-report item. Others have investigated whether performance on implicit association tasks linking 'NSSI' and 'the self' could provide a more objective proxy of NSSI engagement (Powers et al., 2021). However, to date these implicit measures have demonstrated poor utility (Powers et al., 2021).

al., 2015; Whitlock et al., 2006). Thus, relying on or triangulating assessment with others' reports of an individual's NSSI is unlikely to reliably identify all who engage in NSSI. As such, we need to not only determine the reliability and validity of self-report NSSI assessments, but also to identify the source(s) of any assessment discrepancies so that we have a clear understanding of what we are assessing and how well.

Self-report assessments of non-suicidal self-injury

Self-report NSSI assessments vary widely across studies, with one meta-analysis of 128 unique samples identifying 76 different measurement tools (Swannell et al., 2014). NSSI assessments range from structured interviews (e.g., the Suicide Attempt Self-Injury Interview [SASII]; Linehan et al., 2006), to checklists of common NSSI behaviours (e.g., the Deliberate Self-Harm Inventory [DSHI]; Gratz, 2001), to single-item questions (e.g., *'Have you ever tried to hurt yourself on purpose, without trying to kill yourself (for example burning, cutting, or scratching yourself)?'*; Wilkinson et al., 2018; for an overview of the extant NSSI assessment measures, see Klonsky & Lewis, 2014).

This heterogeneity in assessment format is likely due, in part, to the costs and benefits each affords. Although interview assessments have received the most psychometric investigation and are typically considered the 'gold-standard' for assessing self-injury (Klonsky & Lewis, 2014; Lungu et al., 2018), fewer than 25% of studies assess NSSI with interviews (Liu et al., 2017; Swannell et al., 2014; You et al., 2018). This low uptake is likely due to the resource-intensive nature of interviews. For instance, the SASII takes up to 30-minutes and is administered one-to-one by trained personnel (Linehan et al., 2006). In the context of this thesis, assuming that approximately 23% of emerging adults have a lifetime history of NSSI (Gillies et al., 2018), I would need to screen approximately 435 young people—the equivalent of 217.5 hours of interviewing—in order to recruit 100 participants to a laboratory study. In addition to the pragmatic constraints of interview assessments, research on other stigmatised topics, such as suicidal thoughts and behaviours, finds that participants are *less* likely to disclose engaging in these behaviours to an interviewer than in a self-administered questionnaire (Kaplan et al., 1994; Velting et al., 1998; for a review, see Tourangeau & Yan, 2007), raising concerns about underreporting of NSSI when using interviews. Self-administered self-report questionnaires are more likely to encourage disclosure and are the assessment tool of choice in large-scale studies.

Self-administered self-report questionnaires encompass omnibus measures assessing several NSSI domains (e.g., Suicidal Behaviours Questionnaire; Linehan, 1981), functional

measures of NSSI (e.g., the Inventory of Statements About Self-Injury [ISAS]; Klonsky & Glenn, 2009), behavioural measures (e.g., DSHI; Gratz, 2001), and single-item measures (e.g., the item assessing NSSI from the Trauma Symptom Inventory; Briere, 1995).

Behavioural checklists versus single-item assessments

Given both their prevalence in the literature (Muehlenkamp et al., 2012; Swannell et al., 2014) and their suitability for widespread use within screening surveys, here we[17] focus on behavioural checklist and single-item measures of NSSI. Behavioural measures ask participants to indicate whether, and to what extent, they have engaged in common NSSI behaviours (e.g., cutting, scratching, or burning their skin), and typically provide researchers with continuous measures of NSSI methods and frequency. In particular, meta-analyses demonstrate that the DSHI (Gratz, 2001) is the most frequently used NSSI measure (Swannell et al., 2014; You et al., 2018) and checklist scores have shown good internal consistency and adequate test-retest reliability over a four week period ($\alpha = .82$, $\varphi = .68$; Gratz, 2001).

In comparison, single-item assessments ask participants to report their NSSI history, usually with a dichotomous response-format reflecting *'NSSI history'* and *'no NSSI history'* (e.g., Alfonso & Dedrick, 2010; Laye-Gindhu & Schonert-Reichl, 2005; Wong et al., 2007). Although some single-item measures are drawn from larger validated scales (e.g., the NSSI item from the Trauma Symptom Inventory; Brier, 1995), others are created in-house by researchers (e.g., Wilkinson et al., 2018).

Single-item assessments are often used as part of a two-step procedure—only those who report an NSSI history on the screening question go on to complete additional items assessing their self-injurious behaviours (e.g., Robinson et al., 2019; Ross & Heath, 2002; Wilkinson et al., 2018). Ethics committees are often concerned that asking about specific behaviours may encourage NSSI thoughts and behaviours (Lloyd-Richardson et al., 2015; Swannell et al., 2014), despite no evidence that this is the case (e.g., Muehlenkamp et al., 2015; Whitlock et al., 2013). Thus, best-practice guidelines for conducting NSSI research recommend this two-step assessment procedure as one way to minimise concerns over potential iatrogenic effects (Hasking, Lewis, Robinson et al., 2019). However, the consequences of this two-step procedure for assessment are not yet known.

[17] Although this thesis is my own work, I use 'we' when referring to the studies contained within to recognise the contributions of my co-authors to the research. I use 'I' when referring to the thesis as a whole.

Discrepancy across assessments

The choice of assessment is an important one. Meta-analyses of the prevalence (Muehlenkamp et al., 2012; Swannell et al., 2014), associations (Bresin & Schoenleber, 2015; Liu et al., 2016; You et al., 2018), and risk factors of NSSI (Fox et al., 2015) all find that assessment method moderates meta-analytic estimates, suggesting that assessment choice substantively affects the conclusions that may be drawn (and indeed, the scientific consensus of the field). Given their popularity and convenience within the empirical literature, understanding the relative benefits and weaknesses of both single-item assessments and behavioural checklists is important. Two meta-analyses of lifetime prevalence rates of NSSI found that point estimates almost doubled when NSSI was assessed using a behavioural checklist compared to a single-item (23.6% versus 12.5%, and 26.7% versus 11.8% respectively; Muehlenkamp et al., 2012; Swannell et al., 2014). These large differences provide preliminary evidence of limited agreement between single-item and behavioural checklist assessments of NSSI.

Direct evidence that participants report different lifetime NSSI histories across common assessments comes from a small sample of 260 USA university students (Lund et al., 2018). Participants reported their NSSI on a single-item followed by two commonly used behavioural checklists (DSHI, Gratz, 2001; and the ISAS, Klonsky & Glenn, 2009). Of the 79 participants who reported engaging in NSSI, 43.0% reported NSSI across all three measures, 25.3% reported NSSI on two measures, and 31.6% reported NSSI on only one measure. NSSI was more commonly reported on the two behavioural checklists than the single-item questionnaire (89.9% of the NSSI subsample screened positive on the ISAS, and 74.7% on the DSHI, compared to only 46.8% on the single-item). 8.5% of the overall sample reported inconsistent NSSI histories between the single-item and the DSHI, and 13.1% reported inconsistent histories between the single-item and the ISAS. This study provides preliminary evidence of considerable variability in NSSI history by assessment. Inconsistent responding across time and across assessments has also been identified in the suicidal thoughts and behaviours literature (Deming et al., 2021; Eikelenboom et al., 2014; Hart et al., 2013; Klimes-Dougan et al., 2007), suggesting that this phenomenon is not unique to non-suicidal forms of self-injury.

As yet it is unclear *why* participants report different NSSI histories on behavioural checklists compared to single-item assessments. One intuitive explanation for why participants respond differently across assessments is that they are carelessly responding to questionnaires by selecting responses regardless of the item content. Common methods for

identifying careless responders include instructed response items (e.g., *'Please select strongly agree for this item'*), and statistical techniques for identifying unusual patterns in raw data (e.g., long-string index, multivariate outliers; Curran, 2016; Meade & Craig, 2012). Careless responding prevalence estimates range from 3.5% to 12% (Johnson, 2005; Meade & Craig, 2012), with instructed response items generally as good at identifying careless responders as statistical methods (Curran, 2016).

Instead of careless (likely unsystematic) responding, assessment discrepancy may result from *systematic* differences in responding. One hypothesis argues that behavioural checklists 'outperform' single-item assessments because each item of the checklist acts as a recognition memory cue (Lundh et al., 2007; Swannell et al., 2014). In comparison, responding to a single-item is more like a free recall task that is arguably more cognitively demanding, in that it relies on recollection and may not provide a sufficiently strong memory cue for participants to retrieve all instances of NSSI from episodic memory (Lundh et al., 2007; Swannell et al., 2014; although note that many single-items used within the literature include common NSSI behaviours as examples). If memory processes underlie the discrepancy in NSSI prevalence between single-item and behavioural checklists, then the memory benefits afforded by the behavioural checklist should extend to a single-item presented immediately afterwards. At present we do not know if this is the case, because the two-step procedures and the limited research on NSSI assessment discrepancy (Lund et al., 2018) always present the single-item question before the behavioural checklist.

In contrast, participants may interpret a single-item assessment as asking if they are more, or less, similar to people who self-injure (Lundh et al., 2007; Swannell et al., 2014). Single-item assessments may produce different NSSI prevalence rates than behavioural checklists because participants evaluate their own behavioural history in light of their understanding of what self-injury is, and who self-injures. Specifically, this subjective self-identification may be systematic, rather than producing random error. Within lay communities, NSSI is often conceptualised primarily as a behaviour that young women engage in by cutting their skin (Lewis et al., 2014; Taylor, 2003). Given the stigma associated with NSSI (Heath et al., 2011; Lloyd et al., 2018; Staniland et al., 2020) and this stereotype of 'who self-injures', men, older people, and people who engage in methods of NSSI other than cutting may be more hesitant to label their behaviour as NSSI on a single-item because they do not identify as someone who self-injures.

The severity of the behaviour may also play a role in how a person interprets their NSSI status. Studies of suicidal thoughts and behaviours find that discrepant responders

report less severe suicidal thoughts and behaviours than do consistent responders (Eikelenboom et al., 2014; Hart et al., 2013; Hom et al., 2019; Klimes-Dougan et al., 2007). In a similar manner, adolescents who reported a lifetime history of self-injury at 16, but not at 18, were less likely to report recent self-injury at 16 and less likely to have self-injured with suicidal intent compared to consistent reporters (Mars et al., 2016). Turning specifically to NSSI, young adults who reported inconsistent NSSI histories between a behavioural checklist and a single-item also reported fewer NSSI methods, less frequent NSSI engagement, and less psychological distress compared to consistent responders (Lund et al., 2018). Taken together, research across a range of self-injurious behaviours suggests that inconsistent responders may systematically differ from consistent responders.

Study 1a and 1b

Although meta-analyses have highlighted a difference in NSSI prevalence depending on assessment type, and a handful of studies show that participants report different self-injury histories across assessments, the reasons underlying this assessment discrepancy are not yet clear. Across two studies, we manipulated the order in which participants complete a behavioural checklist and a single-item assessment of NSSI. We establish the extent of agreement across the two assessments before testing if memory facilitation, careless responding, or differences in the interpretation of 'what counts as self-injury' and 'who self-injures' explain discrepant reports of NSSI histories.

We first aim to replicate the finding that fewer people report an NSSI history on the single item than the behavioural checklist (Lund et al., 2018) in a larger sample. We then test the following pre-registered predictions:

i) If people report discrepant NSSI histories because behavioural checklists better facilitate recall memory than do single-item assessments, then participants will self-report higher rates of self-injury on the single-item when they complete the single-item *after* the behavioural checklist compared to *before* the behavioual checklist.

ii) If people report discrepant NSSI histories because they are carelessly responding, then participants who fail an instructed response item should be more likely to report discrepant NSSI histories across assessments.

iii) If single-item measures invite participants to reflect on the extent to which they are similar to people who self-injure, then we would expect that:

a. Participants who deviate from the prototypical definition of 'what counts as self-injury' and 'who self-injures' (i.e., men, people who do not self-injure by cutting, and older adults) should be more likely to report discrepant NSSI histories across assessments, and
b. participants with less recent NSSI and less psychological distress should be more likely to report discrepancies across assessments.

Given the paucity of empirical investigation into the (dis)agreement across NSSI assessments and the potential mechanisms underpinning assessment discrepancies, we compare assessment responses in two samples (Study 1a and 1b) in order to internally replicate effects. Preregistered hypotheses, predictions, design, and analytical plans are available at https://osf.io/8gwju/ and in Appendix A and B.

Participants

We invited all students enrolled in introductory psychology courses across two trimesters in 2018 and 2019[18] (Study 1a: *n* = 835; Study 1b; *n* = 1,020) to participate in these studies as part of a broader survey counting towards a research participation course requirement, with the majority accepting the invitation (Study 11: 77.4%; Study 1b: 79.2%). In Study 1b analyses, we excluded 35 participants who took part in both studies (because of the low number, we did not conduct exploratory analyses of how reliably people report discrepant NSSI histories). Across both samples (Study 1a: *n* = 626; Study 1b: *n* = 738), participants tended to be young adults (Study 1a: *M* age = 19.31, *SD* = 3.38; Study 1b: *M* age = 18.85, *SD* = 2.79), and identify as female (Study 1a: 76.0% identified as female, 23.0% identified as male, and 1.0% as gender diverse; Study 1b: 76.2% identified as female, 23.2% as male, and <1% as gender diverse).[19] The majority of participants identified as Pākehā/New Zealand European (Study 1a: 66.9%; Study 1b: 69.5%), with the remainder comprised of Māori (Study 1a: 11.7%; Study 1b: 11.3%), Asian (Study 1a: 11.0%; Study 1b: 9.8%), and Pasifika (Study 1a: 5.6%; Study 1b: 3.6%).

Design

In both experiments, we used a between-subjects design in which the independent variable was assessment order; half of participants completed the single-item assessment followed by the behavioural checklist (single-item first condition), while the remainder

[18] Study 1a data collected 16th–27th July 2018. Study 1b data collected between 4th–17th March 2019.
[19] Open-text responses coded as per best-practise guidelines (Fraser et al., 2019). Given the low number of participants who identified as gender diverse (Study 1a: *n* = 6; Study 1b: *n* = 5), we excluded these participants from analyses involving gender to guard against spurious findings.

completed the behavioural checklist followed by the single-item assessment (behavioural checklist first condition). Participants were randomised to each condition. Given that participants could report an NSSI history on both, one, or neither assessment, for clarity we refer to lifetime NSSI reported on the behavioural checklist as 'behaviourally-identified NSSI', and lifetime NSSI reported on the single-item as 'self-identified NSSI'. Age, gender, and in Study 1b, careless responding and psychological distress, were the predictor variables, and lifetime NSSI history and the two most common types of assessment discrepancy (i.e., participants who reported no NSSI history on the single-item but reported engaging in NSSI behaviours, and participants who reported NSSI ideation-only on the single-item but reported engaging in NSSI behaviours) were the dependent variables.

Measures

Non-suicidal self-injury

At the beginning of both experiments all participants received the following instructions: *'This part of the survey asks questions about some of the things that people sometimes do to hurt themselves. You might not have told anyone about how you have hurt yourself or may not want to tell anyone. By answering these questions honestly, though, you will help us learn how to help others like you. It is very important that you read all the instructions below carefully. Sometimes people can hurt themselves on purpose without intending or expecting to kill themselves. Please only answer these questions if you meant to hurt yourself (not if it was an accident), but without intending to kill yourself. Do not answer yes if you did something accidentally (e.g., you tripped and banged your head accidentally).'* Participants were then presented with the two NSSI assessments.

Single-item assessment. All participants saw the item *'Please indicate whether you have had thoughts about hurting yourself on purpose, or whether you have hurt yourself on purpose (e.g., punched yourself or objects like walls, prevented wounds from healing, or cut, burnt, scratched or carved your skin, etc)'*, and were invited to respond with *'Yes'*, *'No'*, or *'Thought about it'*. The wording of this single-item assessment is similar to others used in the literature (e.g., *'Have you ever tried to hurt yourself on purpose, without trying to kill yourself (for example burning, cutting, or scratching yourself)?'*; Wilkinson et al., 2018) and includes the response option *'Thought about it'* to reflect evidence that NSSI ideation and NSSI actions are related, but often distinct (Martin et al., 2011; Nock, 2010).

Behavioural checklist assessment. All participants completed the simplified version of the Deliberate Self-Harm Inventory (DSHI-s, Gratz, 2001; Lundh et al., 2007) which describes common NSSI behaviours (e.g., cutting skin, punching or banging the body). For each of the 13 items, participants indicated how frequently they have deliberately engaged in the behaviour (in the absence of suicidal intent) on a five-point scale ranging from *'0 – Never'* to *'4 – Many times',* with an additional scale point (*'1 – I have thought about it'*) included to capture NSSI ideation. We combined the *'punched oneself'* and *'banged head'* items into one item (combined item *'punched yourself, or banged your head against something, to the extent that it caused a bruise to appear*) and, given the New Zealand context of these studies, modified two items (*'carved words…'* and *'stuck sharp objects…'*) to explicitly exclude tā moko, the body and face marking that is part of Māori culture. For the full measure, see Appendix C. As the mostly widely used behavioural checklist (Swannell et al., 2014; You et al., 2018), the DSHI is well-suited to investigate the discrepancy in responding across behavioural and single-item assessments. DSHI scores have demonstrated convergent validity with other self-injury measures, as well as internal consistency (α = .82) and adequate test-retest over a period up to four weeks (φ =.68, Gratz, 2001). Scores of both the simplified DSHI-s (α =.90; Lundh et al., 2011) and the DSHI-s modified to capture NSSI ideation and exclude tā moko (α = .79, Robinson et al., 2017) have previously shown good internal consistency within adolescent samples. Across both current samples, DSHI-s scores showed good internal reliability (Study 1a: α = .86; Study 1b: α = .84).

Participants who indicated a lifetime NSSI history on either measure were also asked to report how many times they had engaged in NSSI in the past year: *'In the last year, how many times have you deliberately hurt yourself (but without wanting to kill yourself)?'*. Study 1a item used an open text response format. However, this response format resulted in 4.3% unusable data (e.g., "too many to count", "in the 40's or 50's"). So, in Study 1b we measured NSSI frequency with the item *'In the past year, on how many occasions have you intentionally hurt yourself?'*, with the response format: *'never', '1–3 times', '4–5 times', '6–10 times', '11–20 times', '21–50 times',* and *'>50 times'*. Participants who reported no NSSI history on both the single-item and behavioural checklist were assigned a recency score of 0 (*'never'*).

Psychological distress

In Study 1b, participants completed measures of their depression, anxiety, and stress symptoms in the past week using the Depression, Anxiety, and Stress Scale (DASS-21;

Henry & Crawford, 2005; Lovibond & Lovibond, 1995). Participants responded to 21 items such as *'I felt that I had nothing to look forward to'* on a 4-point scale ranging from *'0 – Did not apply to me at all'* to *'3 – Applied to me very much, or most of the time'*, with seven items comprising each of the depression, anxiety, and stress subscales. Items are totalled and then doubled to create subscales, with higher scores indicating greater depression, anxiety, and stress respectively. Previous research has found that DASS-21 scores have good internal consistency and construct validity within young adult samples (Depression: $\alpha = .83$, Anxiety: $\alpha = .78$, Stress: $\alpha = .87$, Norton, 2007). In the current sample, the Depression ($\alpha = .89$, 95% CI [.88, .90], $\omega = .89$, 95% CI [.88, .90]), Anxiety ($\alpha = .80$, 95% CI [.78, .83], $\omega = .81$, 95% CI [.79, .83]), and Stress ($\alpha = .83$, 95% CI [.81, .85], $\omega = .84$, 95% CI [.82, .85]) subscales scores showed good internal consistency.

Careless responding

In Study 1b, embedded within a scale administered approximately 5 to 7-minutes prior to the experiment as part of another study was the item: *'This is an attention check. Please select 'agree' for this statement'*[20], to which participants could respond on a 7-point scale ranging from *'1 – Strongly Disagree'* to *'7 – Strongly Agree'.* This item is similar to other instructed response items commonly used to identify careless responding (Curran, 2016). Participants who failed this instructed response item (i.e., selected any response option other than *'6 – Agree'*; $n = 30$, 4.1%) were assigned a careless responding score of 1, while those who responded as instructed were assigned a score of 0.

Procedure

Both experiments were embedded approximately 15-minutes into an hour-long pre-screening survey for a department-wide research pool for students enrolled in introductory psychology courses at a large public university. The pre-screening survey was presented online via Surveymonkey and participants took part in their own time and on a device of their choice. In Study 1b, participants completed an attention check prior to the experiment. Following both NSSI assessments, participants reported their past-year NSSI frequency and, in Study 1b, their symptoms of depression, anxiety, and stress. Participants gave informed consent prior to the experiment and received a list of mental health resources available to

[20] The wording of the instructed response item of this attention check differs from our preregistration (*'Please select 'Applied to me very much, or most of the time' for this question to show that you are paying attention'*) and the item was presented before the experimental manipulation rather than afterwards. These changes were made because this version of the instructed response item was already included in the online survey and having two separate instructed response items was considered unnecessary by the pre-screening facilitator.

them after debriefing. Victoria University of Wellington's Human Ethics Committee provided ethical approval for both studies.

Missing Data

Data from participants who completed the survey multiple times (Study 1a: $n = 86$, $M = 2.00$, $SD = 0.65$; Study 1b: $n = 76$, $M = 2.00$, $SD = 0.48$), identified by identical student ID numbers) were inspected and the earliest response was retained. Participants who did not complete both NSSI assessments (Study 1a: $n = 35$, Study 1b: $n = 16$) were excluded. Across both studies, excluded participants did not differ from included participants on age (Study 1a: $t(659) = 0.78$, $p = .434$; Study 1b; $t(787) = 1.37$, $p = .171$), gender (Study 1a: χ^2 (1, $n = 655$) = 0.19, $p = .659$; Study 1b: χ^2 (1, $n = 784$) = 0.25, $p = .621$), or ethnicity (Study 1a: χ^2 (4, $n = 643$) = 1.92, $p = .751$; Study 1b: χ^2 (4, $n = 775$) = 3.77, $p = .438$).

Within the final Study 1a sample ($n = 626$), Little's Missing Completely at Random (MCAR) test suggested that the pattern of missingness on the DSHI-s was not MCAR, $\chi^2(143, n = 621) = 234.42$, $p < .001$. However, as only 0.34% of values were missing, we deemed this inconsequential, following convention (Schafer, 1999). In contrast, for Study 1b ($n = 738$) Little's MCAR test suggested that the pattern of missingness on the DSHI-s *was* likely to be MCAR, χ^2 (95, $n = 734$) = 85.00, $p = .759$, with 0.26% of data missing. Using logistic regression, neither gender, age, ethnicity, or assessment presentation order predicted presence (relative to absence) of DSHI-s missingness (Study 1a: *p*'s range from .872 to .205; Study 1b: *p*'s range from .153 to .618).

Analytic plan

NSSI status was coded as *'No history'*, *'NSSI ideation'*, and *'NSSI history'* for each of the two assessment types. For the single-item assessment, *'Yes'* responses were coded as *'NSSI history'*, *'No'* responses as *'No history'*, and *'Thought about it'* responses were coded as *'NSSI ideation'*. For the behavioural checklist, participants who reported engaging in at least one of the 13 behaviours on one or more occasions were coded as *'NSSI history'*, those who reported thinking about engaging in one or more behaviours (but reported no engagement) as *'NSSI ideation'*, and those who reported never thinking about engaging in *any* of the 13 behaviours were coded as *'No history'*.

Participants whose NSSI status differed across the two assessment types were assigned a discrepancy score of 1, while those assigned to the same status on both assessments were assigned a score of 0. Two specific forms of discrepant responses were also coded. Participants who would typically be screened out in two-step assessments (i.e.,

reported no NSSI history on the single-item, and a NSSI history on the behavioural checklist) were assigned a *'screened out'* score of 1, while those who reported a history of NSSI on both assessments were assigned a score of 0. Participants with self-identified NSSI ideation-only and behaviourally-identified NSSI (i.e., reported NSSI ideation on the single-item, and a NSSI history on the behavioural checklist) were assigned a *'ideation discrepancy'* score of 1, while those who reported a NSSI history on both assessments were assigned a score of 0. Inspection of continuous variables indicated that, although scores for Depression (M = 9.37, SD = 9.10), Anxiety (M =10.97, SD = 8.72) and Stress (M =13.18, SD = 8.89) were low (as expected in a community sample), there was no evidence that they differed significantly from normality.

Pearson Chi-Square statistical tests were used to assess for relationships between assessment order (single-item first vs. behavioural checklist first) and NSSI prevalence measured using the single-item and the behavioural checklist, as well as a relationship between careless responding and assessment discrepancy. Logistic regression models tested whether age, gender, specific NSSI methods, past-year NSSI frequency, and psychological distress are associated with change (versus stability) across assessment types. Exploratory logistic regression models test whether age, gender, and frequency of past-year NSSI predict participants who report both no NSSI history on the single-item *and* a NSSI history on the behavioural checklist (i.e., incorrectly screened out participants) and participants who reported ideation discrepancy (versus participants who report an NSSI history on both assessments). All analyses reported here were preregistered unless noted otherwise, and all preregistered predictions are confirmed as supported, or not supported. For pre-registered analyses, alpha was set at .05. For exploratory analyses, alpha was set at .01 to better guard against spurious findings. Additional exploratory analyses are reported in Appendix D. All analyses were conducted using SPSS version 25.

Results

Table 2 presents the breakdown of NSSI characteristics for both Study 1a and 1b. Notably, across both studies approximately two-thirds of participants reported a lifetime NSSI history on one or both assessments, and one in five reported a lifetime history of NSSI ideation (without engagement). The prevalence of recent NSSI was also high across Study 1a and 1b, with one in three participants reporting having engaged in NSSI in the past-year, most commonly 1 to 3 times. NSSI engagement was greater in Study 1b than Study 1a; a

Table 2

Non-suicidal self-injury characteristics across Study 1a and 1b

NSSI Characteristics	Study 1a	Study 1b
Lifetime NSSI history on one or both assessments	60.5%	69.4%
NSSI ideation on one or both assessments	24.1%	20.9%
Past-year NSSI engagement (total sample)	29.8%	32.7%
Past-year NSSI engagement (NSSI sample)	44.6%	46.4%
Number of past-year NSSI episodes (total sample)		
M (*SD*)	8.63 (14.31)	-
Median	3	-
1 to 3 times	-	25.3%
4 to 5 times	-	8.7%
6 to 10 times	-	4.8%
11 to 20 times	-	4.6%
21 to 50 times	-	2.6%
>50 times	-	0.8%
Most common NSSI methods (NSSI sample)		
Scratching skin	33.4%	35.2%
Cutting skin	32.0%	34.4%
Punching and/or banging the body	31.6%	41.8%

Note. Study 1a $n = 626$, Study 1b $n = 738$. NSSI methods refer to the three most endorsed methods, percentages do not add to 100% as participants could endorse multiple methods.

greater proportion of participants in Study 1b reported a lifetime history of NSSI ($z = 3.44$, $p < .001$) and a past-year history of NSSI ($z = 3.78$, $p < .001$) compared to Study 1a.

Agreement across assessments

Our first aim was to replicate the finding that fewer people report an NSSI history on a single item assessment than a behavioural checklist. Consistent with previous research (Lund et al., 2018), agreement between the single-item and behavioural checklist assessments was low (Study 1a: $\kappa = .50$; Study 1b: $\kappa = .48$), with nearly a third (Study 1a: 31.0%, Study 1b: 31.2%) of participants reporting different NSSI histories. Reflecting meta-analytic research, participants were more likely to report a lifetime history of NSSI on the behavioural

checklist than the single item (Study 1a: 59.3% vs. 37.2%, $\chi^2(4, n = 626) = 339.20$, $p < .001$, *Cramer's V* = .52; Study 1b: 68.6% vs. 44.0%, $\chi^2(4, n = 738) = 362.83$, $p < .001$, *Cramer's V* = .50). There was a high degree of asymmetry across all discrepant responses; 10.9% ($n = 68$) of Study 1a participants and 14.0% ($n = 103$) of Study 1b participants reported no NSSI history on the single-item but reported engaging in NSSI behaviour on the checklist, whereas zero Study 1a participants and 0.7% ($n = 2$) of Study 1b participants reported an NSSI history on the single item, but no engagement on the checklist. Table 3 presents the breakdown of NSSI status by assessment type and presentation order for both Study 1a and 1b.

Memory facilitation

Next, we considered potential explanations for this high rate of assessment discrepancy. If higher rates of NSSI on checklists arise because each checklist item cues memory for engaging in NSSI, then we would expect that respondents would be more likely to report an NSSI history on the single-item if they completed the single-item *after* the checklist than *before*. Counter to this hypothesis, presentation order did not affect NSSI prevalence as assessed with either the single item (Study 1a: $\chi^2(2, n = 626) = 0.66$, $p = .718$, *Cramer's V* = .03; Study 1b: $\chi^2(2, n = 738) = 4.99$, $p = .082$, *Cramer's V* = .08) or the behavioural checklist (Study 1a: $\chi^2(2, n = 626) = 3.15$, $p = .207$, *Cramer's V* = .07; Study 1b: $\chi^2(2, n = 738) = 0.03$, $p = .985$, *Cramer's V* < .01).[21]

Careless responding

In Study 1b we wanted to test the hypothesis that careless responding can explain the high rates of assessment discrepancy. First, at a descriptive level the proportion of participants who failed the attention-check (4.1%) was substantively lower than the percentage of participants who reported inconsistent NSSI histories between the single-item assessment and the behavioural checklist (31.2%), suggesting that carelessness could not fully account for the discrepancies in responding, if at all. Moreover, participants who passed the instructed response item were just as likely to show discrepant responding as those who failed ($\chi^2(1, n = 723) = 1.23$, $p = .267$, *Cramer's V* = .04), providing no evidence for the hypothesis that the high degree of discrepancy found across assessments was due to careless responding.

[21] Given that presentation order was unrelated to assessment discrepancy, we deviated from our preregistration and collapsed across presentation order (instead of analysing only the single-item first condition) to maximise sample size for subsequent analyses.

Table 3

Lifetime non-suicidal self-injury prevalence rates as measured by the single-item and behavioural checklist assessments across Study 1a and 1b

	Behavioural checklist					
		Study 1a			Study 1b	
Single-item first		(*n* = 310)			(*n* = 334)	
Single-item	No History	NSSI Ideation	NSSI History	No History	NSSI Ideation	NSSI History
No History	81 (26.1%)	22 (7.1%)	37 (11.9%)	72 (21.6%)	12 (3.6%)	36 (10.8%)
NSSI Ideation	6 (1.9%)	11 (3.5%)	34 (11.0%)	4 (1.2%)	15 (4.5%)	45 (13.5%)
NSSI History	-	5 (1.6%)	114 (36.8%)	-	1 (0.3%)	149 (44.6%)
		Study 1b			Study 1b	
Checklist first		(*n* = 316)			(*n* = 404)	
Single-item	No History	NSSI Ideation	NSSI History	No History	NSSI Ideation	NSSI History
No History	101 (32.0%)	11 (3.5%)	31 (9.8%)	88 (21.8%)	17 (4.2%)	67 (16.6%)
NSSI Ideation	2 (0.6%)	13 (4.1%)	44 (13.9%)	3 (0.7%)	15 (3.7%)	39 (9.7%)
NSSI History	-	3 (0.9%)	111 (35.1%)	2 (0.5%)	3 (0.7%)	170 (42.1%)

Note. Study 1a *n* = 195 and Study 1b *n* = 229 participants reported different NSSI histories across the two assessment measures.

Individual differences in assessment discrepancy

Our analyses so far show that approximately a third of participants reported inconsistent NSSI histories between a single-item and a behavioural checklist. Two specific forms of discrepant responses made up the majority (Study 1a: 74.8%, Study 1b: 81.6%) of all inconsistent responses; participants who reported engaging in NSSI behaviours on the checklist, but reported either no history or NSSI ideation on the single-item.[22] We next consider the hypothesis that these types of discrepant responses arise because participants do not identify with the lay understanding of 'who self-injures' and 'what counts as self-injury'.

Typically 'screened out' participants

First, we focused on participants who reported no NSSI history on the single-item and also reported engaging in one or more NSSI behaviours on the checklist. These participants would have been screened out in any study using the standard two-step procedure common in the literature. Notably, typically screened out participants reported engaging in an average of two methods of NSSI via the checklist (Study 1a: $M = 2.15$, $SD = 1.93$; Study 1b: $M = 2.43$, $SD = 2.11$), although this was fewer methods of NSSI than the group who consistently reported a NSSI history across both assessments (Study 1a: $M = 4.12$, $SD = 2.35$; Study 1b: $M = 3.90$, $SD = 2.24$; Study 1a: $U = 3413.00$, $p < .001$, $\eta^2 = .16$; Study 1b: $U = 6818.50$, $p < .001$, $\eta^2 = .12$).

If participants who engaged in NSSI behaviours, but reported no NSSI history on the single-item, did so because they saw themselves as dissimilar to the stereotype of 'who self-injures', then certain people should be more (or less) likely to be screened out in two-step NSSI assessment procedures. Across both Study 1a and 1b, the logistic regression model with age, gender, and past-year NSSI frequency as predictor variables was statistically significant (Study 1a: $\chi^2(3, n = 620) = 42.93$, $p < .001$, Nagelkerke $R^2 = .28$; Study 1b: $\chi^2(3, n = 733) = 113.23$, $p < .001$, Nagelkerke $R^2 = .36$). Consistent with our hypothesis, compared to participants who consistently reported a history of NSSI, typically screened out participants had lower frequencies of NSSI over the past-year (Study 1a: OR = 0.38, 95% CI [0.21, 0.69]; $p = .001$; Study 1b: OR = 0.12, 95% CI [0.06, 0.23], $p < .001$), and, in Study 1b only, were more likely to be men (Study 1a: OR = 0.50, 95% CI [0.22, 1.13], $p = .095$; Study 1b: OR = 0.40, 95% CI [0.22, 0.77], $p = .005$). Across both studies, typically screened out participants

[22] Given that these specific forms of assessment discrepancy comprise the majority of discrepant responses, we deviated from our preregistration and chose to focus on these specific forms rather than any form of discrepant response.

did not differ in age from those who consistently reported a history of NSSI (Study 1a: OR = 0.97, 95% CI [0.83, 1.14], p = .722; Study 1b: OR = 0.91, 95% CI [0.82, 1.02], p = .115).

Next, we test the hypothesis that people who engage in NSSI behaviours which deviate from the prototypical definition of 'what counts as self-injury' are more likely to report discrepant NSSI histories. We conducted an exploratory binomial logistic regression predicting whether or not a participant would typically be screened out (i.e., behaviourally-identified NSSI without self-identified NSSI, compared to both behaviourally *and* self-identified NSSI). NSSI past-year frequency, and (in Study 1b only) gender were added to the first step of the model (Step 1), followed by each of the 13 behaviours (Step 2). Across both Study 1a and 1b the logistic regression model was statistically significant (Study 1a: $\chi^2(13, n = 626) = 94.91$, $p < .001$, Nagelkerke $R^2 = .73$; Study 1b: $\chi^2(13, n = 733) = 168.92$, $p < .001$, Nagelkerke $R^2 = .74$). Across Study 1a and 1b, participants who reported engaging in cutting were more likely to self-identify a history of NSSI (Study 1a: OR = 0.12, 95% CI [0.05, 0.26], $p < .001$; Study 1a: OR = 0.13, 95% CI [0.08, 0.23], $p < .001$). In Study 1a only, participants who reported engaging in self-burning behaviour were more likely to self-identify a history of NSSI (Study 1a: OR = 0.36, 95% CI [0.17, 0.75], p = .007), while in Study 1b those who used bleach or oven cleaner on skin were less likely to self-identify a history of NSSI (OR = 5.51, 95% CI [1.87, 16.19], p = .002). No other NSSI method distinguished between participants who typically are screened out and those who self-identify a NSSI history on the single-item and report engaging in NSSI behaviours on the checklist (Study 1a: *p*'s range from .998 for using bleach or oven cleaner on skin, to .048 for punching or banging the body; Study 1b: *p*'s range from .969 for using acid on skin, to .104 for scratching skin).

Individual differences in psychological distress have previously been associated with more discrepant self-injury reports. Thus, within the Study 1b sample we conducted a binomial logistic regression to examine whether depression, anxiety, and stress symptoms predicted whether or not a participant would typically be screened out (i.e., behaviourally-identified NSSI without self-identified NSSI, compared to both behaviourally and self-identified NSSI), controlling for gender and NSSI past-year frequency. The logistic regression model was not statistically significant, $\chi2(3, n = 733) = 6.60$, p = .086, Nagelkerke $R^2 = .38$, providing no evidence that depression (OR = 0.98, 95% CI [0.94, 1.02], p = .399), anxiety (OR = 0.96, 95% CI [0.92, 1.01], p = .083) or stress (OR = 1.01, 95% CI [0.96, 1.06], p = .768) predicted whether participants would have been screened out in a two-step procedure.

NSSI ideation discrepancy

Second, we consider the group of discrepant responders who reported NSSI ideation (but no action) on the single-item and reported engaging in one or more NSSI behaviours on the checklist. Although most single-item measures do not provide a 'thoughts only' response option, in studies that use a two-step procedure and which include this response option (e.g., Robinson et al., 2017) these participants typically would go on to answer additional NSSI items. Participants who reported this ideation discrepancy reported engaging in an average of two methods of NSSI (Study 1a: $M = 2.19$, $SD = 1.22$; Study 1b: $M = 2.13$, $SD = 1.37$), fewer methods than participants who consistently reported a history of NSSI across both assessments (Study 1a: $M = 4.12$, $SD = 2.35$; Study 1b: $M = 3.90$, $SD = 2.24$; Study 1a: $U = 4371.50$, $p < .001$, $\eta^2 = .14$; Study 1b: $U = 9976.00$, $p < .001$, $\eta^2 = .11$).

As with the typically screened out participants, if this group showed discrepant NSSI histories because they see themselves as dissimilar to lay understandings of 'who self-injures', then demographic and NSSI characteristics should predict group membership (relative to people who report an NSSI history on both assessments). We entered age, gender, and past-year NSSI frequency as predictors of whether or not participant reported this ideation discrepancy within a binomial logistic regression. In Study 1a, the logistic regression model was not statistically significant ($\chi^2(3, n = 620) = 2.68$, $p = .443$, Nagelkerke $R^2 = .02$). Participants who reported this ideation discrepancy did not differ from those who reported a history of NSSI on both the single-item and the checklist by past-year NSSI frequency (OR = 0.94, 95% CI [0.94, 1.01], $p = .177$), gender (OR = 0.94, 95% CI [0.44, 2.00], $p = .866$) or age (OR = 1.01, 95% CI [0.92, 1.11], $p = .839$). In comparison, in Study 1b, the logistic regression model *was* statistically significant ($\chi^2(3, n = 733) = 50.65$, $p < .001$, Nagelkerke $R^2 = .19$). Compared to participants who reported a NSSI history on both the single-item and the checklist, participants who reported this ideation discrepancy had engaged in NSSI less frequently in the past-year (OR = 0.41, 95% CI [0.29, 0.58], $p < .001$), and were more likely to be men (OR = 0.35, 95% CI [0.19, 0.65], $p = .001$) and younger (OR = 0.83, 95% CI [0.71, 0.98], $p = .030$).

Next, we considered whether the lay understanding of which behaviours 'count as self-injury' may explain why people report this discrepancy in ideation (i.e., self-identified NSSI ideation and behaviourally-identified NSSI). We conducted an exploratory binomial logistic regression to test whether specific NSSI methods predicted ideation discrepancy (versus both self-identified and behaviourally-identified NSSI), while (in Study 1b only) controlling for past-year NSSI frequency, gender, and age. Across both Study 1a and 1b the

logistic regression model was statistically significant (Study 1a: $\chi^2(13, n = 626) = 96.52$, $p < .001$, Nagelkerke $R^2 = .41$; Study 1b: $\chi^2(13, n = 733) = 93.13$, $p < .001$, Nagelkerke $R^2 = .48$). Consistent with the account that some NSSI behaviours 'count more' as self-injury, across both studies participants who reported greater engagement in cutting were more likely to self-identify a history of NSSI (Study 1a: OR = 0.36, 95% CI [0.25, 0.51], $p < .001$; Study 1b: OR = 0.27, 95% CI [0.19, 0.39], $p < .001$). In Study 1b only, participants who reported greater engagement in punching and banging were more likely to self-identify a history of NSSI (OR = 0.70, 95% CI [0.54, 0.90], $p = .006$). No other NSSI method distinguished between participants who report behaviourally-identified NSSI with self-identified ideation (Study 1a: *p*'s range from .686 for sticking sharp objects into skin, to .074 for punching or banging; Study 1b: *p*'s range from .736 for biting skin, to .027 for burning skin).

Finally, we assessed whether recent depression, anxiety, and stress symptoms could help to explain why some participants report this discrepancy in ideation (i.e., self-identified NSSI ideation and behaviourally-identified NSSI). Within the Study 1b sample, we conducted a hierarchical logistic regression with NSSI past-year frequency, gender, and age entered into the first step of the model (Step 1), followed by the measures of psychological distress (Step 2). Counter to predictions, Step 2 was not statistically significant ($\chi^2(3, n = 733) = 1.82$, $p = .612$; Nagelkerke R^2=.12); depression (OR = 1.01, 95% CI [0.97, 1.05], $p = .608$), anxiety (OR = 1.00, 95% CI [0.97, 1.05], $p = .768$), and stress symptoms (OR = 1.00, 95% CI [0.96, 1.06], $p = .703$) were unrelated to assessment discrepancy.

Discussion

Across both Study 1a and 1b, the prevalence of NSSI was high with approximately two thirds of participants reporting a lifetime history of NSSI on one or both assessments, and nearly one in three participants reporting engaging in NSSI in the past year. Critically, agreement across two of the most commonly used NSSI assessments (Swannell et al., 2014; You et al., 2018) was strikingly low; participants were 1.57 times more likely to report a lifetime NSSI history when assessed using a behavioural checklist than with a single-item. Notably, of the participants who reported engaging in NSSI behaviours on the checklist, 18.3% in Study 1a and 20.4% in Study 1b reported no history of NSSI on the single-item, and 21.0% in Study 1a and 16.6% in Study 1b reported NSSI ideation on the single-item. After replicating the finding that people are less likely to report a history of NSSI on single items than behavioural checklists (Lund et al., 2018), we tested three different explanations for discrepant reports of NSSI history across assessments: (i) memory facilitation offered by

behavioural checklists, (ii) careless responding, or (iii) if single-item assessments prompt people to respond through a lens of 'what counts as self-injury' and 'who self-injures'.

Reasons for assessments discrepancy

One intuitively obvious explanation for the discrepancy between behavioural checklists and single-item assessments is that behavioural checklists provide retrieval cues for incidents of self-injury that may have been forgotten (Lundh et al., 2007; Swannell et al., 2014). However, we found that assessment order did not influence the rate of discrepancy; 9.8% of participants in Study 1a and 16.6% of participants in Study 1b endorsed items on the checklist, and still went on to report no NSSI history on the single item. Rates of careless responding were considerably lower (4.1%, assessed in Study 1b only) than rates of assessment discrepancy (31.2%), and participants who passed the careless responding check were just as likely to show discrepant responding as those who failed. Thus, careless responding also cannot account for the discrepancy in NSSI histories between behavioural checklists and single-item assessments.

Two specific types of inconsistent responding made up the majority of discrepant responses; participants who reported engaging in NSSI behaviours on the checklist, but self-identified either no history of NSSI or only NSSI ideation on the single-item. In both of these instances, participants who reported having engaged in cutting behaviours were more likely to self-identify a history of NSSI, suggesting that this behaviour may be seen unequivocally as, and defining of, self-injury, while other behaviours are open to greater interpretation. Within lay communities, cutting is often seen as the prototypical NSSI method (Lewis et al., 2014). Although cutting is one of the most common NSSI methods (Klonsky, 2011; Plener et al., 2009), many people who self-injure do not cut themselves (Garisch & Wilson, 2015), and men are less likely than women to engage in cutting behaviour (Andover et al., 2010). Compared to participants who reported engaging in NSSI behaviour(s) and self-identified as having a history of NSSI, participants who reported engaging in NSSI behaviour(s) but self-identified as having either no history of NSSI or NSSI ideation-only engaged in fewer methods of NSSI behaviour and did so less frequently, suggesting that this group may have lower NSSI severity. In Study 1b only, men were also less likely to self-identify a history of NSSI. Counter to research on the consistency of self-injury self-reports across a two-year period (Mars et al., 2016), psychological distress was unrelated to either type of discrepancy.

Who are we missing?

Given the low agreement across these two self-report assessments, it is reasonable to ask which assessment is more accurate in capturing 'true NSSI'. In general, continuous scores of psychopathology (i.e., behavioural checklists scores) are more reliable than discrete scores (i.e., single item scores; Markon et al., 2011). However, in the absence of a comprehensive objective measure of NSSI neither assessment type can be compared relative to 'true NSSI'. Given this difficulty, one path forward is to identify 'who' each assessment type captures. Our results suggest that common practises of measuring NSSI with single-item assessments or two-step procedures (single item before additional NSSI assessments like checklists) are more consistently capturing people who self-injure by cutting, but are more likely to miss people who engage in less prototypical behaviours or those who do not identify as someone who self-injures.

We now turn to consider participants who report engaging in NSSI behaviours but who are 'missed' by single-item assessments. Compared to participants who report an NSSI history on both the single-item and the behavioural checklist, participants who typically would have been incorrectly screened out reported less frequent NSSI, were less likely to self-injure by cutting, and (in Study 1b only) were more likely to be men. Excluding these participants creates four key problems for a literature base built heavily on single-item and two-step assessments. First, relying on single-item and two-step assessment procedures likely overestimates gender differences and the predominance of cutting as a method of NSSI. Second, capturing only a 'more severe' NSSI population leads to misrepresentation (most likely under-estimation; Hunter & Schmidt, 1990) of the 'true' effect size of relationships between NSSI and other variables of interest. Third, systematically missing a proportion of the population who self-injures introduces error (and variance) for longitudinal work testing the effect of NSSI on subsequent well-being, curtailing our ability to understand the long-term repercussions of engaging in NSSI. Fourth, sampling only those who self-identify their self-injurious behaviours as NSSI greatly reduces our ability to understand the resilience of people who self-injure, as the most resilient people may be self-selecting out of such a sample. A literature base that underrepresents people who engage in NSSI behaviours, but do not label their behaviour as such, curtails our ability to advance scientific understanding of NSSI. Clinical translations of this research may result in intervention and prevention strategies that are not effective for all people who self-injure.

Where do we go from here?

Taken together, this research necessitates changes to how NSSI is measured and reported. The current research adds to growing evidence of poor agreement between NSSI self-report assessments (Lund et al., 2018; Lungu et al., 2018), and shows that two of the most common NSSI assessment types may be capturing overlapping, but different phenomena. One option to address this issue of poor agreement is to move away from self-reported questionnaire assessments altogether in favour of semi-structured interviews. Among community adolescents (Ross & Heath, 2002), and women engaged in clinical treatment for BPD (Lungu et al., 2018), more people were classified as having a lifetime history of NSSI when assessed with a self-report questionnaire compared to a semi-structured interview. This discrepancy has been interpreted as evidence that self-report measures overestimate NSSI (Lungu et al., 2018). However, in the absence of an objective measure of NSSI it is difficult to determine the accuracy of either self-report measures or semi-structured interviews. Indeed, many of the common interview instruments *begin* with a screening question assessing lifetime NSSI (e.g., the Self-Injurious Thoughts And Behaviours Interview, which begins with *'Have you ever had thoughts of purposely hurting yourself without wanting to die?*'), followed by branching dependent on a *'no'* (skip to next section) or *'yes'* response (questions about behaviour and frequency; Nock et al., 2007). That is, semi-structured interview assessments typically *also* follow a two-step assessment procedure, and it remains to be seen if similar patterns of discrepancy as with self-report questionnaires might be evident.

A second option for addressing this measurement problem is to distinguish between NSSI operationalised as 'engaging in self-injurious behaviour(s)' captured by behavioural checklists and 'self-identification as a person who self-injures' captured by single-item and two-step assessments. Distinguishing between *behaviourally-identified* and *self-identified* NSSI may provide greater conceptual precision within both the empirical literature and in client assessment notes. The choice of which assessment type to use is therefore dependent on the research question under investigation, as the two operationalisations of NSSI provide different information. For instance, the Interpersonal–Psychological Theory of Suicidal Behaviour, a prominent theory of suicide, argues that when a person engages in NSSI behaviour over time they become habituated to the psychophysiological aversiveness of self-injury which, in turn, increases capability for subsequent suicidal behaviour (Joiner et al., 2005). In this instance, engaging in NSSI *behaviour* is the mechanism by which NSSI confers risk of subsequent suicide, rather than the self-identification as a person who engages in

NSSI. Therefore, capturing behaviourally-identified rather than self-identified NSSI is warranted. We encourage researchers to consider this distinction and report their decision-making process.

Limitations and future directions

Across two samples, we found evidence that behavioural checklists and single-item assessments capture different aspects of NSSI. However, this conclusion comes with at least two caveats. First, the single-item assessment has a greater reading complexity than the behavioural checklist, requiring participants to hold in working memory four Boolean alternatives (i.e., 'or'; '*Please indicate whether you have had thoughts about hurting yourself on purpose, or whether you have hurt yourself on purpose (e.g., punched yourself or objects like walls, prevented wounds from healing, or cut, burnt, scratched or carved your skin, etc*)'. Experimental manipulations have revealed that greater reading complexity results in longer response times and more mid-point responses (interpreted as a 'no-opinion' response; Lenzner et al., 2010; Velez & Ashworth, 2007), suggesting that working memory load can influence how participants respond to items. Thus, the greater working memory load of the single-item relative to the behavioural checklist may be an alternative explanation for the discrepancy across NSSI assessments. It is worth noting that all participants in Study 1a and 1b had met the literacy requirements for university enrolment, and so these samples are likely to be more homogenous *and* highly literate than the general population. Thus, if reading complexity did indeed play a role in the assessment discrepancy effect, then we could expect that this effect would be even greater in a more general sample. This hypothesis could be tested in future systematic reviews by calculating the reading complexity of each assessment using well-established techniques (e.g., Peter et al., 2018) before using reading complexity in a meta-regression to assess whether reading complexity of assessment is negatively associated with lifetime NSSI prevalence rates across studies.

A second caveat is the use of university samples. Although the majority of NSSI research has been conducted with university samples (Swannell et al., 2014; and thus a strength of the current work is that it tests the agreement of common assessments within commonly used samples), university samples are only able to provide a truncated understanding of human psychology, including mental health (e.g., Auerbach et al., 2016; Kovess-Masfety et al., 2016). In particular, 90.7% of participants were aged 17-20 and so the current studies do not contain an adequate age range to stringently test the prediction that if NSSI is seen as something (only) younger people do, then older participants should be more

likely to report discrepant NSSI histories across assessments. Thus, these analyses should be considered exploratory. Given that NSSI peaks in mid-adolescence and young adulthood (Gandhi et al., 2018; Plener et al., 2015), and that sample characteristics are associated with choice of assessment type (Swannell et al., 2014), replication across different ages and developmental stages will assist in establishing the generalisability of the current studies and to more stringently test whether age moderates assessment discrepancy. Given that NSSI varies across cultures (Gholamrezaei et al., 2017), replication in other countries and cultures is warranted.

Study 1a and 1b are also unable to shed light on *why* participants show discrepancy across NSSI assessments, only who is *more likely to* report discrepancies. When adolescents who had reported discrepant suicide histories were asked to explain the discrepancy, many reported changing their operational definition of suicidal behaviour across assessments, or misunderstanding the instructions (Velting et al., 1998). Future research could establish whether these explanations extend to NSSI assessments by using a mixed design where participants who report discrepant responses across a single-item and a behavioural checklist are later interviewed and asked to explain *why* they reported different NSSI histories. Understanding the explanations that participants give for their discrepant responding may help identify the mechanism(s) that distinguish behaviourally-identified NSSI from self-identified NSSI. Given that people who self-injure often feel ashamed about their self-injury (Rosenrot & Lewis, 2018; Stacy et al., 2017), one possibility is that reporting a NSSI history on a single item (i.e., self-identification as a person who self-injures) creates more shame and judgement for the respondent than does a behavioural checklist, and so fewer people report their history of NSSI on a single-item. Future research could test this potential mechanism by manipulating shame (e.g., by inviting participants to recall a past shameful experience) prior to completing both single-item and behavioural checklist assessments of NSSI, or by assessing whether people who demonstrate greater socially desirable responding are more likely to report discrepant responses.

Distinguishing between behaviourally-identified and self-identified operationalisations of NSSI also necessitates future research comparing the two. We found that people who engage in NSSI behaviours, but do not self-identify as a person who self-injures, engage in fewer NSSI methods, and have done so less recently. Given the cross-sectional nature of these studies, the direction of this relationship remains unclear. Perhaps people with less severe NSSI are less likely to subsequently identify with the behaviour. Or perhaps people who identify as someone who self-injures are more likely to subsequently

self-injure with greater severity. Longitudinal research tracking the relationship between behaviourally-identified NSSI and self-identified NSSI over time may provide valuable insight into who self-injures and who identifies as someone who self-injures.

What do these findings mean for this thesis?

I now return to the broader aim of these studies to consider how 'best' to assess NSSI in subsequent studies investigating emotional responding in NSSI. First, the high prevalence of lifetime and past-year NSSI in both Study 1a and Study 1b demonstrates the feasibility of recruiting participants for future studies from this population. Second, the discrepancy between NSSI assessments offers clarity for how to operationalize NSSI. For the subsequent studies presented in this thesis I will classify the NSSI group as 'people who report engaging in NSSI *behaviour*', regardless of whether they self-identify as a person who self-injures. In contrast, I classify the Control group as 'people who report no engagement in NSSI behaviours'. The rationale behind this decision was two-fold.

First, I wanted to classify the NSSI group in a manner most similar to previous research. Doing so allows me to situate my work more directly within the current evidence-base and draw valid comparisons across studies regarding the role of emotional responding in NSSI. Although we are the first to describe and distinguish between behaviourally-identified and self-identified NSSI, much of the current NSSI literature has assessed NSSI with a behavioural checklist (Swannell et al., 2014). Thus, people who are identified as engaging in NSSI using this assessment type are, by default, identified on the basis of their NSSI behaviour, making a behavioural-identification approach most consistent with previous research.

The second factor was a pragmatic consideration of sample size and, relatedly, statistical power. A more conservative criteria would have been to require both behavioural and self-identification for the NSSI group. However, I was mindful that adding additional eligibility criteria for my NSSI group for Study 2 and 3 of this thesis would reduce the number of potential participants within the recruitment pool, further restricting the number of participants I would be able to recruit to a laboratory-based session within any given year. For instance, more than a third (Study 1a: 39.4%; Study b: 39.5%) of participants who reported engaging in NSSI behaviour reported 'NSSI thoughts only' or 'no NSSI history' on the single-item. Requiring self-identification of NSSI in addition to behaviourally-identified NSSI would have reduced the recruitment pool by $n = 146$ in Study 1a (39.4% of the $n = 371$ participants who reported engaging in NSSI behaviours) and $n = 187$ in Study 1b (37.0% of

the *n* = 506 participants who reported engaging in NSSI behaviours), before additional exclusions (e.g., gender, consent to link data with future studies) were added. In contrast, requiring both behavioural-identification and self-identification for participants in the Control group only nominally reduced the hypothetical recruitment pool (Study 1a: *n* = 8; Study 1b: *n* = 9)—reflective of the very assessment discrepancy effect we establish in Study 1a and Study 1b. Therefore, I decided against requiring self-identification of a history of NSSI in addition to behavioural identification for this thesis.

Conclusion

Across Study 1a and 1b, we found that approximately a third of participants reported different NSSI histories between a behavioural checklist and a single-item measure. Counter to predictions, neither memory nor careless responding explained this assessment discrepancy. Instead, participants who engaged in cutting as a method of NSSI—the 'prototypical' method of NSSI—were more likely to self-identify a history of NSSI on the single-item. Critically, this suggests that the poor agreement across two of the most common NSSI assessments types may be systematic, rather than the result of random error. The subjective interpretation of 'what counts as NSSI' within single-item and two-step screening measures creates the need for greater conceptual clarity in how NSSI is defined and measured. These studies add to growing evidence from young adult, adolescent, and military samples that between 9% to 35% of participants report inconsistent self-injury histories across assessments (Fliege et al., 2006; Gratch et al., 2020; Hom et al., 2016, 2019; Mars et al., 2016), raising substantial psychometric concerns for the field of self-injury research. Decisions concerning operationalisation lie at the heart of many psychological questions and we are obliged to get these decisions as 'right' as we are able. Failure to do so impedes our scientific understanding and, especially when we conduct research we hope will inform prevention and intervention, risks resulting in recommendations that will, at best, make a less positive impact than we hope and, at worst, harm our communities of interest. Having established how best to assess NSSI, I now return to investigate the possibility that NSSI is characterised by alterations in real-time emotional responding.

Chapter 4: Emotional responding to acute stress in non-suicidal self-injury

Thus far, I have established a behavioural checklist as the best way to assess NSSI when I need to select participants based on NSSI status. I now return to consider the central question of this thesis: is NSSI characterised by alterations in real-time reactivity to and recovery from to emotional challenges? In this chapter, I present a deep dive into real-time, multi-channel emotional responding to a well-established acute stress manipulation among people with a past-year NSSI history and people with no NSSI history.

To recap, mainstream theories of NSSI have proposed that an amplified emotional response and poorer emotion regulation skills create the context for NSSI (Chapman et al., 2006; Hasking et al., 2016; Nock, 2010). Consistent with these theoretical assertions, people who engage in NSSI consistently report greater global emotion reactivity and emotion dysregulation (e.g., Wolff et al., 2019; You et al., 2018). In addition, global self-reports of emotional functioning predict future NSSI onset (e.g., Robinson et al., 2019), and reduced NSSI behaviour following therapeutic intervention (e.g., Asarnow et al., 2021). Together, these findings have led to suggestions that NSSI is characterized by pervasive emotional dysregulation. However, this interpretation relies on inferences about the generation and recovery of the emotional response without directly observing this process in real-time.

Capturing multi-channel emotional responding in real-time

Despite the well-established differences in global emotional functioning by NSSI status, research assessing real-time responding to emotional challenge manipulations is much more mixed (for an overview, see Table 1 in Chapter 2). Most of the research in this domain has focussed on how people who self-injure subjectively react to emotional challenges. Two studies have found that, compared to people with no history of self-injury, people who self-injure experienced greater negative mood reactivity to conflict discussions (Kaufman et al., 2019), and, for people with both NSSI and BPD, imagined social rejection (Gratz et al., 2019). In contrast, other studies have found no difference in how people with and without a history of self-injury subjectively respond to anger inductions (Weinberg & Klonsky, 2012), sad film clips (Davis et al., 2014; Mettler et al., 2021), acute social stress (Kaess et al., 2012), personally-relevent social distress or criticism scripts (Allen et al., 2019; Gratz et al., 2011, 2019), or social exclusion paradigms (Groschwitz et al., 2016; Schatten et al., 2015). Still other studies have reported that, compared to people with no history of self-injury, people

who self-injure show *reduced* subjective reactivity when writing about a personal failure (Bresin & Gordon, 2013) or watching a sad film clip (Boyes et al., 2020).

This pattern of mixed findings extends to studies which have assessed physiological reactivity to emotional challenge manipulations. Again, some studies have found that, compared to people with no history of self-injury, people who self-injure show greater reactivity in skin conductance (Nock & Mendes, 2008), RSA (Crowell et al., 2005), and cortisol responses to emotional challenge (Kaess et al., 2012). In contrast, other research has found no difference by self-injury status in skin conductance (Crowell et al., 2005; Tatnell et al., 2018), RSA (Kaufman et al., 2019), cortisol (Plener et al., 2017), or heart rate (Kaess et al., 2012) responses to emotional challenge. Taken together, to date there is limited evidence to suggest that people who engage in self-injury show greater subjective or physiological responses to emotional challenges compared to people with no history of self-injury.

Although previous research has investigated reactivity to emotional challenge, only a handful of studies have investigated subsequent recovery from challenge—a critical component of emotional responding, and perhaps more in keeping with the theoretical position that NSSI reflects poor emotion regulation. Boyes and colleagues (2020) found that young adults who engaged in NSSI experienced more prolonged negative affect following a sad film clip than did those with no history of NSSI. In contrast, Mettler and colleagues (2021) found that both women who engaged in NSSI and those with no history of NSSI experienced a similar subjective recovery following a sad film clip. Within physiological channels of emotion, adolescent women with and without a history of self-injury showed similar patterns of RSA and skin conductance recovery from emotional challenge (Crowell et al., 2005). Taken together, there is little investigation into whether people who engage in NSSI show impaired subjective or physiological recovery from emotional challenge compared to controls.

Where to from here?

As discussed in Chapter 2, drawing firm conclusions from these mixed findings is difficult. There is considerable variability in how self-injury is conceptualised and selected for across studies, and the majority (64.3%, $k = 9$) of the studies which focus on NSSI specifically are conducted with people who report a lifetime NSSI history—many of whom may no longer self-injure. In addition, 68.4% ($k = 13$) of previous studies have included samples comprised of both men and women, adding additional variation in NSSI presentation features, as well as emotional evaluations. These challenges to interpretation are exacerbated

by small sample sizes, particularly for the self-injury group (*M n* = 37.00, *SD* = 16.53), and especially for studies which assess emotional responding across both subjective and physiological channels (of the three studies, *M n* = 24.67, *SD* = 9.24). Thus, well-powered, investigation of how women[23] with a recent history of NSSI respond to well-established emotional challenges across multiple channels of emotion is needed. In addition to overcoming the limitations of previous research investigating real-time emotional responding in people who self-injure, Study 2 tests two alternative explanations for why we see poorer global emotional functioning in people who engage in NSSI.

Looking beyond the emotional response

Perhaps people who engage in NSSI report poorer global emotional functioning because they are less likely to use effective emotion regulation strategies during emotional challenge than people with no history of NSSI (Gross & Jazaieri, 2014). To date, only one study has assessed how people who self-injure respond when directed to use regulation strategies to manage real-time emotional challenge. Relative to both a control group without self-injury and a depression-matched control group, adults with a lifetime history of self-injury experienced a similar increase in negative affect to a sad film clip (Davis et al., 2014). Although both the Healthy Control and Depression Control groups were able to reduce their negative affect following reappraisal instructions, the Self-Injury group showed no improvements in affect (Davis et al., 2014). In a second sample, adults with a history of self-injury showed greater amygdala activation while under reappraisal instructions, suggesting ongoing emotional processing, compared to those with no history of self-injury (Davis et al., 2014). This study provides preliminary evidence that people who self-injure are less effective at using reappraisal to repair negative mood. However, to date no research has investigated how people who engage in NSSI *spontaneously* use emotion regulation strategies during real-time emotional challenge. In addition to a person's ability to effectively implement regulation strategies, their choice of whether or not to deploy strategies in a specific context, and which strategy they select is critical to understanding how people who engage in NSSI regulate their emotions in daily life.

[23] Of course, we could have achieved our goal of limiting variability by focusing on young men or gender diverse people rather than young women. We chose to focus on young women for pragmatic reasons—the majority of potential participants within our recruitment pool are female. For instance, in Trimester 2 of 2018 when we began Study 2 data collection, 76.0% of participants who completed our eligibility screener identified as female, compared to 23.0% who identified as male, and 1.0% of participants who identified as gender diverse.

A second possibility is that the differences in global emotional functioning by NSSI status may not lie in the emotional response at all, but rather in how that emotional response is later *remembered*. Global self-report assessments typically require people to reflect on past emotional experiences and indicate how they *typically* feel and respond, making them subject to memory and inferential biases (Schwartz et al., 1999; Solhan et al., 2009). The affect associated with autobiographical events typically fades over time, with unpleasant events showing greater emotional flattening over time than positive events (e.g., Walker et al., 1997, 2003). However, this emotional flattening is reduced or eliminated among people with symptoms of depression (Marsh et al., 2019), anxiety (Walker et al., 2014), and eating disorders (Ritchie et al., 2019); all forms of psychopathology which co-occur with NSSI (Nock et al., 2006; Svirko & Hawton, 2007). NSSI is also associated with the tendency to ruminate on unpleasant events (Hoff & Muehlenkamp, 2009; Selby et al., 2013). Thus, preliminary research suggests that understanding how people who engage in NSSI remember emotional challenges may prove important for understanding their global emotional functioning.

Study 2

Although people who engage in NSSI consistently report experiencing greater emotion reactivity and emotion dysregulation than their peers, the cause(s) of these differences is unknown. In Study 2, we test two mutually exclusive hypotheses that, relative to people with no history of NSSI; (i) people who engage in NSSI generate a more intense subjective and physiological response to emotional challenge; or (ii) generate a similar physiological response but appraise it as more intense. We then test two non-exclusive hypotheses that, relative to people with no history of NSSI, people who engage in NSSI: (iii) are less effective at recovering, both subjectively and physiologically, from an emotional challenge; and (iv) later go on to remember their emotional experience as more intense. Finally, we explore the extent to which people who engage in NSSI spontaneously engage in cognitive reappraisal and expressive suppression strategies during emotional challenge. Preregistered hypotheses, predictions, design, and analytical plans for Study 2 are available at https://osf.io/px534/ and in Appendix E.

Participants

One hundred and one young adults (*M* age = 18.72, *SD* = 1.29) were recruited from an undergraduate research pool between 3rd August 2018 – 3rd May 2019 on the basis of their NSSI history; 51 participants reported a past-year history of NSSI behaviour and 50 reported

no lifetime history of NSSI behaviour.[24] To be eligible to participate in this study, young adults had to be women[25] aged 17-25 years old, fluent in English, able to use a computer mouse and keyboard, with normal (or corrected to normal) eyesight, and consent to take part in self-injury related research. The majority of participants (87.04%) identified as Pākehā/ New Zealand European, 10.19% identified as Māori, 3.70% as Samoan, 2.78% as Chinese, 0.93% as Indian, and 9.26% as a non-listed ethnicity. Participants completed the laboratory session for course credit, and voluntarily took part in the follow-up survey.

General procedure

Ethical approval was obtained from Victoria University of Wellington's Human Ethics Committee. Eligible students (as assessed in an online screening survey at the beginning of the trimester) were invited to take part in an in-person experiment in the laboratory. Participants were not told prior to debriefing that recruitment was based on NSSI status in order to limit group specific demand characteristics. Both experimenter and confederate were blind to the participant's NSSI-status. See Figure 6 for an overview of the Study 2 procedure.

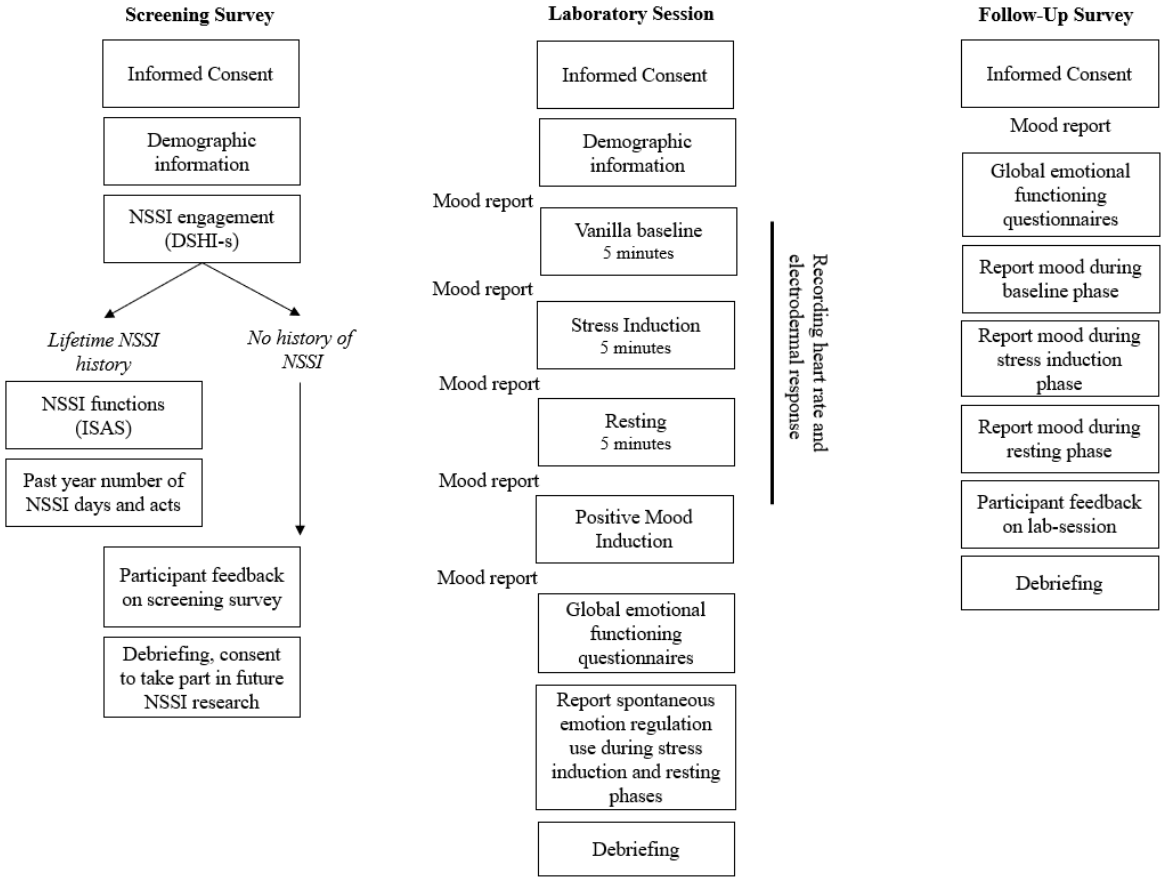
During the laboratory session, participants provided informed consent, reported their demographic information, and any health diagnoses or prescription medications. Next participants completed three phases of emotional challenge: a five-minute baseline phase, five-minute stress induction phase, and the five-minute recovery phase. Heart rate and electrodermal activity were continuously recorded during each of the three phases and after each phase participants reported their current mood. Following the recovery phase, participants completed a positive mood induction, followed by questionnaires assessing their spontaneous use of cognitive reappraisal and expressive suppression during the recovery

[24] A-priori power analysis aimed to provide a sample size large enough to detect an interaction between NSSI status and Phase across the three channels of emotional responding. Based on the difference in electrodermal reactivity by NSSI status described by Nock and Mendes (2008; $d = 0.57$), G*Power analysis indicated a total sample size of 28 (14 per group) would be sufficient at 0.8 power to detect an effect size of Cohen's $f = 0.29$). Based on the difference in mood repair by self-injury status described by Davis et al. (2014; $\eta p^2 = .09$), G*Power analysis indicated a total sample size of 22 (11 per group) would be sufficient at 0.8 power to detect an effect size of Cohen's $f = 0.31$). Given the mixed evidence for a difference in real-time emotional responding by NSSI status, these effect sizes are likely overestimates. We decided to approximately triple the sample-size suggested by a-priori power analysis ($n = 101$) to ensure that we had enough participants to test our hypotheses.

[25] Eligibility was assessed during a screening survey. During the laboratory session, one participant reported their gender identity as genderfluid. We conducted the analyses presented here with, and without, this participant and the overall pattern remained consistent. We report analyses which include this participant and refer to our participants as young adults rather than young women.

Figure 6

Study 2 procedure across the screening survey, laboratory session, and follow-up survey



phase, as well as their global emotion reactivity and emotion dysregulation. Two weeks after the laboratory session, all participants were invited to take part in an online survey where they reported how they remembered their subjective experience during the baseline, stress induction, and recovery phases of the laboratory session.

Non-suicidal self-injury

At the beginning of the trimester (i.e., 2–12 weeks before participation in the laboratory session), all prospective participants completed the simplified Deliberate Self-Harm Inventory (DSHI-s; Lundh et al., 2007) as part of a screening survey. As described in Chapter 3, the DSHI-s asks *'Have you ever deliberately (but without wanting to kill yourself) ...'* before listing 13 common NSSI behaviours, such as *'cut your wrist, arms, or other areas of your body'* to which participants respond on a 5-point scale ranging from '*0 – I've never thought about doing this'* to *'4 – I've done this many times'*. As in Study 1a and 1b, the

DSHI-s response format was modified to include NSSI ideation and to be appropriate within an Aotearoa New Zealand context (Robinson et al., 2017). For the full measure, see Appendix C. The DSHI has been validated for use in young adult samples (Gratz, 2001), and showed good internal reliability in this sample (α = .87). We calculated the number of NSSI methods a participant reported engaging in within their lifetime (range: 0 13) as an index of lifetime NSSI severity.

During the screening survey, participants who reported engaging in NSSI behaviours also reported how many times in the last year they had engaged in NSSI, on how many days, and the functions of their NSSI. As described in Chapter 2, the Inventory of Statements About Self-Injury (ISAS) assesses 13 possible functions of NSSI which broadly map on to two superordinate groups: intrapersonal functions describing patterns of self-focused NSSI reinforcement (comprised of affect regulation, self-punishment, anti-dissociation, anti-suicide, marking distress, and self-care functions) and interpersonal functions describing patterns of social reinforcement (comprised of autonomy, interpersonal boundaries, interpersonal influence, peer-bonding, revenge, sensation-seeking, and toughness functions; Klonsky & Glenn, 2009). Participants were invited to respond to 39 items such as *'When I self-harm, I am calming myself down'* on a 3-point scale ranging from *'0 – Not relevant'* to *'2 – Very relevant'*. For the full measure, see Appendix F. Consistent with previous use (e.g., Klonsky & Glenn, 2009), both the Intrapersonal (α = .88) and Interpersonal (α = .81) subscales showed adequate internal consistency within this sample.

Acute stress manipulation

To capture baseline subjective and physiological measures of affect, participants completed a nondemanding, colour-counting task for five-minutes (Jenning et al., 1992) while sitting still and alone in the testing room. This 'vanilla baseline' is often used in affective science research with clinical groups (e.g., Gratz et al., 2019) as the task results in less anxiety than sitting quietly without instruction (Jenning et al., 1992).

We then induced emotional challenge for five minutes using the mathematics component of the Trier Social Stress Test (TSST; Kirschbaum et al., 1993). In this task, the experimenter (Robinson) told participants that they would complete a mental arithmetic task assessing working memory and verbal intelligence, administered by an evaluator who is specially trained to assess verbal and non-verbal behaviour (in reality, an older male confederate). The confederate maintained a neutral, professional manner while instructing the

participant to count aloud backwards from 2023 in intervals of 17 as quickly and as accurately as possible. Participants were instructed to restart each time they made an error, and those who performed well in the task were pressed to count faster. See Appendix G for greater details of the acute stress protocol. This task has been shown to reliably induce acute psychophysiological stress within laboratory settings (Kudielka et al., 2007).

Finally, to capture recovery from emotional challenge, participants were told that the working memory task was finished, and that their task was to sit and relax. Our goal was to assess recovery while participants were left to regulate their own emotions (i.e., spontaneous regulation), and so participants were not given a vanilla task in the recovery phase. Participants were left to sit alone in the testing room for five minutes.

Real-time emotional responding

Subjective emotional response. Subjective mood was assessed immediately following the baseline, stress, and recovery phases of the laboratory session using visual analogue scales. Participants were invited to rate the degree to which they experienced nine feelings (happy, sad, angry, anxious, stressed, jittery, frustrated, embarrassed, and ashamed) in the present moment using a 17.8cm visual analogue scale that ranges from '*0 – Not at All'* to *'100 – Extremely'*, presented on the computer screen. Participants responded by moving the marker with the computer mouse from its original placement at the midpoint (i.e., 50). The order of the nine moods was randomised at each assessment and for each participant. Happiness was reverse coded, and participants' responses at each time point were averaged to create an overall score of negative mood that ranged from 0 to 100.

Physiological responding. Physiological responding was captured using heart rate and electrodermal response (EDR). Changes in heart rate are regulated by the dual influence of the sympathetic and parasympathetic branches of the autonomic nervous system on the sinoatrial node. Heart rate was measured using electrocardiogram (ECG), which tracks the depolarisation of the heart muscle and was recorded using three disposable adhesive Ag-AgCl foam ECG electrodes (Kendall Meditrace, Tyco Healthcare). A Lead II system was used with electrodes positioned on the right side of the chest (negative) and left ribcage (positive), referenced to a ground electrode on the left side of the chest. The two chest electrodes were positioned below the clavicle and medially adjacent to the coracoid process. The rib electrode was positioned directly below the left chest electrode, below the left ribcage. After familiarisation with the equipment, participants attached the ECG electrodes in a private room with a diagram for reference. The experimenter then verbally checked that

electrodes had been placed in the correct location and attached the electrodermal response electrodes. Changes in skin conductance reflect the cholinergically mediated influence of the sympathetic nervous system on eccrine sweat gland secretion. Electrodermal activity was recorded using ADInstruments MLT116F EDR dry electrodes attached to the medial phalanx of the index and ring fingers of the right hand. Electrodermal activity was sampled at 1000 Hz and amplified using a EDR Amp (ML116; AD Instruments, Australia). ECG was sampled at 1000 Hz and amplified using an ADInstruments ML408 Dual Bio Amp/Stimulator. Analogue signals were converted to digital via a PowerLab 16/30 Amplifier (ML880; ADInstruments, Australia). Digitized signals were recorded by LabChart Pro 8.0 software (ADInstruments, Australia) on a Dell Optiplex 9020 computer, running Windows 7 Enterprise operating system. The experimenter or, during the stress induction, the confederate, entered triggers in to the LabChart recording to mark the beginning and end of each phase.

ECG data was filtered offline using LabChart version 8 (ADInstruments, 2014), with a band-pass filter of 8–40 Hz to remove slow movement-related artifacts. R–wave spikes more than two standard deviations above mean activity were identified as peaks, with heart rate calculated using the inter-beat interval (the time between R-wave spikes) and then converted to number of beats per minute. Electrodermal activity was converted from volts to micro-Siemens (μS) offline (1 V = 20 μS) and smoothed at 999 samples per second using a median filter. Physiology data recorded during the first 30 seconds of each of the three phases was excluded to allow the participant to habituate to the experience of the task and to allow the experimenter to exit the recording room. Two experimenters visually inspected the ECG and electrodermal activity channels for artefacts and any disagreements were resolved. Raw averages of heart rate and electrodermal activity in the baseline, stress, and recovery phases were used for analysis.

Global emotion reactivity and emotion dysregulation

Global emotion reactivity was assessed with the 21-item Emotion Reactivity Scale (ERS; Nock et al., 2008). Participants responded to items such as *'I tend to get very emotional very easily'*, on a 5-point Likert scale ranging from *'0 – Not at all like me'* to *'4 – Completely like me'*. For the full measure, see Appendix H. Consistent with previous use (Nock et al., 2008), the ERS showed good internal reliability ($\alpha = .93$). Items are totalled to create an overall score of global emotion reactivity. Global emotion dysregulation was assessed with the 16-item brief version of the Difficulties in Emotion Regulation Scale

(DERS-16; Bjureberg et al., 2016). Participants respond to items such as *'When I'm upset, I believe that I will remain that way for a long time'* on a 5-point scale from *'1– almost never (0-10%)'* and *'5 – Almost always (91-100%)'*. For the full measure, see Appendix I. Item scores were totalled to give an overall score of emotion dysregulation. Consistent with previous use (e.g., Bjureberg et al., 2016), the DERS-16 showed good internal reliability (α = .94).

Spontaneous reappraisal and suppression use

Participants completed a modified version of the 10-item Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) to assess the extent to which they spontaneously engaged in cognitive reappraisal and expressive suppression during the Recovery Phase. Each item of the questionnaire was modified to begin with *'During the resting task…'* (for a similar context-dependent modification, see Ford, Feinerg, et al., 2018). Participants responded to items such as *'When I wanted to feel more positive emotion (such as joy or amusement) I changed what I was thinking about'* and *'When I was feeling negative emotions, I make sure not to express them'* on a 7-point Likert scale ranging from '*1 – Strongly Disagree'* to *'7 – Strongly Agree'*. Six items make up the Cognitive Reappraisal subscale, and 4 items make up the Expressive Suppression subscale. For the full measure, see Appendix J. Consistent with previous use in university samples (e.g., Brewer et al., 2016), both the Cognitive Reappraisal (α =.91) and Expressive Suppression (α =.81) subscales showed good internal reliability. Items within each subscale were averaged to create an index of spontaneous reappraisal and suppression use during the Recovery Phase.

Memory of emotional challenge

Two weeks after the laboratory session, participants were invited to complete a follow-up online survey that assessed how they felt *during* the three phases of the laboratory session. Participants were instructed to report how they felt during the laboratory session, rather than how they currently felt about the laboratory session. Participants were invited to rate the degree to which they experienced the nine feeling labels (happy, sad, angry, anxious, stressed, jittery, frustrated, embarrassed, and ashamed) during the Baseline, Stress, and Recovery Phase of the laboratory session. The procedure of these mood reports was identical to those of the laboratory session reported earlier.

Ethical considerations

Although there is currently no evidence to suggest that taking part in NSSI and self-injury research causes iatrogenic effects (e.g., Gould et al., 2005; Muehlenkamp et al., 2015), given that we created emotional challenge for people who consistently report difficulties managing their emotional experiences, we included three processes to mitigate any potential iatrogenic effects. First, participants were explicitly told the study involved a challenging mathematics task before providing consent. Second, following the recovery phase, participants completed a mood elevation task designed to restore their mood to baseline levels where they watched a clip from a nature documentary describing the prosocial behaviours of the crested black macaque (https://www.youtube.com/watch?v=2IPCymrG9hA), followed by a 6-minute filler task rating photographs of nature scenes. Finally, at the end of the laboratory session participants were debriefed and given the opportunity to ask questions, thanked for their time, and provided with a list of support services in the community. Clinical support was available for any participant who experienced distress that was not alleviated by the cessation of participation and debriefing; however, this level of care was not required by any participant.

Missing Data

One hundred and eight young adults initially took part in the laboratory session. Seven were excluded from analysis. One participant was excluded for not following instructions, and six participants (NSSI $n = 4$, Control $n = 2$) chose to withdraw from the study (during or immediately after the stress phase). Participants recruited to the NSSI group were no more or less likely to withdraw from the study than those in the Control group, $\chi^2(1) = 0.67$, $p = .414$, Cramer's $V = .08$. One participant was excluded from heart rate analysis due to equipment failure, and one participant did not report baseline mood data. One participant left one item of the stress mood report blank. Given that a) the scale marker that participants move to indicate their response was automatically set at 50 (i.e., the midpoint), and b) the participant reported no ratings between 45 and 60 over the course of the laboratory session, this missing value was interpreted as a 50 response. There were no missing responses in the emotion regulation questionnaires, or the measures of global emotion reactivity or emotion dysregulation.

All 101 participants were invited to take part in a follow-up survey two weeks after the laboratory session, and 42 participants (NSSI group $n = 23$, Control group $n = 21$; 43.6% of total n) agreed to do so. Participants recruited to the NSSI group were no more or less

likely to complete the follow-up survey than those in the Control group, $\chi^2(1) = 0.51$, $p = .474$, Cramer's $V = .07$. Within a logistic regression, global emotional functioning and subjective and physiological responding during the stress phase were unrelated to whether or not participants took part in the follow-up survey (*p*s range from .982 for global emotion reactivity to .058 for EDR). There were no missing responses in any of the follow-up survey mood reports.

Analysis Plan

Statistical analyses were conducted using jamovi, mixed-effects models and graphing were conducted in R using lme4 (Bates et al., 2015) and ggplot2 (Wickham, 2016). Statistical significance was set at $p < .050$, with $p < .100$ considered a trend for predicted effects only. All analyses reported here were preregistered unless noted as exploratory, and all preregistered predictions are identified. Significant findings that were not predicted are noted as such. Exploratory analyses are corrected for multiple comparisons using Bonferroni corrections.

Chi-squared analyses tested for group differences in medication use and clinical diagnoses, and independent *t*-tests for group differences in measures of global emotion reactivity and global dysregulation. Mixed-model ANOVAs tested the hypothesis that people who engage in NSSI have a more reactive and more sustained response to emotional challenge with Phase (Baseline, Stress, Recovery) as a within-subjects factor and NSSI Status (NSSI, Control) as the between-subjects factor, with each of the three measures of emotional responding (heart rate, EDR, and subjective mood) as dependent variables. Exploratory mixed-effects models predicted momentary heart rate and EDR from NSSI Status (NSSI, Control) across the course of the three phases. Exploratory hierarchical linear regressions assessed whether NSSI characteristics are associated with real-time emotional reactivity and recovery. An exploratory mixed-model ANOVA assessed whether people who engage in NSSI use different emotion regulation strategies during recovery from emotional challenge with NSSI Status (NSSI, Control) as the between-subjects factor and Strategy Type (Reappraisal, Suppression) as a within-subjects factor. Finally, we tested the hypothesis that people who engage in NSSI amplify challenging emotional experiences in memory with a mixed-model ANOVA with NSSI Status (NSSI, Control) as the between-subjects variable, and Phase (Baseline, Stress, Recovery) and Time (During Session, Follow-Up) as the within-subjects variable.

Results

NSSI characteristics

All participants in the NSSI group reported engaging in NSSI at least once in the past year; 49.0% had done so 1–3 times, 11.8% 4–5 times, 21.6% 6–10 times, 11.8% 11–20 times, 3.9% 21–50 times, and 2.0% more than 50 times. On average, the NSSI group reported engaging in 3.45 (*SD* = 2.01) NSSI methods in their lifetime, most commonly scratching (70.6%) or cutting the skin (60.8%). Compared to the Control group, participants in the NSSI group were more likely to report having received a psychiatric diagnosis (45.1% vs. 14.0%, $\chi^2(1)$, = 11.69, $p < .001$, Cramer's $V = .34$), most commonly depressive disorders (27.5% vs. 2.0%), anxiety disorders (19.6% vs. 8.0%), eating disorders (13.7% vs. 4.0%), and trauma and stressor related disorders (9.8% vs. 0%). The NSSI group was no more likely to be taking prescribed medications (37.3% vs. 24.0%, $\chi^2(1)$, = 2.09, p =.149, Cramer's $V = .14$). Following birth control medication (21.6% of NSSI group, 12.0% of Control group), the most commonly reported medications were those that treat physical health concerns (e.g., iron deficiency, asthma; 17.6% vs. 14.0%) and anti-depressants (9.8% vs. 2.0%). The two groups did not differ by age, $t(99) = -.02$, $p = .983$, $d = -0.02$.

Global self-reports of emotion evaluations

See Table 4 for descriptive and inferential statistics across global self-report questionnaires, real-time emotional responding, and memory of emotional challenge. Consistent with a wealth of previous research, the NSSI group reported significantly greater global emotion reactivity and emotion dysregulation than did the Control group. Within the NSSI group, exploratory analyses revealed that lifetime number of NSSI methods was positively associated with global emotion dysregulation ($r = .52$, $p < .001$) and emotion reactivity ($r = .29$, p =.003), whereas of past-year NSSI frequency was positively associated with global emotion dysregulation ($r = .40$, $p < .001$) but not emotion reactivity ($r = .18$, p = .070).

Real-time emotional responding

Subjective response to emotional challenge

Figure 7 displays average negative mood across the laboratory phases separated by NSSI status. Average Negative Mood changed over the course of the laboratory session, $F(1.27, 124.63) = 108.06$, $p < .001$, $\eta_p^2 = .52$, Greenhouse-Geisser correction. Follow-up *t*-tests revealed that Negative Mood was elevated following the Stress phase compared to both Baseline ($t(99) = 11.46$, $p < .001$, $d = 1.15$) and Recovery phases ($t(100) = 12.25$, $p <$

Table 4

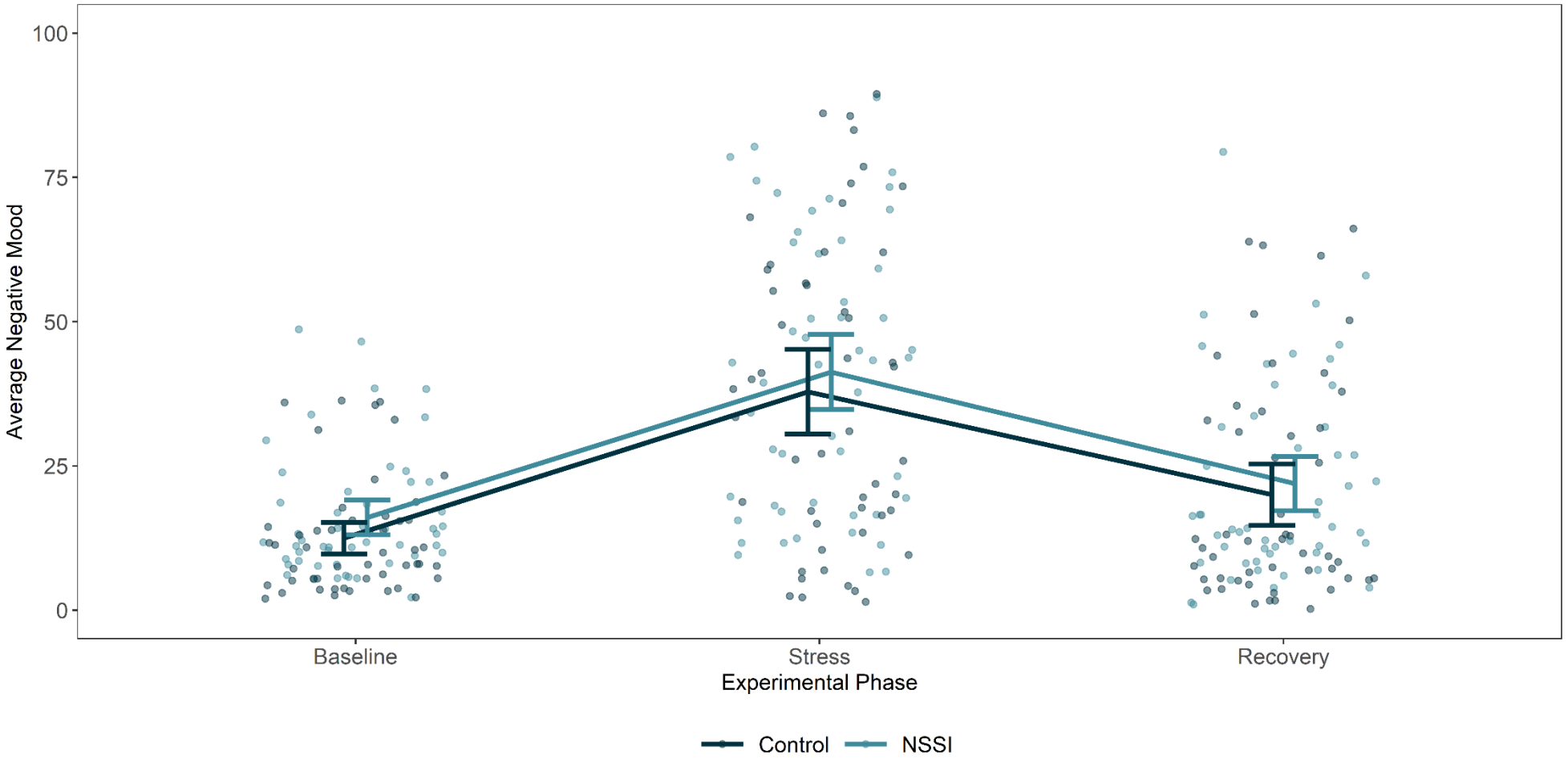
Descriptive and inferential statistics for global self-report measures and real-time emotional responding by non-suicidal self-injury status

Variable	Total Sample *Mean* (*SD*)	NSSI *Mean* (*SD*)	Control *Mean* (*SD*)	Inferential statistics
Global Self-Report				
Emotion Reactivity	1.99 (0.80)	2.30 (0.79)	1.67 (0.67)	$t(99) = 4.27$, $p <. 001$, $g = 0.93$
Emotion Dysregulation	2.58 (0.90)	3.05 (0.82)	2.11 (0.73)	$t(99) = 6.07$, $p <. 001$, $g = 1.21$
Real-Time Emotional Responding				
Negative Mood (0-100)				NSSI Status by Phase:
Baseline	14.27 (10.42)	16.06 (10.78)	12.48 (9.84)	$F(1.27, 124.63) = 0.29$, $p = .591$, $\eta_p^2 < .01$
Stress	39.80 (25.06)	41.40 (23.91)	37.85 (26.48)	
Recovery	20.97 (18.15)	21.97 (17.29)	20.97 (19.27)	
Heart Rate (BPM)				NSSI Status by Phase:
Baseline	78.73 (11.72)	79.16 (13.02)	78.29 (10.31)	$F(1.27, 124.63) = 0.82$, $p = .395$, $\eta_p^2 = .01$
Stress	94.42 (15.40)	95.75 (14.63)	93.03 (16.20)	
Recovery	74.85 (11.65)	75.10 (12.72)	74.60 (10.54)	
Electrodermal Response (μS)				NSSI Status by Phase:
Baseline	3.97 (4.44)	3.43 (4.41)	4.53 (4.44)	$F(1.51, 149.64) = 0.89$, $p = .389$, $\eta_p^2 = .01$
Stress	15.25 (7.84)	15.40 (8.79)	15.11 (6.83)	
Recovery	11.01 (7.06)	10.40 (8.31)	11.63 (5.52)	

Note. NSSI $n = 51$, Control $n = 50$. BPM = Beats Per Minute.

Figure 7

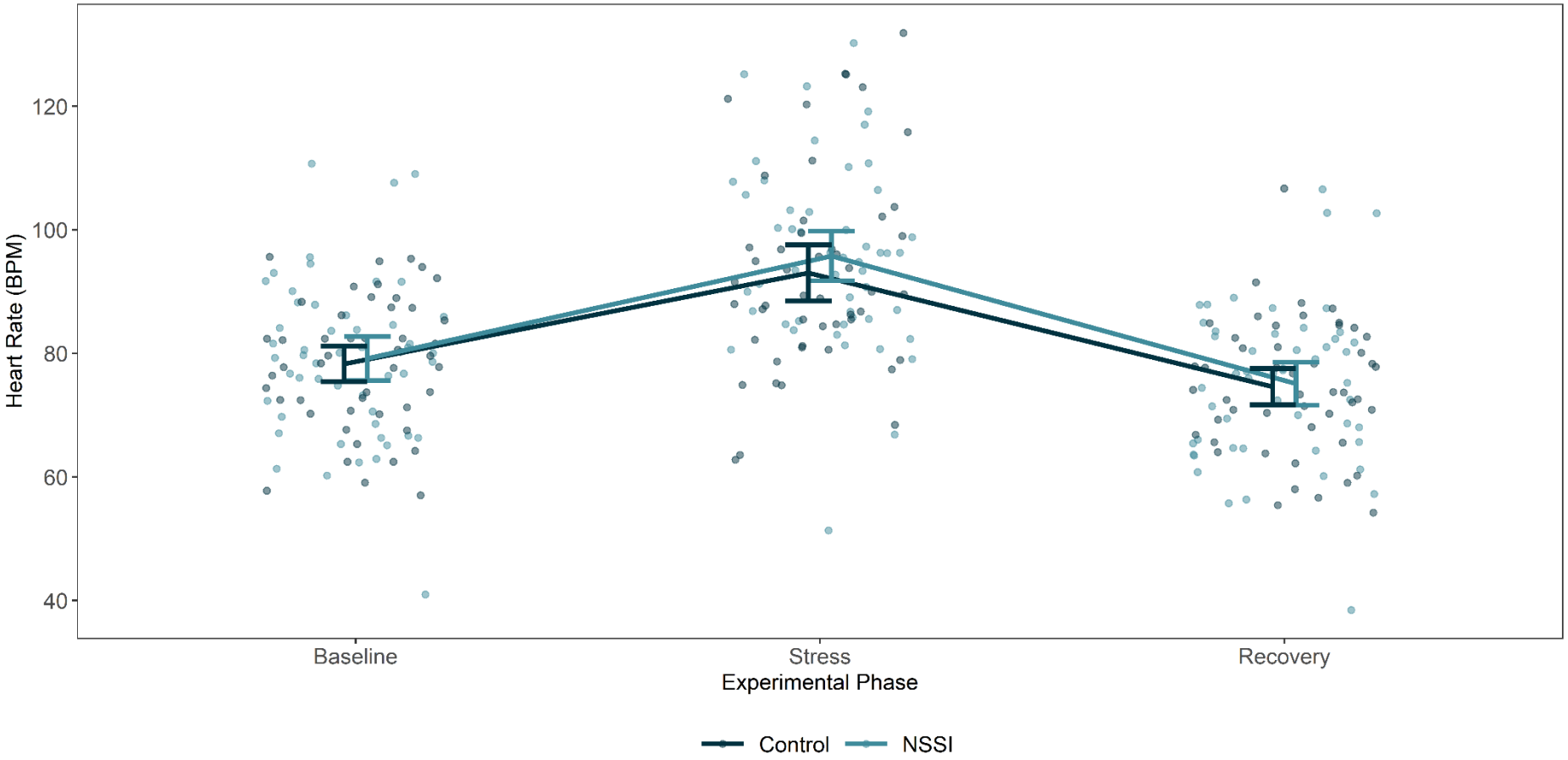
Average negative mood across laboratory session phases separated by non-suicidal self-injury status



Note. Scatter represents individual's responses at each phase, error bars represent 95% confidence intervals. NSSI n = 51, Control n = 50.

Figure 8

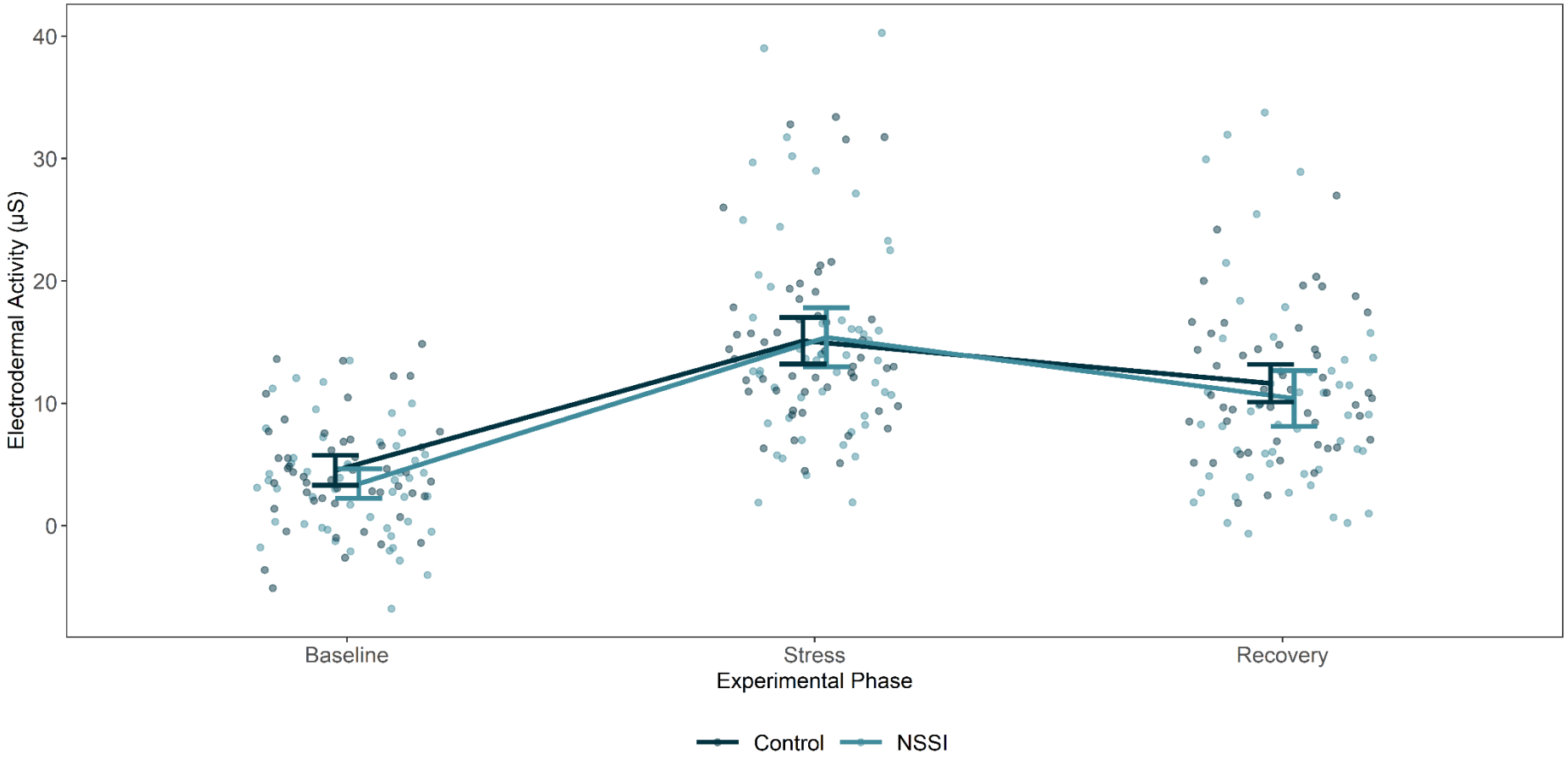
Average heart rate across laboratory session phases separated by non-suicidal self-injury status



Note. Scatter represents individual's responses at each phase, error bars represent 95% confidence intervals. NSSI n = 51, Control n = 50.

Figure 9

Average electrodermal responding across laboratory session phases separated by non-suicidal self-injury status



Note. Scatter represents individual's responses at each phase, error bars represent 95% confidence intervals. NSSI n = 51, Control n = 50.

.001, d = 1.22), suggesting that the acute stress induction was effective at creating increasing negative mood. In addition, negative mood was greater following the Recovery phase compared to Baseline ($t(99) = 4.48$, $p < .001$, $d = 0.45$), suggesting participants' negative mood did not completely return to pre-stress levels following the Recovery phase.

Focusing on NSSI, we found no evidence of a main effect of NSSI Status on Negative Mood ($F(1, 98) = 0.91$, $p = .343$, $\eta_p^2 = .01$) suggesting that groups did not differ in their overall negative mood across the course of the laboratory session. Critically, counter to the hypotheses that people who engage in NSSI generate a more intense emotional response to emotional challenge, or have a more sustained emotional response following emotional challenge than do controls, we found no evidence of an interaction between NSSI Status and Phase, $F(1.27, 124.63) = 0.13$, $p = .874$, $\eta_p^2 < .01$, Greenhouse-Geisser correction. Further inspection revealed no evidence of a NSSI Status by Phase interaction in any of the nine discrete moods assessed (see Appendix K).

Physiological responding to emotional challenge

Overall physiological responding. Next, we consider whether young adults with a recent history of NSSI show an amplified physiological response to emotional challenge compared to people with no history of NSSI. Figures 8 and 9 display heart rate and electrodermal responding, respectively, across the laboratory phases separated by NSSI status. Consistent with the pattern observed for negative mood, both Heart Rate ($F(1.27, 124.63) = 248.53$, $p < .001$, $\eta_p^2 = .72$, Greenhouse-Geisser correction) and EDR ($F(1.51, 149.64) = 160.91$, $p < .001$, $\eta_p^2 = .62$, Greenhouse-Geisser correction) changed over the course of the laboratory session. Follow-up t-tests revealed that both Heart Rate and EDR were elevated during the Stress phase compared to both Baseline (Heart Rate: $t(99) = 14.57$, $p < .001$, $d = 1.46$; EDR: $t(99) = 14.56$, $p < .001$, $d = 1.45$) and Recovery phases (Heart Rate: $t(99) = 17.77$, $p < .001$, $d = 1.78$; EDR: $t(99) = 9.30$, $p < .001$, $d = 0.93$), suggesting that the acute stress induction was effective at creating emotional challenge in physiological channels of emotion. Heart Rate was lower following the Recovery Phase compared to Baseline Phase ($t(99) = 8.51$, $p < .001$, $d = -0.85$), suggesting that participants' heart rate recovered to below baseline vanilla task levels. In contrast, EDR remained elevated following the Recovery Phase compared to Baseline Phase, $t(99) = 11.13$, $p < .001$, $d = 1.11$.

Focusing on NSSI, there was no evidence of a main effect of NSSI Status on either Heart Rate ($F(1, 98) = 0.33$, $p = .569$, $\eta_p^2 < .01$) or EDR ($F(1, 99) = 0.39$, $p = .343$, $\eta_p^2 <$

.01), suggesting that groups did not differ in their overall physiological response across the course of the laboratory session. Critically, counter to the hypotheses that people with a recent history of NSSI generate a more intense emotional response to, or impaired recovery from emotional challenge compared to controls, we found no evidence of an interaction between NSSI Status and Phase for Heart Rate ($F(1.27, 124.63) = 0.82$, $p = .395$, $\eta_p^2 = .01$) or EDR ($F(1.51, 149.64) = 0.89$, $p = .389$, $\eta_p^2 = .01$).

Moment-to-moment physiological responding. Given that Heart Rate and EDR were captured continuously within each of the three phases of the laboratory session, we next took an exploratory approach to consider if the NSSI group showed divergent physiological responding at *any point* across the three phases. For instance, although averaging across the Recovery Phase shows that the NSSI group recover from emotional challenge to the same extent as the Control group, relying on an average across the 4.5 minute Recovery Phase might obscure the fact that the NSSI group take longer to recover.

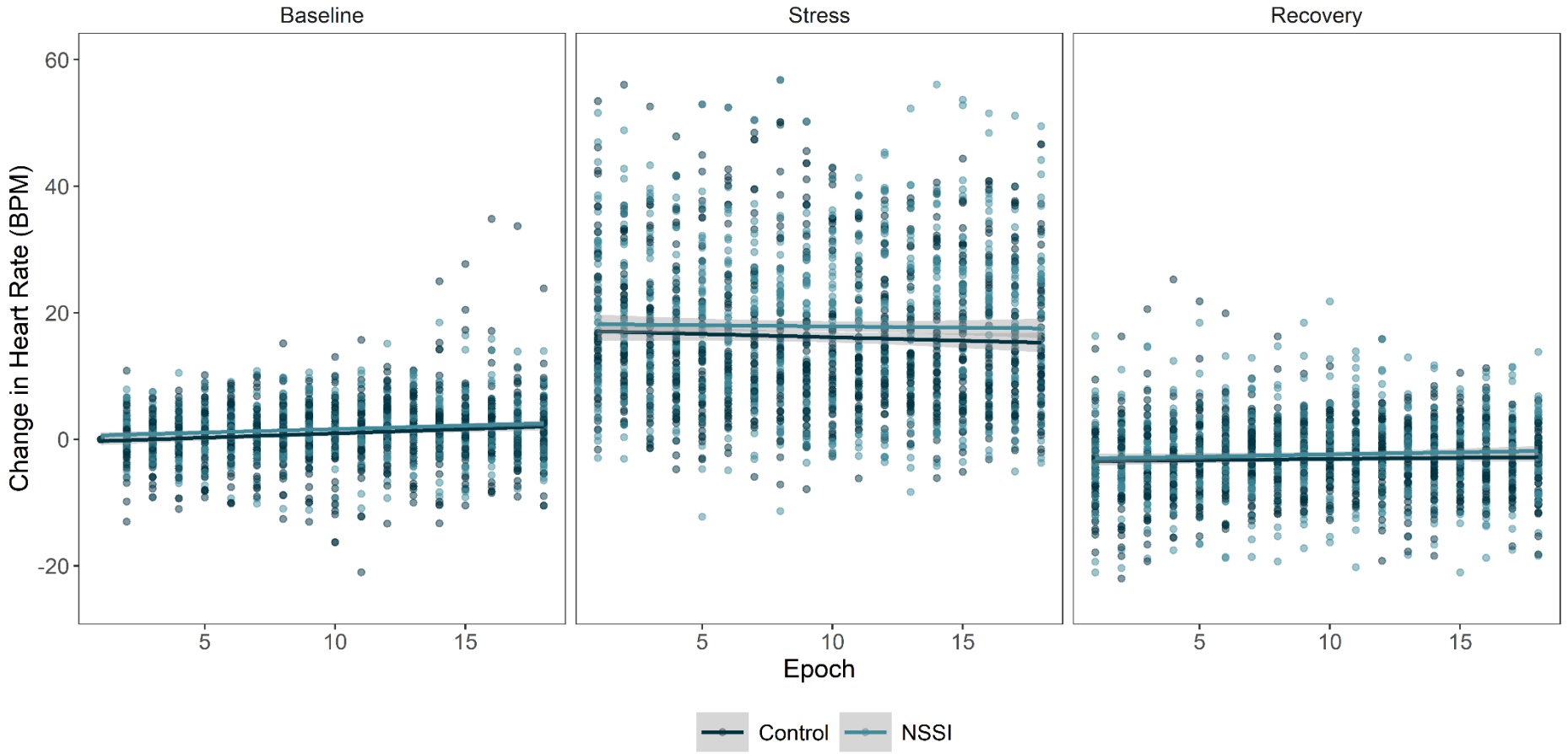
To assess for more fine-grained differences in emotional responding across the course of the experiment, the 4.5 minutes of each phase were split into 18 epochs of 15 seconds each to create a measure of Time, and the average physiological response within each epoch was calculated. Figures 10 and 11 display change (relative to the first epoch) in heart rate and electrodermal responding across epochs within laboratory phases separated by NSSI status. We then conducted two separate mixed-effects models predicting Heart Rate and EDR from NSSI Status (NSSI, Control), the orthogonal first and second order polynomials of Time (epoch 1–54), and the interaction between NSSI Status and Time. In addition to these fixed effects, we also included a random intercept for each participant to account for the within-subject nesting of observations. Critically, there was no interaction between NSSI Status and Time in predicting Heart Rate for the linear ($p = .347$) or quadratic effect ($p = .356$). In contrast, there was an interaction between NSSI Status and Time in predicting EDR for both the linear ($p = .023$) and quadratic effects ($p = .041$), but neither of these effects survived the correction for multiple comparisons. See Appendix L for the estimates for all main effects and interactions for both models.

Associations between NSSI characteristics and real-time emotional responding

Given the considerable variability in NSSI characteristics among people who engage in NSSI, one possibility for why groups show a similar pattern of emotional responding is that a group-level ‘past-year NSSI status’ obscures meaningful differences *among* people

Figure 10

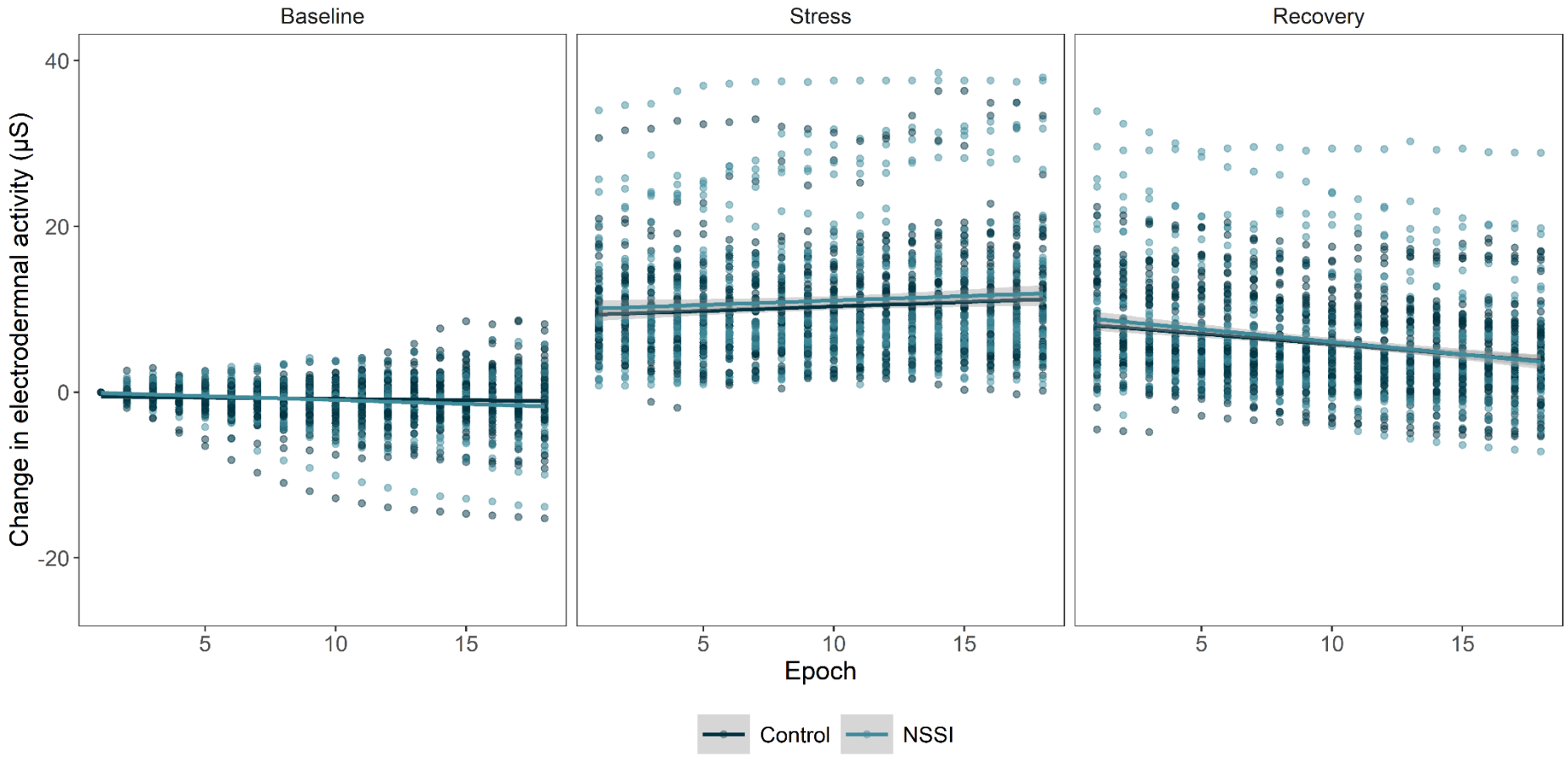
Change (relative to the first epoch) in heart rate across laboratory session phases separated by non-suicidal self-injury status



Note. Scatter represents individual's responses at each phase, shading indicates 95% confidence interval. NSSI n = 51, Control n = 50.

Figure 11

Change (relative to the first epoch) in electrodermal responding across laboratory session phases separated by non-suicidal self-injury status



Note. Scatter represents individual's responses at each phase, shading indicates 95% confidence interval. NSSI *n* = 51, Control *n* = 50.

Table 5

Non-suicidal self-injury characteristics predicting subjective and physiological reactivity to and recovery from acute stress

	Negative mood		Heart rate (BPM)		Electrodermal responding (μS)	
	β (95% CI)	*p*	*β* (95% CI)	*p*	*β* (95% CI)	*p*
Responding at Stress Phase						
Step 1	$F(1, 48) = 12.23$, $p = .001$, Adj. $R^2 = .19$		$F(1, 49) = 49.80$, $p < .001$, Adj. $R^2 = .49$		$F(1, 49) = 5.14$, $p = .028$, Adj. $R^2 = .08$	
Baseline response	**.45 (.12 .71)**	**.008**	**.70 (.49, .91)**	**< .001**	.28 (.01, .55)	.046
Step 2	$F(5, 44) = 2.65$, $p = .036$. Adj. $R^2 = .14$		$F(5, 45) = 9.55$, $p < .001$, Adj. $R^2 = .46$		$F(5, 45) = 2.40$, $p = .052$, Adj. $R^2 = .12$	
Number of NSSI methods	.17 (-.15, .49)	.287	-.12 (-.49, .91)	.331	.18 (-.13, .49)	.247
Past-year NSSI frequency	-.02 (-.32, .28)	.897	< .01 (-.22, .23)	.983	.20 (-.08, .49)	.159
Intrapersonal functions	.05 (-.29, .38)	.779	.04 (-.22, .31)	.757	-.31 (-.65, -.03	.073
Interpersonal functions	-.13 (-.45, .20)	.433	.01 (-.24, .26)	.934	-.07 (-.40, .25)	.647
Responding at Recovery Phase						
Step 1	$F(2, 47) = 41.42$, $p < .001$, Adj. $R^2 = .62$		$F(2, 48) = 210.52$, $p < .001$, Adj. $R^2 = .89$		$F(2, 48) = 105.39$, $p < .001$, Adj. $R^2 = .81$	
Baseline response	**.27 (.07, .47)**	**.008**	**.92 (.79, 1.06)**	**< .001**	**.24 (.11, .37)**	**< .001**
Stress response	**.64 (.44, .84)**	**< .001**	.03 (-.11, .16)	.694	**.76 (.65, .93)**	**< .001**
Step 2	$F(6, 43) = 18.91$, $p < .001$, Adj. $R^2 = .68$		$F(6, 44) = 66.59$, $p < .001$, Adj. $R^2 = .89$		$F(6, 44) = 36.06$, $p < .001$, Adj. $R^2 = .78$	
Number NSSI of methods	.23 (.04, .43)	.021	-.04 (-.16, .07)	.429	.14 (-.01, .29)	.067
Past-year NSSI frequency	-.12 (-.30, .06)	.174	.02 (-.09, .12)	.761	<.01 (-.13, .14)	.965
Intrapersonal functions	-.12 (-.32, .09)	.255	-.03 (-.15, .10)	.674	.01 (-.16, .17)	.941
Interpersonal functions	.17 (-.02, .37)	.084	.06 (-.06, .17)	.328	-.05 (-.21, .11)	.488

Note. Analyses conducted within the NSSI subsample ($n = 51$). Statistically significant ($p < .001$) estimates are bolded for clarity.

who self-injure in how they respond to, and recover from, acute stress. Focusing only on the NSSI group (*n*= 51), we conducted three exploratory hierarchical linear regression analyses predicting Stress response across Negative Mood, Heart Rate, and EDR channels. Within each regression model, we included Baseline response at Step 1, and number of NSSI methods, past-year NSSI frequency, intrapersonal functions, and interpersonal functions at Step 2. We then conducted three additional exploratory linear regression analyses predicting Recovery response across emotional channels, adding Stress response to Step 1 of the models described above. See Table 5 for all model fit statistics and standardised estimates.

Considering first how participants within the NSSI group responded to stress, Baseline response positively predicted Stress response for both Negative Mood and Heart Rate. However, the association between Baseline EDR and Stress EDR did not survive the correction for multiple comparisons, perhaps because EDR was baselined for each participant prior to the Baseline Phase. Over and above baseline responding, the number of NSSI methods a participant had engaged in, the frequency of their past-year NSSI, or the extent to which they endorsed intrapersonal or interpersonal functions was unrelated to their subjective or physiological response to acute stress.

Turning to consider how the NSSI group recovered from emotional challenge, Baseline response positively predicted Recovery response across all three channels of emotion. Stress response positively predicted Recovery response for both Negative Mood and EDR. However, Heart Rate during the Stress phase did not uniquely predict Heart Rate during the Recovery phase, consistent with the conclusion that heart rate fully recovered to baseline levels during the recovery period. Over and above Baseline and Stress responses, NSSI characteristics were unrelated to how participants physiologically recovered from acute stress. A greater number of NSSI methods positively predicted Negative Mood at recovery, although this association did not survive the correction for multiple comparisons. Taken together, these exploratory analyses provide no evidence that the characteristics of a person's NSSI predict how they respond to, or recover from, acute stress.

Spontaneous emotion regulation strategy use

Next, we explore whether people who engage in NSSI differ in their use of cognitive reappraisal and expressive suppression during the Recovery phase compared to the Control group. We conducted a mixed-model ANOVA with NSSI Status (NSSI, Control) as the between-subjects variable and Strategy Type (Reappraisal, Suppression) as the within-subjects variable. Analysis revealed that, in general, participants were more likely to use

reappraisal (M = 5.08, SD = 1.13) than suppression (M = 4.21, SD = 1.21, scales range from 1–7) during the Resting Phase ($F(1, 99) = 27.55$, $p < .001$, $\eta_p^2 = .22$). We found no evidence to suggest that strategy use differed by NSSI status ($F(1, 99) = 0.01$, $p = .926$, $\eta_p^2 < .01$), or that NSSI status interacted with Strategy Type ($F(1, 99) = 0.81$, $p = .372$, $\eta_p^2 = .01$), suggesting that both the NSSI and Control groups used reappraisal and suppression strategies to a similar extent to manage their emotional experience following acute stress.[26]

Memory of emotional challenge

Finally, we test the hypothesis that people who engage in NSSI report poorer global emotional functioning than do controls because they amplify challenging emotional experiences in memory. These analyses are pre-registered but should be interpreted with caution given the small sample size (n = 44). See Table 6 for descriptive statistics of negative mood across the laboratory session and the follow-up session separated by NSSI status. We conducted a mixed-model ANOVA with NSSI Status (NSSI, Control) as the between-subjects variable, and Phase (Baseline, Stress, Recovery) and Time (During Session, Follow-Up) as the within-subjects variable. Analysis revealed a main effect of Phase ($F(2, 82) = 71.33$, $p < .001$, $\eta_p^2 = .64$) and a main effect of Time ($F(1, 41) = 13.52$, $p < .001$, $\eta_p^2 = .25$), which were qualified by a Phase by Time interaction ($F(2, 82) = 14.21$, $p < .001$, $\eta_p^2 = .26$).

Among the subset of the sample who took part in the follow-up session, the pattern of negative mood during the laboratory session was comparable to the results in the overall sample; Negative Mood was elevated following Stress compared to both Baseline ($t(42) = 7.11$, $p < .001$, $d = 1.09$) and Recovery ($t(43) = 7.45$, $p < .001$, $d = 1.12$), and Negative Mood was equivalent between Baseline and Recovery ($t(42) = 1.62$, $p = .112$, $d = 0.25$). Participants also remembered the stress induction as emotionally challenging: in the follow-up session, Negative Mood was elevated following Stress compared to both Baseline

[26] We had also intended to assess spontaneous reappraisal and suppression use *during* emotional challenge. A second modified version of the ERQ was administered, with each item beginning with '*During the maths task…'.* Due to a technical error, only a subset (n = 56, 28 per group) of the overall sample completed this questionnaire. We report these analyses here but emphasise that they should be interpreted with caution. In a similar manner to the pattern of results found during the Recovery Phase, participants in general were more likely to use reappraisal (M = 4.19, SD = 1.33) than suppression (M = 3.71, SD = 1.14) during the Stress phase ($F(1, 54) = 5.26$, $p = .026$, $\eta_p^2 = .09$). Again, we found no evidence to suggest that strategy use differed by NSSI status ($F(1, 54) = 0.04$, $p = .839$, $\eta_p^2 < .01$), or that NSSI status interacted with Strategy Type ($F(1, 54) = 0.72$, $p = .400$, $\eta_p^2 = .01$), suggesting that both the NSSI and Control groups used reappraisal and suppression strategies to a similar extent to manage their emotional experience during acute stress.

Table 6

Negative mood across the laboratory and follow-up sessions separated by non-suicidal self-injury status

	Negative mood					
	Laboratory session			Follow-up Session		
	Baseline *M* (*SD*)	Stress *M* (*SD*)	Recovery *M* (*SD*)	Baseline *M* (*SD*)	Stress *M* (*SD*)	Recovery *M* (*SD*)
Overall follow-up sample	14.88 (10.20)	36.67 (23.09)	17.93 (15.82)	14.78 (12.01)	51.45 (25.41)	21.37 (20.60)
NSSI group	18.32 (10.52)	38.96 (22.28)	21.23 (14.88)	20.43 (13.19)	55.45 (22.30)	22.82 (15.83)
Control group	11.26 (8.68)	34.17 (24.24)	14.32 (16.24)	8.60 (6.48)	47.08 (28.34)	19.79 (25.13)

Note. NSSI $n = 23$, Control $n = 21$.

($t(43) = 9.95$, $p < .001$, $d = 1.50$) and Recovery ($t(43) = 9.03$, $p < .001$, $d = 1.36$). There was a statistical trend to suggest that Negative Mood was higher following Recovery compared to Baseline ($t(43) = 2.01$, $p = .050$, $d = 0.30$), suggesting that participants remembered their negative mood as elevated following Recovery. To elaborate on the Time by Phase interaction, we compared participant's negative mood assessed during the laboratory session to how they remembered their negative mood two weeks later during the follow-up session. Participants' memory of their emotional experience at both Baseline and Recovery phases were accurate; there were no differences between the laboratory and follow-up sessions (Baseline: $t(42) = 0.21$, $p = .837$, $d = 0.03$; Recovery: $t(43) = 1.32$, $p = .194$, $d = 0.20$). Critically, participants amplified in memory the extent of their negative mood during the Stress Phase, $t(43) = 5.07$, $p < .001$, $d = 0.76$.

Returning to the overarching ANOVA, a statistical trend was found to suggest a main effect of NSSI Status whereby, among the participants who took part in the follow-up survey, the NSSI group reported overall greater levels of negative mood than did the Control group (NSSI group: $M = 29.83$, $SD = 13.10$, Control group: $M = 22.54$, $SD = 13.99$, $F(1, 41) = 3.12$, $p = .085$, $\eta_p^2 = .07$). Critically, there was no evidence of an interaction between NSSI Status and Phase ($F(2, 82) = 0.31$, $p = .731$, $\eta_p^2 = .01$), NSSI Status and Time ($F(1, 41) = 0.31$, $p = .581$, $\eta_p^2 = .01$), or a three-way interaction between NSSI Status, Phase, and Time ($F(2, 82) = 1.27$, $p = .287$, $\eta_p^2 = .03$). Counter to hypotheses, although participants remembered their subjective response to acute stress as more intense than they reported during the laboratory session, we found no evidence to suggest that this memory amplification process differed by NSSI status.

Discussion

People who engage in NSSI consistently report greater global emotion reactivity and emotion dysregulation compared to those with no NSSI history. However, studies which manipulate challenge to assess for amplified emotional responding in real-time have reported mixed findings. Study 2 compared how young adults with a recent history of NSSI and those with no lifetime NSSI history reacted to, and recovered from, acute stress across subjective (negative mood) and physiological (heart rate, and EDR) channels of emotion. We also assessed the extent to which participants spontaneously engaged in reappraisal and suppression to recover from the challenge. A subset of the sample took part in a follow-up session two-weeks later where they reported how they remembered their experience of the emotional challenge.

Consistent with a wealth of research (for meta-analytic reviews, see Wolff et al., 2019; You et al., 2018), the NSSI group reported substantially greater global emotion reactivity (g = 0.93) and emotion dysregulation (g = 1.21) than the Control group. Despite these large differences in global emotional functioning, groups showed a similar emotional response to, and recovery from, real-time emotional challenge. Within the NSSI group, characteristics of a person's NSSI were unrelated to their real-time emotional response. In addition, both the NSSI and Control groups used reappraisal and suppression strategies to a similar extent to manage their emotional experience following acute stress. Although two-weeks later participants came to remember their experience as more intense, both the NSSI group and the Control group did so in a similar manner. That is, counter to the amplified emotion response account, we found no evidence that people who engage in NSSI show greater subjective or physiological reactivity to emotional challenge compared to controls. We also found no evidence that people who engage in NSSI are less effective at recovering from an emotional challenge, use different emotion regulation strategies in real-time, or go on to later remember their emotional response as more intense.

Subjective responding to acute stress

Focusing first on the subjective response, counter to predictions we found no evidence that young adults with a recent history of NSSI experienced greater increases in negative mood following acute stress, or were less able to recover from acute stress compared to those with no history of NSSI. This null effect is consistent with other research that finds no difference in subjective responding by self-injury status in response to the TSST (Kaess et al., 2012), social exclusion (Groschwitz et al., 2016; Schatten et al., 2015), a sad film (Mettler et al., 2021), or to personalised anger (Weinberg & Klonsky, 2012) or distress manipulations (Gratz et al., 2011). Some studies have found the opposite of the predicted effect; people who self-injure experienced *less* subjective reactivity than controls when writing about a personal failure (Bresin & Gordon, 2013) or watching a sad film clip (Boyes et al., 2020). Of the two studies that find greater subjective reactivity among people who self-injure, both had self-injury groups who reported greater BPD symptoms than the control group (Gratz et al., 2019; Kaufman et al., 2019). People with BPD show altered emotional processing (for a review see, Schmahl et al., 2014), greater affect instability in daily life (for a review, see Houben et al., 2015), and amplified responding to real-time emotional challenge (e.g., Gratz et al., 2010; Schmahl et al., 2004; although see Herpertz et al., 1999; Herpertz & Koetting, 2005). Given that BPD often presents with NSSI (Nock et al., 2006; Soloff et al., 1994), variability in BPD

symptoms among NSSI groups may explain the mixed results in subjective reactivity in the literature (for a similar interpretation, see Hooley & Franklin, 2018). Taken together, this pattern of results provides limited evidence that people who engage in NSSI experience an amplified subjective response to emotional challenge.

In terms of recovery from negative mood, counter to our predictions we found no evidence that young adults with a recent history of NSSI recovered less effectively from emotional challenge compared to controls. In a similar manner, young adults who had engaged in NSSI in the past two years and those without a history of NSSI showed similar subjective recovery from a sad film clip (Mettler et al., 2021). In contrast to both Study 2 and Mettler and colleagues (2021), Boyes and colleagues (2020) found that young adults with a lifetime history of NSSI experienced less subjective recovery from the emotional challenge compared to controls. The discrepancies between these findings may lie in how recovery was assessed. Study 2 assessed recovery using a mood report after a five-minute resting task. Mettler and colleagues (2021) used a similar procedure, assessing mood after a two-minute resting task. In contrast, Boyes and colleagues (2020) used a more nuanced approach, assessing ratings of sadness every minute for five minutes. Critically, the NSSI and Control group did not differ from each other at the end of the five-minute period. Taken together, this pattern of results suggests that although people who engage in NSSI might repair their mood to a similar extent as people without a history of NSSI, they may be slower to do so. Future research should test this possibility using continuous measures of negative mood following emotional challenge (e.g., turning a dial to indicate valence and/or arousal dial; Ruef & Levenson, 2007).

Physiological responding to acute stress

Focusing on physiological channels of emotion, and again counter to our expectations, we found no evidence that young adults with a recent history of NSSI showed a greater heart rate increase in response to, or impaired heart rate recovery from, acute stress compared to those with no history of NSSI. Despite the prevalence of heart rate as a measure of physiological responding to emotional challenge within the affective science literature more generally (Kreibig, 2010), within the NSSI literature only one study has assessed for differences in heart rate responding by self-injury status. Kaess and colleagues (2012) found that adolescent women with repetitive NSSI showed a similar heart rate response to the TSST as those with no NSSI history. Study 2 replicates this null effect in a larger (n = 101 vs. n = 28) sample, and among a NSSI group recruited from the community (compared to inpatient

and outpatient settings). Study 2 also took a more nuanced approach by assessing dynamic change in heart rate across emotional challenge, finding no evidence to suggest that young adults who engage in NSSI respond differently to those without a history of NSSI *at any point* during or following acute stress. Thus, in two studies, there is no evidence from heart rate indices that people who engage in NSSI have a more intense response to, or recover more slowly from, emotional challenge compared to controls.

In a similar vein, Study 2 also failed to find any evidence for altered electrodermal reactivity or recovery by NSSI status. In contrast, Nock and Mendes (2008) found that adolescents with a history of NSSI (n = 62; 90% of whom had engaged in NSSI within the past year) showed considerably elevated electrodermal responding (d = 0.57) over the course of a frustrating task compared to controls (n = 30). Notably, the difference between the NSSI and Control groups was most prominent six to fourteen minutes into the frustration task. Given that the Stress Phase of Study 2 lasted for five minutes, one possibility for the disconnect between Study 2 and Nock and Mendes (2008) is that amplified electrodermal reactivity to challenge in NSSI only appears at longer latencies. However providing evidence against this possibility, Tatnell and colleagues (2018) administered the full ~13 minute TSST protocol—a time span consistent with Nock and Mendes' (2008) emotional challenge—with young adults with (n = 25) and without (n = 53) a lifetime NSSI history and found no difference in electrodermal responding by NSSI-status. One previous study has investigated electrodermal recovery from emotional challenge among people who self-injure (Crowell et al., 2005). Consistent with Study 2, adolescent women with recent or chronic self-injury behaviours showed no difference in electrodermal responding to, or recovery from, a sad film compared to controls. Taken together, there is limited evidence for amplified electrodermal responding to emotional challenge among people who self-injure. Future research should first replicate the difference found in electrodermal responding by NSSI status using Nock and Mendes' (2008) frustrating task, before assessing whether amplified electrodermal reactivity in NSSI is specific to frustrating experiences.

NSSI characteristics and real-time responding to acute stress

Next, we explored whether specific characteristics of a person's NSSI were associated with their real-time emotional response. Among people who engage in NSSI, self-reports of global emotion dysregulation are positively associated with the number of lifetime NSSI methods (Chen & Chun, 2019), lifetime NSSI frequency (Sorgi et al., 2020), and intrapersonal functions (specifically, affect regulation, feeling generation and self-punishment

functions; Turner et al., 2012). Likewise, in Study 2 global emotion dysregulation reports were positively associated with lifetime number of NSSI methods and past-year NSSI frequency. However, when accounting for baseline responding, neither number of NSSI methods, past-year NSSI, intrapersonal functions, nor interpersonal functions were related to reactivity or recovery across any of the three channels of emotional responding. Taken together, this suggests that heterogeneity in NSSI characteristics is unlikely to capture meaningful differences among people who self-injure in how they respond to, and recover from, acute stress. Overall, this pattern of results again highlights the disconnect between global self-reports of emotional functioning and moment-to-moment emotional responding.

Spontaneous reappraisal and suppression use

In addition to tracking how young adults with a recent history of NSSI subjectively and physiologically respond to emotional challenge, Study 2 assessed the extent to which they reported spontaneously engaging in reappraisal and suppression strategies when recovering from acute stress. Contrary to expectations, we found no evidence that the NSSI group utilised reappraisal or suppression strategies during recovery differently than the Control group. To date, little research has considered how people who self-injure engage in emotion regulation strategies during real-time emotional challenge. Using an instructed regulation paradigm, Davis and colleagues (2014) found that, compared to both controls without self-injury, and depression-matched controls, people with a history of self-injury were unable to repair their negative mood, suggesting an impaired ability to successfully reappraise the emotional challenge. Moving beyond emotional challenge manipulations, in a 10-day experience sampling study participants who reported engaging in NSSI to regulate negative emotions were more likely to also use suppression, both in general and when regulating specific instances of emotional challenge (Southward & Cheavens, 2020). In contrast, we found no evidence of poorer mood repair, or greater engagement in suppression among people who engage in NSSI compared to controls. Taken together, drawing across different paradigms, the evidence for poorer emotional regulation efficiency or different strategy use in NSSI is mixed.

Memory of emotional challenge

Finally, we considered whether people who engage in NSSI subsequently remember emotional challenges as more intense than their peers. Two-weeks after the laboratory session, a subset of the sample reported how they remembered experiencing the Baseline, Stress, and Recovery phases. Counter to previous research documenting that the affect

associated with negative autobiographical events fades with time (e.g., Walker et al., 1997, 2003), participants remembered their emotional experience during the Stress phase as *more* intense than they reported during the laboratory session, but reported no differences in their memory for the Baseline or Recovery phases. Previous research has demonstrated that fading of negative affect is present one day after the emotional event and persists 4.5 years later (Gibbons et al., 2011; Walker et al., 1997). However, studies typically assess fading negative affect of autobiographical events using daily diary studies (e.g., Gibbons et al., 2011; Walker et al., 1997, 2014), rather than manipulating emotional challenge as we did in Study 2. It is worth noting that as part of the laboratory session debriefing procedure (i.e., before the follow-up session), we emphasised to participants that the arithmetic test was explicitly designed to be stressful, perhaps priming them to amplify their emotional experience of the Stress phase in memory. Future research should first replicate the amplified emotional memory effect using the TSST, before assessing whether the typical fading affect effect is specific to autobiographical events that occur in daily life, but which maybe do not have the intensity of the TSST. Critically, counter to predictions, the amplification of emotional experiences in memory did not differ by NSSI status; young adults with a recent history of NSSI amplified the emotional event in memory to the same extent as did those with no history of NSSI. Thus, Study 2 provides no evidence that the elevated global emotion reactivity and emotion dysregulation we see in people who engage in NSSI can be attributed to differences by NSSI status in how emotional experiences are remembered.

Where to next for the amplified emotional responding account?

Consistent with previous research (e.g., Wolff et al., 2019; You et al., 2018), young adults with a recent history of NSSI reported substantially greater global emotion reactivity and emotion dysregulation than did controls. However, inconsistent with the amplified emotional responding account, both the NSSI and Control groups showed a similar pattern of subjective and physiological reactivity to, and recovery from, acute stress. One possibility for this disconnect between global reports and real-time responses may lie in the choice of emotional challenge. The TSST can be considered to be a strong stress induction; maths anxiety is common among young adults (e.g., Hill et al., 2016), and the TSST is designed so that participants feel like they are doing poorly (regardless of actual performance). Strong stressors, such as the TSST, are almost universally emotionally arousing, and so might create ceiling effects that mask differences by NSSI status (for a similar argument, see Tatnell et al., 2018). People who engage in NSSI may show no differences in responses to strong emotional

challenges (e.g., a romantic relationship break-up) compared to controls, but show amplified responses to more subtle emotional challenges (e.g., the knowledge that your text message has been read, without a response from the recipient). To test this possibility, Study 3 will investigate whether people who engage in NSSI differ in their subjective response to mild, more ambiguous emotional challenges.

Strengths and limitations

Study 2 findings should be interpreted in light of several strengths and limitations. Study 2 has four key strengths. First, we tested our pre-registered predictions in a study well-powered to find a 'true' effect. For instance, the sample size of the NSSI group falls approximately one standard deviation above the mean (35.33, *SD* = 16.97) number of self-injury participants in the experimental literature, and two standard deviations above the mean (22.00, *SD* = 11.31) for studies which assess both subjective and physiological channels of emotional responding (for more detail, see Table 1). In addition, participants were recruited for the NSSI group based on reporting NSSI engagement within the *past-year*, limiting the variability inherent among people who self-injure by constraining the group to those more likely to be currently engaging in NSSI. We also tested for differences in emotional responding using a within-subjects, 'strong' emotional challenge. Together, these design decisions increase the power of Study 2 to find a 'true' difference in emotional responding by NSSI status, meaning that our null findings are unlikely to reflect a Type II error.

Second, we assessed responses to, and recovery from, emotional challenge across different three channels of emotional responding, including both subjective and physiological indices. Although subjective channels of emotion are commonly assessed in this literature, physiological channels are not—only 26.3% of studies within this literature have measured physiological responses to emotional challenge. Thus, Study 2 adds to this growing literature base investigating how people who self-injure respond across multiple channels of emotion.

Third, Study 2 also took an in-depth approach to investigate the emotional response in NSSI. We considered both the average physiological response across phases and the more dynamic response *within* a phase, as well as considering whether characteristics of a person's NSSI were associated with their subjective and physiological real-time emotional response. Finally, we considered the strategies people might use to regulate their emotional responses following stress, and how they later remember their emotional experience. Together, these approaches provide a nuanced picture of emotional responding in NSSI.

There are three key caveats to findings of Study 2. First, inspection of the epoch-level physiological responses in Figure 10 and 11 demonstrates that we likely did not capture the onset of stress, but rather peak stress. That is, within the Stress Phase, heart rate and electrodermal responding did not increase over time, but rather maintained a level of elevated responding. We did not include a time marker in the physiology recording to note when a participant was initially told the nature of the Stress phase and pre-registered that we would exclude the first 30 seconds of each phase (including Stress) to allow the participant to habituate to the experience of the task and to allow the experimenter to exit the recording room. It is likely that the initial physiological onset occurred during this period. In a similar manner, inspection of physiological responding over the Recovery Phase in Figure 10 and 11 shows that heart rate recovery to baseline seems to have already occurred by the beginning of the recovery task (i.e., there is no downwards slope across time). Although both heart rate and electrodermal responding were measured continuously, we are unable to conduct continuous analyses because participants stood up and moved chairs in order to report their subjective mood ratings between each phase (and thus this time period consists largely of uninterpretable artefacts). Newer mobile sensors might do a better job of capturing these dynamic changes.

Second, we made the pragmatic decision to use only the arithmetic component of the TSST protocol, removing the three-minute speech preparation and five-minute speech in front of a panel of confederates (Kirschbaum et al., 1993; Kudielka et al., 2007). This decision makes it difficult to directly compare Study 2 with other NSSI studies that used the complete TSST protocol (Kaess et al., 2012; Plener et al., 2017; Tatnell et al., 2018). However, we found good evidence that the arithmetic test produced subjective and physiological markers of stress, demonstrating that our modified TSST was effective at creating emotional challenge. Finally, only 43.6% of the sample took part in the follow-up session two weeks after the laboratory session. Although the *n* of these analyses is consistent with other studies in this literature (e.g., Crowell et al., 2005; Gratz et al., 2011; Groschwitz et al., 2016; Kaess et al., 2012), these analyses should be considered exploratory until replicated in other samples.

Conclusion

Extending a large body of previous research, Study 2 found that young adults who had engaged in NSSI in the past year reported greater global emotion reactivity and emotion dysregulation than did their peers. However, we found no evidence of a difference by NSSI

status in real-time subjective and physiological responding to, and following, acute stress. Moreover, exploratory analyses revealed no differences in how people who engage in NSSI spontaneously use reappraisal and suppression emotion regulation strategies, or in how they later come to remember their emotional experience compared to people without a history of NSSI. Taken together, Study 2 found no evidence to suggest that NSSI is characterised by amplified emotional responding to real-time challenges. Given that the TSST can be considered a strong emotional challenge that may obscure meaningful individual differences, Study 3 assesses how people who engage in NSSI subjectively respond to a mild, more ambiguous emotional challenge.

Chapter 5: Subjective responding to social exclusion in non-suicidal self-injury

Study 2 showed that young adults with a past-year history of NSSI subjectively and physiologically react to, and recover from, acute stress in much the same way as those with no lifetime history of NSSI. However—despite the lack of any meaningful differences in real-time responding to acute stress—the NSSI group reported experiencing considerably greater global emotion reactivity and emotion dysregulation in their daily lives. This contradiction between global self-reports and real-time responding extends a growing body of research which finds robust differences by NSSI status in global reports of emotional functioning (e.g., Wolff et al., 2019; You et al., 2018), but limited evidence of differences in real-time responding to emotional challenge manipulations (e.g., Allen et al., 2019; Davis et al., 2014; Glenn et al., 2011; Tatnell et al., 2018; see Table 1 for an overview). One possibility for the disconnect between global self-reports and real-time emotional responding may be that typical experimental manipulations do not adequately model the characteristics of emotional challenges that present difficulties for people who engage in NSSI. In this Chapter, I focus on the subjective response to emotional challenge to assess whether amplified emotional responding in NSSI is specific to mild, more ambiguous emotional challenge.

Reconsidering type of emotional challenge

Most research that has investigated whether self-injury is characterised by an amplified emotional response has used interpersonal emotional challenge manipulations. Given the emotional salience of interpersonal conflict both in general (e.g., O'Connor et al., 1995) and for people who engage in NSSI (e.g., Kaess et al., 2019), interpersonal emotional challenges such as the TSST (Study 2; and Kaess et al., 2012; Plener et al., 2017; Tatnell et al., 2018), provide a stringent test of this hypothesis. In particular, the TSST is a strong emotional challenge. Maths anxiety is common among young adults (e.g., Hill et al., 2016), and the TSST is designed so that participants feel like they are doing poorly (regardless of actual performance). Due to its nature as an uncontrollable, socially evaluative challenge, the TSST almost universally creates psychosocial stress (for reviews, see Dickerson & Kemeny, 2004; Kudielka et al., 2007). For instance, 96% of Study 2 participants reported an increase in negative mood following the TSST. However, strong emotional challenges might create ceiling effects in emotional responding which mask individual differences by NSSI status. Drawing from personality and social psychology theories, the Situation Strength Hypothesis

suggests that the impact of personality (i.e., individual differences) is strongest in 'weak' situations with fewer implicit and/or explicit cues for desirable behaviours, and blunted in 'strong' situations with greater cues (Cooper & Withey, 2009; Meyer et al., 2010). Applied to emotional situations, the Situation Strength Hypothesis suggests that individual differences impact the emotional response *less* in instances of strong challenge (e.g., a beloved family member dying) and *more* in instances of weak challenge (e.g., waving at an acquaintance across the road who does not respond). People who engage in NSSI may show no differences compared to controls when responding to strong emotional challenges like the TSST but show amplified responding to more subtle emotional challenges.

Appraisal is one reason why two people may have two entirely different emotional experiences in response to the same stimulus. The appraisal component of the emotion generation process occurs after an individual has attended to a stimulus in the external or internal environment. During this process, the significance of the stimulus is assessed in terms of whether it helps or hinders an individual's concerns (for a comprehensive overview of appraisal theory, see Scherer et al., 2001). These concerns are highly idiosyncratic and comprise an individual's overarching goals (e.g., survival) and current goals (e.g., getting to work on time), as well as their values, needs, and beliefs (Moors et al., 2013; Uusberg et al., 2019). Thus, appraisal is an interactional process between the stimulus and the individual. In instances where an attended stimulus is evaluated to be significant, this appraisal then triggers the emotional response (Gross, 2015a; Moors et al., 2013).

Individual differences in appraisal and psychopathology

Research investigating the role of individual differences in appraisal for psychopathology tends to focus on interpretation biases in the appraisal of ambiguous information (e.g., Chen et al., 2020; Everaert et al., 2017). Interpretation is the cognitive process in which aspects of a situation are integrated in a way that resolves ambiguity (Blanchette & Richards, 2010). This interpretation process may occur with or without conscious awareness, and an established interpretation can be deliberately adjusted with reappraisal (Blanchette & Richards, 2010). The Cognitive Model of Depression argues that depression arises, in part, because of interpretation biases in which people tend to appraise neutral or benign information as negative (Beck, 1967; Clark & Beck, 1999). Over time, these biases become embedded into cognitive processing structures (i.e., schemas) through which information is organised and interpreted (Beck, 1967; Clark & Beck, 1999). Consistent with this proposal, meta-analyses demonstrate that, compared to people without depression,

people with depression are more likely to interpret ambiguous stimuli as more negative and less positive, especially when stimuli are personally relevant (Everaert et al., 2017).

The tendency to appraise ambiguous stimuli and events as negative may be a cognitive mechanism implemented in psychopathology more broadly. Meta-analyses demonstrate that socially anxious people are more likely to interpret social scenarios as negative and threatening compared to people without social anxiety (Chen et al., 2020). Critically, this interpretation bias appears to be specific to social situations and does not extend to interpretation of ambiguous non-social situations (Miers et al., 2008). Likewise, a growing body of evidence suggests that people with post-traumatic stress disorder are also more likely to interpret ambiguous stimuli as negative than people without post-traumatic stress disorder (Amir et al., 2002; Kimble et al., 2002, 2012). Taken together, research on other forms of psychopathology which commonly present with NSSI (Kiekens et al., 2018b; Nock et al., 2006) demonstrates robust group-level differences where people with psychopathology are more likely to appraise ambiguous stimuli as negative than those without psychopathology. Thus, perhaps people who engage in NSSI report poorer global emotional functioning not because they have a more intense emotional response to emotional challenge, but because they have a more sensitive appraisal system in which benign and/or neutral stimuli are appraised as threatening.

Non-suicidal self-injury and appraisal

Indirect evidence that people with and without NSSI appraise information differently comes from studies which assess self-reported stress among people who self-injure. Among Flemish and Dutch adolescents, the cross-sectional relationship between NSSI and neuroticism, agreeableness, and conscientiousness was medicated by greater perceived stress, suggesting that young people whose personality traits predispose them to appraise their lives as more stressful are more likely to engage in NSSI (Kiekens et al., 2015). In a similar manner, self-reported negative attribution style moderated the longitudinal relationship between stressful life events and NSSI; higher levels of stressful life events prospectively predicted greater NSSI frequency only in the context of higher levels of negative attributional style (Guerry & Prinstein, 2009). Together, these studies suggest that people who engage in NSSI are more likely to make negative appraisals than people with no history of NSSI, and that patterns in global self-reported appraisal longitudinally predict NSSI. However, without the control offered by experimentally manipulating emotional challenge, it remains unclear whether: i) people who engage in NSSI are more likely than controls to appraise information

negatively, or ii) are more likely to experience a greater number of negative events. Of course, it may be the case that both these possibilities are true; people who engage in NSSI are more likely to appraise an event as negative and more likely to experience a greater number of negative events. To disentangle these possibilities, experimental tests of appraisal are needed.

To date, experimental investigation into the appraisal process in NSSI is limited. Perini and colleagues (2019) indirectly observed the outcome of the appraisal process among adolescent women with a past 6-month history of NSSI and those with no lifetime history of NSSI. Participants took part in a simulated social media interaction task where they appeared to receive positive and negative feedback about themselves from other participants (but in reality, simulated participants). Despite the fact that both groups received equal amounts of positive and negative feedback, the NSSI group reported being rejected more often than did the Control group (Perini et al., 2019). Focusing on the intentional readjustment of an initial appraisal, Davis and colleagues (2014) found that adults with a history of self-injury were less effective than control groups at using reappraisal to repair their negative mood following emotional challenge. In a second sample, adults with a lifetime history of self-injury showed greater amygdala activation while under reappraisal instructions compared to a depression-matched control group, suggesting elevated processing of emotional content (Davis et al., 2014). However, it remains unclear whether intentional *reappraisal* occurs in the same way as initial *appraisal* (for a discussion, see Uusberg et al., 2019). Taken together, there is initial evidence that people who engage in NSSI may be more likely to appraise ambiguous emotional challenges as negative compared to controls. A stronger test of this hypothesis requires manipulation of the ambiguity of emotional challenge rather than simply observing appraisal outcomes. If a more sensitive appraisal system creates amplified emotional responding in NSSI, then people who engage in NSSI should show a similar response to controls when emotional challenge is more overt, but a greater response when emotional challenge is mild and more ambiguous. Thus, to directly test appraisal in people who engage in NSSI, we need a manipulation that can be modified to be both an explicit and a more ambiguous emotional challenge.

Cyberball as an explicit emotional challenge

Cyberball is one such manipulation. Cyberball initially had its genesis as a face-to-face paradigm in which ‘participants’ (in reality, a participant and several confederates) toss a ball between them while ostensibly waiting for the experimenter to return (Williams &

Sommer, 1997). Subsequently, Cyberball has been refined into an online ball-tossing game (Williams & Jarvis, 2006) that reliably creates feelings of social ostracism (for a meta-analysis, see Hartgerink et al., 2015). At the beginning of each Cyberball game, participants are told that they are playing with other participants over a network (i.e., they can't see each other), and that the ball-passing game is a task to allow them to practise their mental visualisation for a subsequent task. During the typical inclusion condition, the three players pass the ball between each other such that the participant receives approximately one third of the total number of throws (Williams & Jarvis, 2006).[27] In contrast, during the typical exclusion condition, the participant is passed the ball once at the beginning of the game and then never again, leaving them to observe the two other 'players' passing the ball to each other (Williams & Jarvis, 2006). Previous research has found that, compared to control groups, people with BPD (Gutz et al., 2016; Seidl et al., 2020), depression (Jobst et al., 2015; Seidl et al., 2020), and a history of peer-victimisation (Iffland et al., 2014b; Lambe et al., 2019) experience greater subjective reactivity to Cyberball exclusion, suggesting that the paradigm is sensitive to individual differences.

Two studies have used the typical Cyberball inclusion and exclusion games as an emotional challenge to assess emotional responding in NSSI. Groschwitz and colleagues (2016) assessed subjective and neural responding to Cyberball social exclusion among a small sample of adolescents with both depression and NSSI (n = 14), adolescents with depression only (n = 14), and healthy controls (n = 15). Adolescents with both depression and NSSI showed enhanced neural activation in the medial prefrontal cortex and the ventrolateral prefrontal cortex during social exclusion compared to both control groups, suggesting altered neural processing of social exclusion in NSSI (Groschwitz et al., 2016). However, all three groups reported equivalent subjective experiences of distress following exclusion, providing no evidence of altered emotional responding in NSSI. In a similar manner, young adults with a lifetime history of NSSI (n = 24) experienced similar levels of subjective distress following Cyberball exclusion compared to those with no history of NSSI (n = 36; Schatten et al., 2015). However, it is worth noting that Schatten and colleagues (2015) used a between-subjects emotional challenge manipulation (i.e., participants completed either the inclusion game *or* the exclusion game), a design choice that results in reduced power to test whether emotional responding is amplified in NSSI. Thus, both Groschwitz and colleagues (2016) and

[27] Given that the participant chooses which of the other two 'players' to pass the ball, the precise ball throwing schedule is unable to be fixed.

Schatten and colleagues (2015) were both likely under-powered to find a difference in subjective reactivity to social exclusion among people who engage in NSSI.

Cyberball as an ambiguous emotional challenge

Moving beyond the typical total exclusion condition, the extent to which a participant is excluded in Cyberball can be precisely calibrated allowing the emotional challenge to be more or less ambiguous. Two studies have assessed how participants respond to different Cyberball throw probabilities. Williams and colleagues (2000) compared how participants experienced four Cyberball variations; an overinclusion condition (participants receive 67% of throws), the typical inclusion condition (33% of throws), a partial exclusion condition (20% of throws), and the typical total exclusion condition (0% of throws). Greater levels of exclusion created greater aversive impact (a composite score comprised of ratings of negative mood, exclusion intensity, and perceived group cohesiveness); participants in the typical exclusion group reported the greatest aversive impact, followed by the partial exclusion group, followed by those in the typical inclusion group, and with participants in the overinclusion group reporting the lowest aversive impact (Williams et al., 2000). Boyes and French (2009) created an ambiguous partial exclusion Cyberball condition with a 70% probability the two computerized 'players' would throw the ball to one another.[28] Participants who scored high and low on neuroticism perceived themselves as having a similar a level of control during a total-exclusion Cyberball game (Boyes & French, 2009). In a separate experiment with partial social exclusion, participants who scored highly on neuroticism perceived themselves to have less control over the Cyberball game than did those who scored low on neuroticism, suggesting that individual differences in appraisal are most evident in appraisals of ambiguous situations (Boyes & French, 2009). Taken together, these studies provide preliminary evidence that partial exclusion Cyberball conditions create a milder, more ambiguous emotional challenge that is sensitive to individual differences in appraisal.

Study 3

Study 3[29] compared how people with a past-year history of NSSI subjectively respond to two versions of Cyberball exclusion: total exclusion, and partial exclusion. If a generalised

[28] Note that Williams and colleagues (2000) and Boyes and French (2009) used different approaches to manipulate the extent to which participants received the ball. Williams and colleagues (2000) predetermined the number of throws on the throw schedule that went to the participant (the approach we take in Study 3). In contrast, Boyes and French (2009) manipulated the probability that each throw went to the participant.

[29] Study 3 was developed with assistance outside of my PhD supervision team. I would like to thank Dr Mark Boyes for his contribution to the study conceptualisation, study design, and analysis plan, and André Botes for his assistance programming the Cyberball games.

amplified emotional response creates the context for NSSI, then people who engage in NSSI should show a larger subjective emotional response to social exclusion than people without a history of NSSI. We also explore how people who self-injure respond to a milder, more ambiguous emotional challenge, to test whether the appraisal of a stimulus (and thus, the subjective emotional response) differs by NSSI status. Thus, we test two pre-registered hypotheses that, relative to controls, people who engage in NSSI will either: (i) have a greater subjective emotional response to both types of social exclusion; or (ii) have a similar subjective response to overt emotional challenge, but a greater subjective response to more subtle emotional challenge. Preregistered hypotheses, predictions, design, and analytical plans are available at https://osf.io/cm2xy and in Appendix M.

Participants

Following initial screening, two hundred young women (*M* = 18.61 years, *SD* = 1.15 years) were recruited from an undergraduate research pool between 24th July 2020 – 11th April 2021 on the basis of their NSSI history; 100 participants reported a past-year history of NSSI behaviour and 100 reported no lifetime history of NSSI behaviour. As for Study 2, eligible participants were young women aged 17–25 years old, fluent in English, who consented to take part in self-injury related research, and were able to use a computer mouse and keyboard, with normal (or corrected to normal) eyesight. The majority of participants (79.0%) identified as Pākehā/New Zealand European, 6.5% identified as Māori, 5.0% as Indian, 1.5% as Samoan, 3.5% as Chinese, 0.5% as Tongan, and 15.5% as a non-listed ethnicity. Participants took part in Study 3 for course credit.

General procedure

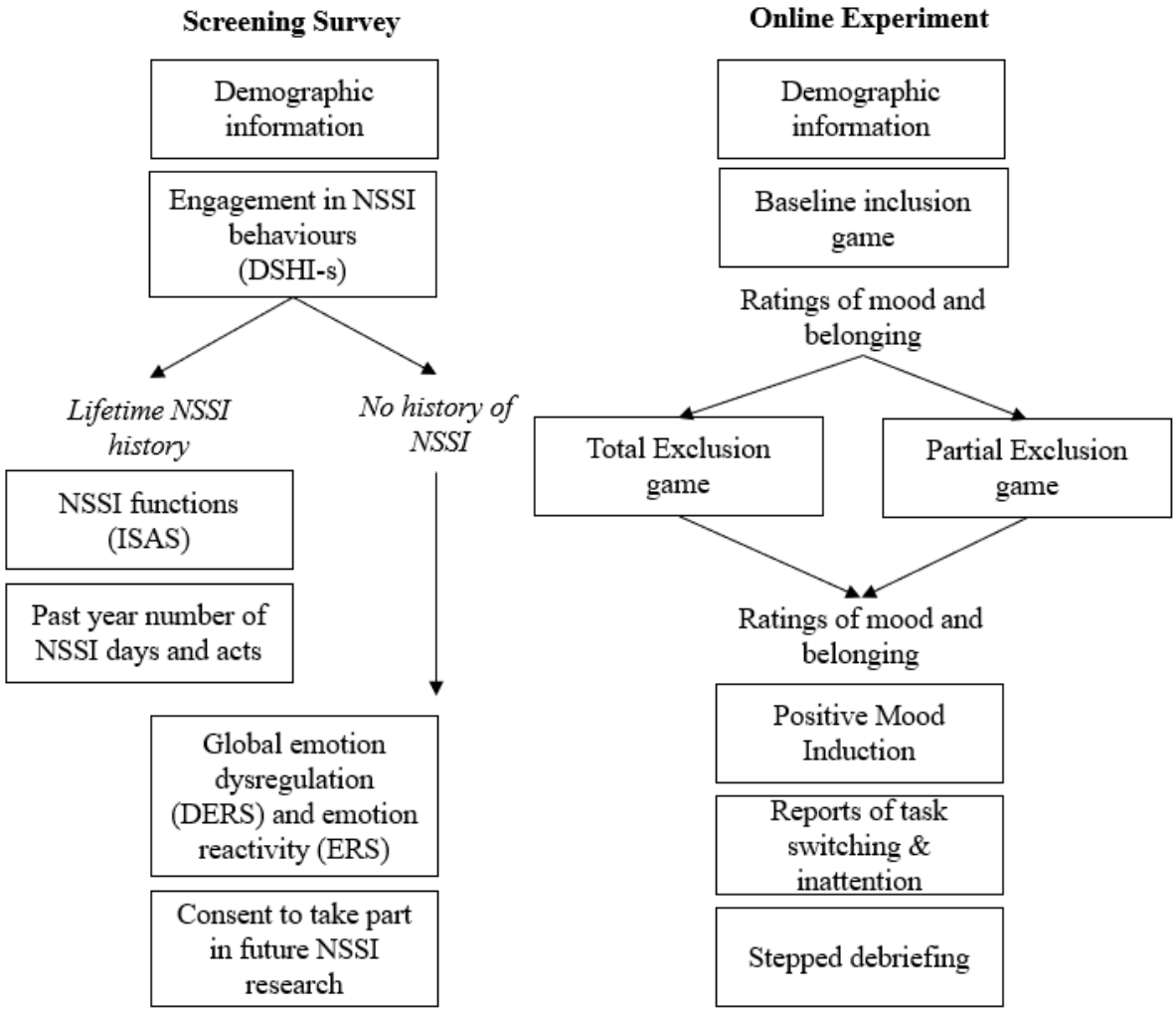
Ethical approval was obtained from Victoria University of Wellington's Human Ethics Committee. Eligible students (as assessed in an online screening survey at the beginning of the trimester) were invited to take part in an online[30] experiment hosted on Qualtrics. As in Study 2, participants were not told prior to debriefing that recruitment was based on self-injury in order to limit NSSI specific demand characteristics. See Figure 12 for an overview of the Study 3 procedure.

After providing informed consent, participants reported their demographic information, and any health diagnoses or prescription medications. Next, participants

[30] Study 3 was originally intended to be conducted in-person, with data collection conducted in groups of three or six participants. COVID-19 restrictions on in-person contact meant that instead participants took part online and in their own homes.

Figure 12

Study 3 procedure across the screening survey and the online experiment



completed the baseline Inclusion Cyberball game with two other 'students'—in reality, all the passes from the other players were pre-programmed—followed by a mood rating. Next, participants took part in one of two possible social exclusion games. In the Total Exclusion condition, participants received the ball once at the beginning of the game, and then never again; the two other 'players' passed the ball between themselves for the remainder of the game. In the Partial Exclusion condition, participants received the ball 6 times (15.0% of the total 40 throws), a proportion lower than chance, followed by a mood rating. Participants then completed a positive mood induction in which they rated photos of nature scenes for attractiveness and familiarity. Participants were then asked to report the extent to which they believed they were playing with other students in their class, as well as the extent to which

they switched their attention away from the online study (e.g., to browse the internet or check their phone). At the end of the study, participants were debriefed and provided with a list of support services available to them in the community (including, given the context of COVID-19, telehealth options).

Non-suicidal self-injury

The process of NSSI assessment mirrored that described in Study 2. At the beginning of the trimester (i.e., 2–12 weeks before participation in the laboratory session), all prospective participants completed the DSHI-s (Lundh et al., 2007) as part of a screening survey. Participants who reported engaging in NSSI behaviours also reported how many times in the last year they had engaged in NSSI, on how many days, and the functions of their NSSI (assessed using the 26-item version of the ISAS; Klonsky & Glenn, 2009). Consistent with Study 2 and previous use (e.g., Klonsky & Glenn, 2009), both the Intrapersonal functions ($\alpha = .90$) and Interpersonal functions ($\alpha = .72$) subscales showed adequate internal consistency within this sample. Participants recruited to the NSSI group ($n = 100$) reported having engaged in NSSI at least once in the past year. Participants recruited to the Control group ($n = 100$) indicated that they have never engaged (or thought about engaging) in 13 common NSSI behaviours (Lundh et al., 2007).

Global self-reports of reactivity and dysregulation

As described in Study 2, global self-reports of emotion reactivity and emotion dysregulation were assessed with the 16-item brief version of the Difficulties in Emotion Regulation Scale (DERS-16; Bjureberg et al., 2016) and the 21-item Emotion Reactivity Scale (ERS; Nock et al., 2008), respectively. Consistent with Study 2, both measures demonstrated good internal reliability within this sample (DERS $\alpha = .96$; ERS: $\alpha = .96$).

Social exclusion manipulation

Social interaction was modelled in the online version of Cyberball embedded into Qualtrics (Cyberball Version 5.4.1; Williams & Jarvis, 2006). At the beginning of the study, participants were told that they would play two ball passing games with other students in their course. Before each game, a screen with a 'loading'-style GIF was presented for five seconds below the text *'Waiting for other players to come online'*. Before each game, participants were told that their task was to mentally visualise the experience in as much detail as possible (see Appendix N for the complete instructions). All ball-tossing games involved 40 ball tosses.

In the first Cyberball game, all participants took part in an Inclusion (i.e., baseline) condition where they received 32.5% of throws from the two other 'players' (i.e., 13 throws, approximately a 'fair' distribution of all throws). In the second Cyberball game, participants took part in one of two Exclusion conditions. In the Total Exclusion condition, participants took part in the usual social exclusion manipulation (Hartgerink et al., 2015; Williams & Jarvis, 2006), in which they received the ball once at the beginning of the game and never again (2.5% of throws). In the Partial Exclusion condition, participants received 15.0% of throws (i.e., 6 throws, considerably fewer throws than would be 'fair').[31] This Partial Exclusion condition is similar to the ambiguous Cyberball condition used previously by Boyes and French (2009), where each computerised 'player' had a 30% probability of throwing the ball to the participant.

Real-time subjective emotional responding

Subjective mood was assessed after both the Inclusion and Exclusion Cyberball games, using visual analogue scales similar to those used in Study 2. Participants were instructed to rate the degree to which they experienced eleven feelings (angry, sad, ashamed, irritable, frustrated, anxious, alert, relaxed, interested, happy, and confident)[32] in the present moment using a 17.8 cm visual analogue scale ranging from *'0 – Not at All'* to *'100 – Extremely'*, presented on the computer screen. Participants responded by moving the marker with the computer mouse from its original placement at the midpoint (i.e., 50). The order of the feeling labels was randomised for each presentation and for each participant. Scores for alert, relaxed, interested, happy, and confident were reverse coded prior to analysis. Participants' responses at each time point were averaged to create an overall score of negative mood that ranged from 0 to 100.

Ratings of belongingness

As a manipulation check, participants also completed three items to assess feelings of belonging (Zadro et al., 2004) after both the Inclusion and Exclusion Cyberball games. All items began with *'During the [first] ball-passing game…'* and were completed by *'... I felt*

[31] The precise number of throws was decided after piloting three versions (10.0%, 15.0%, and 22.5% of throws) within a small sample (n = 26). Given that we were looking for an ambiguous emotional challenge that could be interpreted differently by participants, we selected the condition that resulted in the greatest variability (i.e., the largest *SD*) in mood change (Exclusion Negative Mood – Baseline Negative Mood).

[32] Compared to Study 2, the feelings labels 'stressed', 'jittery', and 'embarrassed' were removed, and the labels 'irritable', 'alert', 'relaxed', 'interested', and 'confident' were added. The labels 'interested', 'alert', 'irritable' were taken from the Positive and Negative Affect Scale (Watson et al., 1988), 'confident' was taken from Nock and Mendes (2008), and 'relaxed' was added to capture a low arousal positive experience.

poorly accepted by the other participants' (reverse-coded), *'...I felt as though I had made a 'connection' or bonded with one or more of the participants'*, and *'...I felt like an outsider'* (reverse-coded). The response format (typically assessed on a 9-point scale ranging from *'1 – Not at all'*, to *'9 – Very much'*) was modified to mirror the response options of the subjective mood ratings to allow for direct comparisons across these two measures. Participants were invited to respond using a 17.8 cm visual analogue scale that ranges from '*0 – Not at All'* to *'100 – Extremely'*, presented on the computer screen. Participants' responses at each time point were averaged to create an overall rating of belongingness that ranged from 0 to 100. These belongingness items have been used previously in the Cyberball literature as one of the 'fundamental needs' impacted by Cyberball and are sensitive to changes in between-subject manipulations of exclusion (Zadro et al., 2004).

Belief in other 'players'

To assess the extent to which participants believed they were playing with other students in their class, participants were invited to respond to the item *'How confident are you that the other players in the two ball-passing games are other students in* [undergraduate course]*?'* Participants responded on 17.8 cm visual analogue scale ranging from *'0 – Not at All'* to *'100 – Extremely'*, presented on the computer screen.

Inattention

Participants were invited to respond to four items assessing inattention during the study. For items beginning with *'During the two ball passing games…'* and *'During the questionnaires and picture viewing tasks* [i.e., the mood elevation task]…' participants were asked *'...how often did you switch your attention to browse the internet?'* and *'...how often did you check your phone?'*. Response options included: *'Never'*, *'1–2 times'*, *'3–5 times'*, *'6–9 times'*, and *'≥10 times'*.

Missing data

When 199 participants had completed the online study, we calculated the average time in minutes it took to complete the study (M = 38.83, SD = 140.46). Participants who completed the study in a time three standard deviations above or below the mean were identified (n = 3), removed, and replaced. One participant left 13 items (54.17%) of the negative mood and belongingness visual analogue scales blank. Given that a) the scale marker that participants moved to indicate their response was automatically set at 50 (i.e., the midpoint), and b) the participant reported no rating between 40 and 60, these missing values

were interpreted as a 50 response. Little's Missing Completely at Random (MCAR) test suggested that the pattern of missingness on the Emotion Reactivity Scale and the Difficulties in Emotion Regulation Scale was not MCAR, $\chi^2(641, n = 200) = 751.45$, $p = .002$. However, as only 1.46% of values were missing, following convention (Schafer, 1999) we deemed this missingness inconsequential. Missing values were imputed using expectation-maximization.

Analysis plan

Statistical analyses were conducted using jamovi and graphing was conducted in R using ggplot2 (Wickham, 2016). Statistical significance was set at $p < .050$, with $p < .100$ considered a trend for predicted effects only. All analyses reported here were preregistered unless noted as exploratory, and all preregistered predictions are identified. Significant findings that were not predicted are noted as such. Exploratory analyses are corrected for multiple comparisons using Bonferroni corrections.

Chi-squared analyses tested for group differences in medication use and clinical diagnoses, and independent *t*-tests for group differences in measures of global emotion reactivity and global dysregulation. A mixed-model ANOVA ensured that the social exclusion manipulation was effective at making participants feel like they did not belong in the group of Cyberball players, with Phase (Inclusion, Exclusion) as a within-subjects factor and NSSI Status (NSSI, Control) and Exclusion Severity (Total Exclusion, Partial Exclusion) as between-subjects factors, and belongingness ratings as the dependent variable. A similar mixed-model ANOVA with negative mood as the dependent variable tested whether people who engage in NSSI have either an amplified subjective response to social exclusion in general, or an amplified response only to more ambiguous social exclusion. Exploratory hierarchical linear regression assessed whether NSSI characteristics are associated with subjective reactivity to social exclusion. Finally, we explored whether differences by Exclusion Severity or NSSI status in the extent to which participants believed in the other players or engaged in inattentive behaviours might explain our findings using chi-squared analyses and paired proportion tests.

Results

NSSI characteristics

All 100 participants in the NSSI group reported engaging in NSSI in the past-year; 36.0% had done so 1–3 times, 11.0% 4–5 times, 15.0% 6–10 times, 20.0% 11–20 times, 13.0% 21–50 times and 5.0% had engaged in NSSI more than 50 times in the past-year. Lifetime frequency of NSSI was also highly variable; 6.1% of the NSSI group reported

engaging in NSSI 1–3 times in their lifetime, 11.1% 4–5 times, 11.1% 6–10 times, 8.1% 11–20 times, 24.2% 21–50 times, and 39.4% more than 50 times.[33] On average, the NSSI group reported engaging in 5.15 (*SD* = 2.31) NSSI methods, most commonly scratching their skin (84.0%), punching or banging their body (78.8%), and cutting their skin (72.7%). Within the NSSI group, participants who took part in the Total Exclusion and Partial Exclusion conditions reported similar past-year ($\chi^2(5) = 1.36$, $p = .929$, Cramer's $V = .12$) and lifetime ($\chi^2(5) = 3.80$, $p = .579$, Cramer's $V = .20$) frequencies of NSSI.

Compared to the Control group, the NSSI group were more likely to report a psychiatric diagnosis (59.0% vs. 12.0%, $\chi^2(1), = 48.24$, $p < .001$, Cramer's $V = .49$), most commonly depressive disorders (52.0% of NSSI group, 5.0% of Control group), anxiety disorders (40.0% vs. 4.0%), eating disorders (16.0% vs. 5.0%), and trauma and stress-related disorders (12.0% vs. 0%). The NSSI group were also more likely to be taking prescribed medications (43.0% vs. 18.0%; $\chi^2(1), = 13.46$, $p < .001$, Cramer's $V = .27$). Following birth control medication (17.0% of NSSI group, 11.0% of Control group), the most commonly reported medications were anti-depressants (18.0% vs. 2.0%, respectively), medications to treat physical health concerns (e.g., epilepsy, asthma; 19.0% vs. 4.0%), and anti-psychotics (3.0% vs. 1.0%, respectively). The NSSI and Control groups did not differ by age (NSSI: *M* = 18.46, *SD* = 1.03; Control: *M* = 18.75, *SD* = 1.25; $t(198) = 1.79$, $p = .075$, $d = 0.25$).

Global self-reports of emotion evaluations

Consistent with both Study 2 and previous meta-analytic research, the NSSI group reported significantly greater global emotion reactivity (*M* = 2.39, *SD* = 0.82) than the Control group (*M* = 1.29, *SD* = 0.80, $t(198) = 9.87$, $p < .001$, $d = 1.40$). Likewise, the NSSI group reported significantly greater global emotion dysregulation (*M* = 3.40, *SD* = 0.85) than the Control group (*M* = 2.09, *SD* = 0.75, $t(198) = 11.55$, $p < .001$, $d = 1.63$). Within the NSSI group, the lifetime number of NSSI methods was positively associated with both global emotion reactivity ($r = .32$, $p = .010$) and emotion dysregulation ($r = .26$, $p < .001$). In addition, the frequency of past-year NSSI was positively associated with both global emotion reactivity ($r = .36$, $p < .001$) and emotion dysregulation ($r = .36$, $p < .001$).

Belongingness manipulation check

Next, we turn to consider if the emotional challenge manipulation was effective at creating feelings of social exclusion. See Table 7 for descriptive statistics of belongingness and negative mood ratings separated by Exclusion Severity condition and NSSI status.

[33] One participant did not report the lifetime frequency of their NSSI.

Figure 13 displays ratings of belongingness across the phases separated by Exclusion Severity condition and NSSI status. We found a main effect of Phase ($F(1, 196) = 667.62$, $p < .001$, $\eta_p^2 = .77$), but not Exclusion Severity ($F(1, 196) = 1.96$, $p = .163$, $\eta_p^2 = .01$) on ratings of belongingness. Critically, there was a significant interaction between Exclusion Severity and Phase, $F(1, 196) = 10.96$, $p = .001$, $\eta_p^2 = .05$. Follow-up *t*-tests showed that the switch from the Inclusion game to the Exclusion game reduced belongingness in both the Partial Exclusion ($t(99) = 20.47$, $p < .001$, $d = 2.05$) and Total Exclusion conditions ($t(99) = 16.19$, $p < .001$, $d = 1.65$), although this reduction was greater in the Total Exclusion condition than the Partial Exclusion ($t(198) = 3.33$, $p = .001$, $d = 0.47$). Thus, although both versions of social exclusion reduced feelings of belongingness, overt exclusion from the other Cyberball 'players' was a more effective at reducing feeling of belongingness than subtle exclusion, suggesting that the Partial Exclusion game was experienced as a milder form of social exclusion than the Total Exclusion game.

In terms of NSSI Status, we found a trend towards a main effect of NSSI on belongingness ratings, $F(1, 196) = 3.56$, $p = .061$, $\eta_p^2 = .02$. Follow-up analyses indicated a trend to suggest that the NSSI group reported feeling they belonged less ($M = 62.72$, $SD = 18.27$) following the baseline *Inclusion* game than did the Control group ($M = 67.29$, $SD = 16.51$; $t(198) = 1.86$, $p = .065$, $d = 0.26$). Both the groups reported similar ratings of belongingness following the Exclusion game (NSSI: $M = 20.39$, $SD = 20.47$; Control: $M = 23.68$, $SD = 20.58$; $t(198) = 1.13$, $p = .259$, $d = 0.16$). Critically, we found no evidence of an interaction for NSSI Status × Phase ($F(1, 196) = 0.15$, $p = .701$, $\eta_p^2 < .01$) or NSSI Status × Phase × Exclusion Severity ($F(1, 196) < .001$, $p = .987$, $\eta_p^2 < .01$).

Table 7

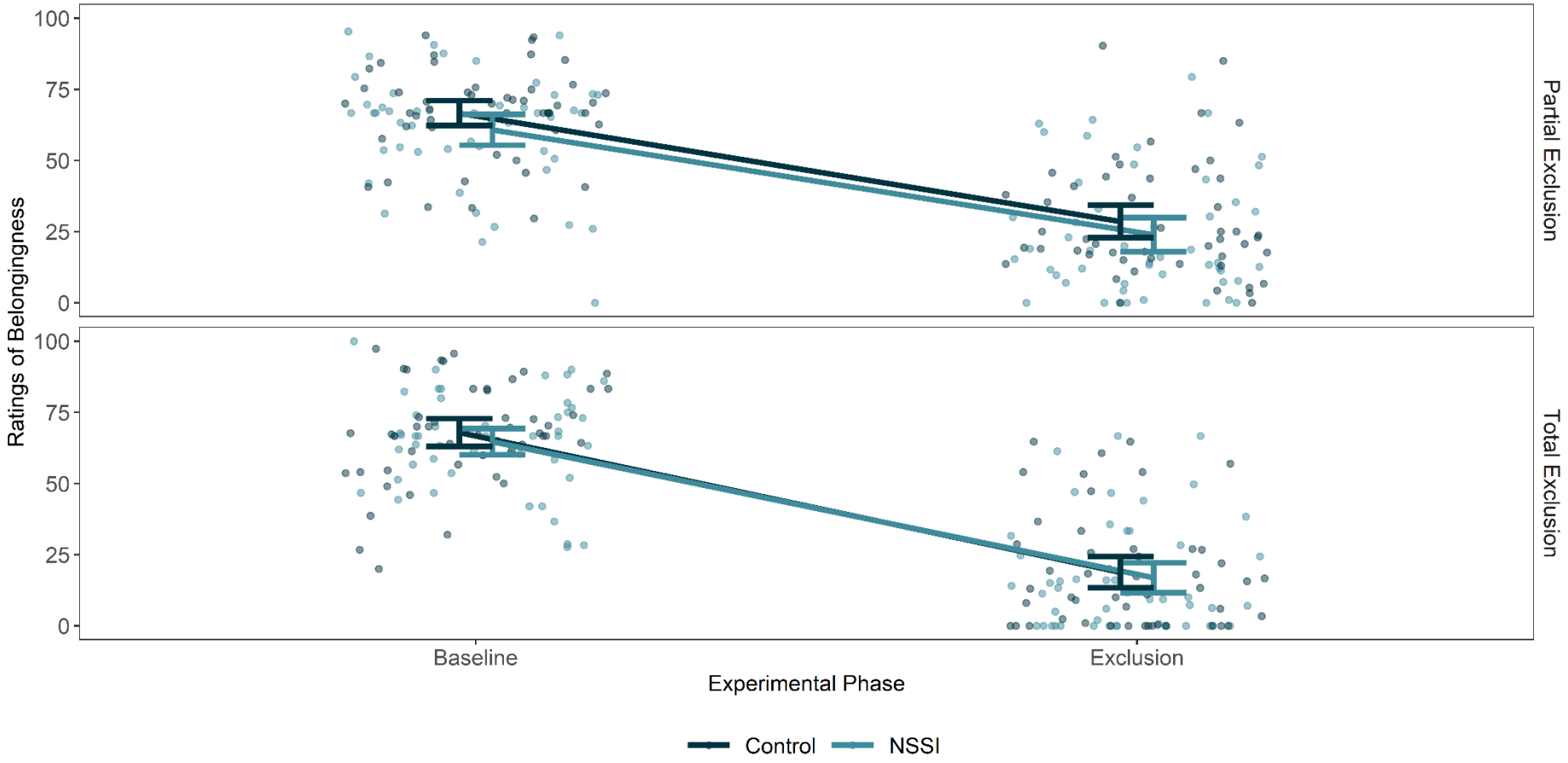
Descriptive statistics of ratings belongingness and negative mood separated by exclusion severity condition and non-suicidal self-injury status.

	Total Exclusion			Partial Exclusion		
Variable	Overall sample *Mean* (*SD*)	NSSI *Mean* (*SD*)	Control *Mean* (*SD*)	Overall sample *Mean* (*SD*)	NSSI *Mean* (*SD*)	Control *Mean* (*SD*)
Belongingness ratings						
Inclusion	66.30 (17.06)	64.67 (16.69)	67.93 (17.44)	63.71 (17.96)	66.65 (15.68)	60.77 (19.7)
Exclusion	17.82 (19.36)	16.85 (19.13)	18.79 (19.73)	26.25 (20.92)	28.57 (20.44)	23.92 (21.35)
Negative mood						
Inclusion	37.23 (16.76)	43.59 (17.73)	30.87 (13.07)	35.59 (16.74)	41.09 (17.99)	30.10 (13.45)
Exclusion	51.99 (19.56)	57.72 (20.01)	46.27 (17.48)	45.66 (17.46)	52.09 (16.46)	39.24 (16.14)

Note. Partial Exclusion n = 100 (NSSI n = 50, Control n = 50), Total Exclusion n = 100 (NSSI n = 50, Control n = 50).

Figure 13

Average ratings of belongingness across emotional challenge separated by non-suicidal self-injury and exclusion severity



Note. Scatter represents individual responses at each phase, error bars represent 95% confidence intervals. Partial Exclusion n = 100 (NSSI n = 50, Control n = 50), Total Exclusion n = 100 (NSSI n = 50, Control n = 50).

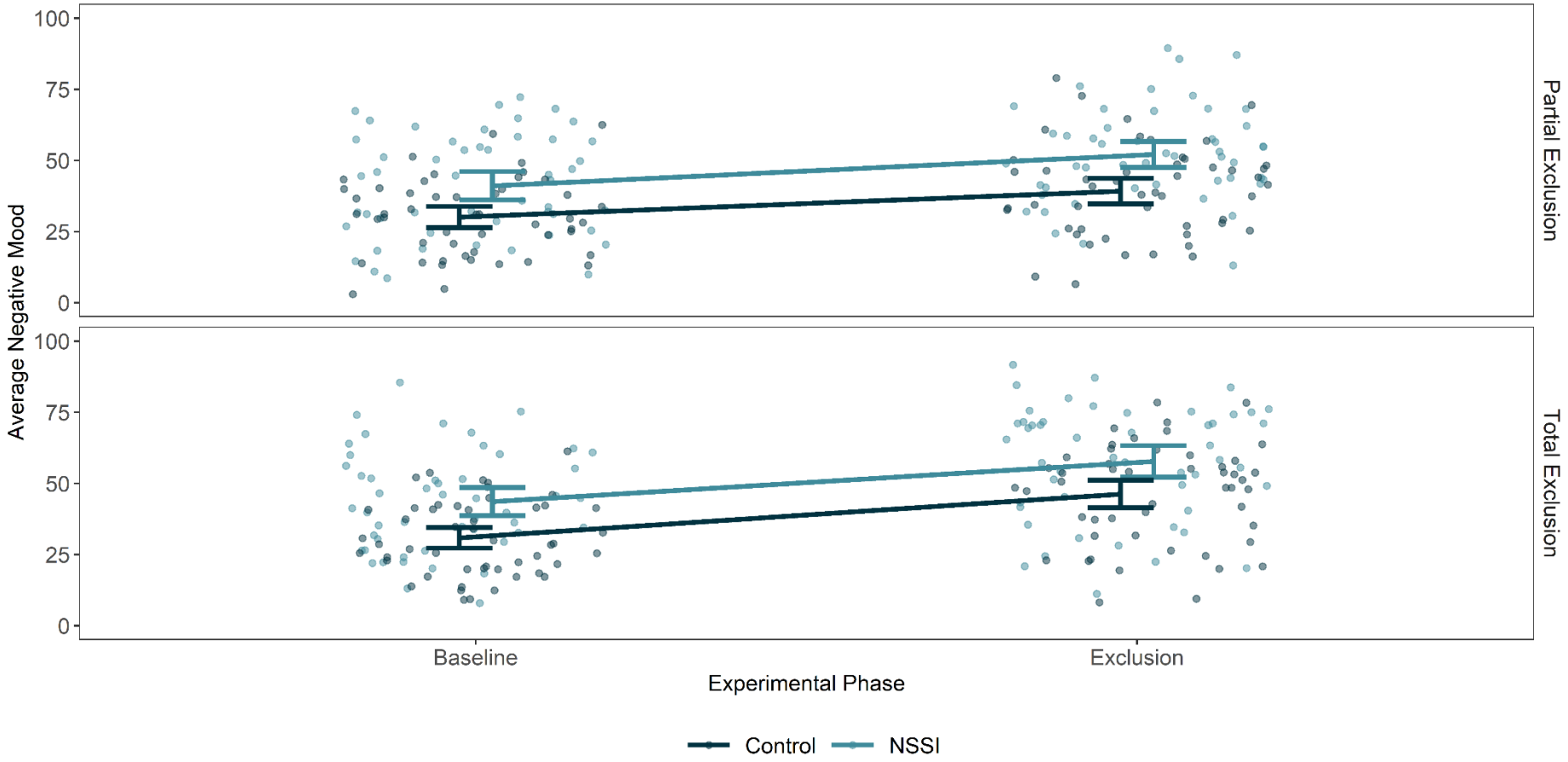
Subjective responding to emotional challenge

Now I test the hypotheses that, relative to controls, people who engage in NSSI experience either: (i) a greater subjective response to social exclusion in general; or (ii) a similar subjective response to overt social exclusion, but a greater subjective response to more subtle social exclusion. Figure 14 displays ratings of negative mood across the phases separated by Exclusion Severity condition and NSSI status. We found a main effect of Phase ($F(1, 196) = 135.43$, $p < .001$, $\eta_p^2 = .41$) and a trend towards a significant effect of Exclusion Severity ($F(1, 196) = 3.58$, $p = .060$, $\eta_p^2 = .02$) on negative mood. Critically, these two main effects were qualified by a significant interaction between Exclusion Severity and Phase $F(1, 196) = 4.83$, $p = .029$, $\eta_p^2 = .02$). Follow-up *t*-tests revealed that, compared to the baseline Inclusion game, negative mood increased following the Exclusion game for both the Total Exclusion ($t(99) = 9.96$, $p < .001$, $d = 1.00$) and Partial Exclusion conditions ($t(99) = 6.61$, $p < .001$, $d = 0.66$). Notably, there was no difference in negative mood across both baseline Inclusion games ($t(198) = 0.69$, $p = .490$, $d = 0.10$), but the Total Exclusion game resulted in greater negative mood than did the Partial Exclusion game ($t(198) = 2.41$, $p = .017$, $d = 0.34$). Thus, although both versions of social exclusion increased negative mood, the Total Exclusion game was more effective at doing so than the Partial Exclusion game. Again, this pattern of results suggests that the Partial Exclusion game was experienced as a milder emotional challenge than the Total Exclusion game.

Considering NSSI Status, we found a main effect of NSSI on negative mood, $F(1, 196) = 32.52$, $p < .001$, $\eta_p^2 = .14$, whereby the NSSI group reported considerably greater negative mood in general than did the Control group following both the baseline Inclusion games (NSSI: $M = 42.34$, $SD = 17.81$; Control: $M = 30.49$, $SD = 13.20$; $t(182.54) = 5.35$, $p < .001$, $d = 0.76$, equal variances not assumed) and Exclusion (NSSI: $M = 54.91$, $SD = 18.45$; Control: $M = 42.75$, $SD = 17.11$; $t(198) = 4.83$, $p < .001$, $d = 0.68$) games. However, counter to our hypotheses, we found no evidence of interactions for NSSI Status × Phase ($F(1, 196) = 0.02$, $p = .888$, $\eta_p^2 < .01$), NSSI status × Exclusion Severity ($F(1, 196) = 0.71$, $p = .968$, $\eta_p^2 < .01$), or NSSI Status × Phase × Exclusion Severity ($F(1, 196) = 0.54$, $p = .464$, $\eta_p^2 < .01$). Further exploratory inspection of the nine discrete moods in each Exclusion Severity condition revealed no evidence of a NSSI Status × Phase interaction (see Appendix O). Taken together, we found no evidence that, compared to controls, people who engage in NSSI showed an amplified subjective response to social exclusion in general, or an amplified subjective response to subtle social exclusion in particular.

Figure 14

Average negative mood across emotional challenge separated by non-suicidal self-injury status and exclusion severity



Note. Scatter represents individual responses at each phase, error bars represent 95% confidence intervals. Partial Exclusion n = 100 (NSSI n = 50, Control n = 50), Total Exclusion n = 100 (NSSI n = 50, Control n = 50).

Table 8

Linear regression analysis predicting responding to social exclusion by non-suicidal self-injury characteristics

Predictors	Negative mood		Belongingness ratings	
	β (95% CI)	*p*	*β* (95% CI)	*p*
Step 1	$F(2, 94) = 35.22$, $p < .001$, Adj. $R^2 = .43$		$F(2, 94) = 2.57$, $p = .082$, Adj. $R^2 = .03$	
Baseline inclusion ratings	**.63 (.48, .79)**	**< .001**	.14 (-.06, .34)	.182
Exclusion severity condition	.12 (-.04, .28)	.130	-.19 (-.01, .39)	.060
Step 2	$F(6, 90) = 13.82$, $p < .001$, Adj. $R^2 = .48$		$F(6, 90) = 2.13$, $p = .057$, Adj. $R^2 = .07$	
Number of NSSI methods	-.08 (-.27, .12)	.437	**.26 (-.51, -.02)**	**.036**
Past-year NSSI frequency	.08 (-.09, .25)	.340	-.14 (-.08, .35)	.219
Intrapersonal functions	**.20 (.02, .37)**	**.026**	-.22 (-.01, .44)	.062
Interpersonal functions	.05 (-.12, .23)	.563	.02 (-.25, .20)	.830

Note. Analyses conducted within the NSSI subsample ($n = 100$). Significant predictors are bolded for clarity.

NSSI characteristics and real-time subjective responding

People who engage in NSSI show considerable variability in their NSSI characteristics, and thus group-level 'past-year NSSI status' may obscure meaningful individual differences *among* people who self-injure in how they respond to social exclusion. Focusing only on the NSSI group (n = 100), we conducted an exploratory hierarchical linear regression predicting subjective mood following social exclusion. Within the regression model, we included baseline Inclusion negative mood, and Exclusion Condition at Step 1, and lifetime number of NSSI methods, past-year NSSI frequency, intrapersonal functions, and interpersonal functions at Step 2. See Table 8 for model fit statistics and standardised estimates.

Focusing first on ratings of belongingness, neither Step 1 nor Step 2 of the linear regression model significantly predicted feelings of belonging following social exclusion. A greater number of lifetime NSSI methods was negatively associated with feelings of belonging following social exclusion, although this should be interpreted with caution as the overall regression model was not significant (p = .057). Next, I turn to consider whether NSSI characteristics predict subjective reactivity to social exclusion. Both Step 1 and Step 2 of the regression model significantly predicted negative mood following social exclusion. After accounting for baseline negative mood, neither the lifetime number of NSSI methods, past-year NSSI frequency, or interpersonal functions predicted negative mood following social exclusion. Notably, intrapersonal functions (β = .20) positively predicted negative mood following social exclusion, suggesting that the more a participant reported engaging in NSSI to manage their internal experiences the greater their subjective reactivity to social exclusion.

Influences on these effects

Finally, we explore whether belief that the other Cyberball 'players' were students and inattentive behaviours during the study might have influenced the effects described above.

Belief in other Cyberball 'players'

Although previous research has demonstrated that Cyberball is effective at inducing feelings of ostracism even when participants are aware that the ball-throws are pre-programmed (Zadro et al., 2004), we first assess whether participants' belief in the other players was associated with the efficacy of Cyberball for creating emotional challenge. In

general, participants reported low confidence that the players in the two Cyberball games were their fellow students (*M* rating = 9.21, *SD* = 14.47, Range 0–100), suggesting that they were not fooled by the Cyberball instructions. Belief ratings did not differ by Exclusion Severity (Total Exclusion: *M* = 7.69, *SD* = 13.81; Partial Exclusion: *M* = 10.72, *SD* = 15.01; $t(198) = 1.49$, $p = .139$, $d = 0.21$), or NSSI status (NSSI group: *M* = 8.29, *SD* = 14.75; Control group: *M* = 10.12, *SD* = 14.19; $t(198) = 0.89$, $p = .372$, $d = 0.13$). Critically, belief ratings were unrelated to negative mood following either baseline Inclusion ($r_s = -.04$, $p = .528$) or Exclusion games ($r_s = -.04$, $p = .528$).[34] Thus, the extent to which participants believed they were playing other students cannot account for the differences in belongingness ratings or negative mood we see across the two social exclusion conditions.

Inattentive behaviours

Study 3 took place online, with minimal control over how participants engaged in the study. Given that distraction is a commonly used emotion regulation strategy (e.g., Scheibe et al., 2015; Wolgast & Lundh, 2017), inattentive behaviours which allow participants to disengage from the game may be a *consequence* of social exclusion. Table 9 describes how often participants reported browsing the internet and checking their phone during the two 'sections' of the online study—the two Cyberball games (i.e., the emotional challenge), and the questionnaires and mood-elevation tasks. In general, inattentive behaviours were (reportedly) infrequent during the study, except for checking phones during the emotional challenge. Notably, more participants reported checking their phone (63.0% vs. 24.0%, $z = 6.51$, $p < .001$) and browsing the internet (26.5% vs. 15.0%, $z = 2.57$, $p = .006$) during the Cyberball games compared to the rest of the online study. Exclusion Severity was unrelated to the frequency participants reported browsing the internet during the emotional challenge (Exclusion Severity: $\chi^2(4) = 6.17$, $p = .187$, Cramer's $V = .18$). However, participants in the Total Exclusion condition were more likely to check their phone during the Cyberball games than those in the Partial Exclusion condition (74% vs. 52%; $\chi^2(4), = 11.62$, $p = .020$, Cramer's $V = .24$). Critically, the NSSI group were as likely to report checking their phone ($\chi^2(4), = 5.97$, $p = .201$, Cramer's $V = .19$) and browsing the internet ($\chi^2(4), = 6.10$, $p = .192$, Cramer's $V = .19$) during the Cyberball games as the Control group.

[34] Given that confidence ratings were zero-inflated, we use non-parametric Spearman's rho here.

Table 9

Frequencies of inattentive behaviour by procedural task

	Questionnaires and mood elevation task		Cyberball games (mood induction)	
	Browsing the internet	Checking phone	Browsing the internet	Checking phone
Frequency of inattentive behaviour				
Never	85.0%	76.5%	73.5%	37.0%
1–2 times	11.5%	16.0%	17.0%	35.0%
3–5 times	2.0%	4.5%	6.5%	18.5%
6–9 times	1.0%	2.0%	2.0%	6.5%
≥10 times	0.5%	1.0%	1.0%	3.0%

Note. $n = 200$.

Table 10

Correlations between inattentive behaviours during the Cyberball games and ratings of negative mood and belongingness separated by exclusion severity condition

	Partial Exclusion		Total Exclusion	
Variable	Inclusion	Exclusion	Inclusion	Exclusion
Correlations with negative mood				
Check phone	.13	.13	**.24***	**.25***
Browsing internet	.18	.09	.12	.12
Correlations with belongingness ratings				
Check phone	.02	-.10	-.07	-.11
Browsing internet	.02	.09	.03	.10

Note * $p < .050$. Statistically significant estimates are bolded for clarity. Partial Exclusion $n = 100$, Total Exclusion $n = 100$.

Next, we assess whether inattentive behaviours during the emotional challenge could explain the effects on belonginess and negative mood. Table 10 presents the correlations between inattentive behaviours during the emotional challenge and ratings of negative mood and belongingness for both Inclusion and Exclusion games, separated by Exclusion Severity. Inattentive behaviours were largely unrelated to negative mood and ratings of belongingness. The exception was that among participants in the Total Exclusion condition, negative mood following both the Inclusion and Exclusion games was positively associated with the extent to which participants reported checking their phone during the Cyberball games. However, in a linear regression model, ($F(2, 97) = 42.50$, $p < .001$, *Adjusted* $R^2 = 0.47$), accounting for baseline negative mood ($\beta = .65$ [95% CI: 0.50, 0.81], $p < .001$), the extent to which participants reported checking their phone during the Cyberball games failed to uniquely predict negative mood following Total Exclusion ($\beta = .10$ [95% CI: -0.06, 0.24], $p = .213$). Participants who reported greater increases in negative mood following total social exclusion were no more or less likely to report checking their phone during the Cyberball games, suggesting that inattentive behaviours were not a consequence of social exclusion.

Discussion

Despite consistently reporting poorer global emotional functioning compared to controls, people who engage in NSSI largely fail to show systematic differences in emotional responding to real-time challenges. However, much of the previous research, including Study 2, has assessed for differences in emotional responding by NSSI status using strong emotional challenges such as the TSST (e.g., Kaess et al., 2012; Tatnell et al., 2018). Strong emotional challenges may create ceiling effects in the emotional response which mask meaningful differences by NSSI status. Perhaps people who engage in NSSI report poorer global emotional functioning not because they have an amplified emotional response system *in general*, but rather because they have a more sensitive appraisal system where benign and/or neutral stimuli are interpreted as a threat. If this is the case, then relative to controls, people who engage in NSSI should experience a similar subjective response to overt social exclusion, but a greater subjective response to more subtle social exclusion. Study 3 extends Study 2 by testing the amplified emotional account in a different, peer-to-peer interpersonal challenge, before assessing whether the appraisal system is more sensitive to threat in NSSI.

Manipulating the severity of social exclusion

Previous research has shown that total exclusion from other Cyberball 'players' reliably creates social ostracism (for a meta-analysis, see Hartgerink et al., 2015). Drawing

from previous research (Boyes & French, 2009; Williams et al., 2000), Study 3 used a partial social exclusion Cyberball game to create more mild, ambiguous social exclusion. Consistent with previous research (Boyes & French, 2009; Williams et al., 2000), participants were sensitive to the extent to which they were excluded from Cyberball; although both social exclusion conditions increased negative mood and decreased belongingness compared to social inclusion, the Partial Exclusion game was less effective at doing so than the Total Exclusion game.

Previous research has demonstrated that Cyberball exclusion creates feelings of ostracism even when participants are aware that the ball-throws are pre-programmed (Zadro et al., 2004). Extending this finding, we assessed whether the extent to which participants believed they were playing other students in their class influenced the efficacy of Cyberball for creating emotional challenge. In general, belief in the other players was low. Participant's belief ratings did not differ between the Partial Exclusion and Total Exclusion conditions, or by NSSI status. Critically, ratings of negative mood following both baseline inclusion and social exclusion were unrelated to the extent to which participants reported being confident that they were playing other students in their class, suggesting that belief in the other player is not necessary for Cyberball to be an effective emotional challenge.

Given that participants took part online, we had limited control over how often they switched their attention away from the study. Distraction is a commonly used emotion regulation strategy (e.g., Scheibe et al., 2015; Wolgast & Lundh, 2017), and inattentive behaviours which allow participants to disengage from the game may be a *consequence* of emotional challenge. The initial Cyberball study using in-person versions of the ball-tossing games, found that participants totally excluded from the game often engaged in object-manipulation behaviours (e.g., retying shoe laces, or looking at their keys), which were interpreted as attempts to mask negative mood (Williams & Sommer, 1997). In a similar manner, we found that participants in the Total Exclusion condition were more likely to report checking their phone (but no more likely to report browsing the internet) during the Cyberball games than those in the Partial Exclusion condition. Given that the Total Exclusion condition created greater negative mood than the Partial Exclusion Condition, it may be that participants in the Total Exclusion condition were more likely to seek out distraction opportunities in the form of checking their phone. Counter to this proposal, after accounting for baseline negative mood, phone-checking during the Cyberball games was not associated with negative mood following Total Exclusion. Instead, greater phone-checking in the Total Exclusion condition may simply reflect less engagement in the

exclusion game. The Total Exclusion game, by design, includes several minutes where the participant does not have to engage in the game, whereas the Partial Exclusion game requires sporadic engagement throughout. Taken together, these findings demonstrate that subtle social exclusion may be a useful paradigm to create more ambiguous emotional challenge in online experiments.

Emotional responding to social exclusion in NSSI

Extending both Study 2 and a vast body of research (e.g., Wolff et al., 2019; You et al., 2018), young women with a past-year history of NSSI reported significantly greater global emotion reactivity and emotional dysregulation than did those with no history of NSSI. In terms of real-time negative mood, young women with a recent history of NSSI reported greater negative mood in general compared to controls. This overall difference in negative mood has been documented in previous studies tracking real-time emotion (e.g., Kaufman et al., 2019), and likely reflects the co-morbidity of NSSI with psychiatric disorders characterised by low mood (e.g., Nock et al., 2006). For instance, 52.0% of the NSSI group reported a depressive disorder, compared to only 5.0% of the Control group. However, as highlighted in Chapter 2, although group-level differences tell us about overall emotion, they can tell us little about emotion reactivity or recovery because they do not capture changes in emotion over time. Evidence of altered emotional responding in NSSI comes only from an interaction between NSSI status and emotional challenge.

Counter to the hypothesis that people who engage in NSSI have an amplified emotional response, both the NSSI group and the Control group showed a similar pattern of subjective reactivity to total social exclusion. In a similar manner, both Groschwitz and colleagues (2016) and Schatten and colleagues (2015) found that people with and without a history of NSSI showed similar increases in subjective distress to Cyberball total exclusion. Study 3 extends these findings in a larger sample (Study 3 n =100, vs. n =14, Groschwitz et al., 2016), and a within-subjects manipulation of social exclusion (compared to a between-subject manipulation, Schatten et al., 2015). Study 3 replicates and extends the Study 2 subjective reactivity findings to a peer-focused emotional challenge where ‘failure’ is interactional. Taken together, although people who engage in NSSI may experience heightened negative mood in general, there is no evidence to suggest that they have an amplified subjective response to social exclusion in general.

Counter to the hypothesis that people who engage in NSSI have a more sensitive appraisal system, both the NSSI and Control groups showed a similar pattern of subjective

reactivity in response to both overt *and* ambiguous social exclusion. Boyes and French, (2009) also used partial Cyberball exclusion to investigate the role of individual differences in appraisal of emotional challenge. Compared to low-neuroticism participants, high-neuroticism participants perceived themselves as having less control in the Partial Exclusion condition, but not in the Total Exclusion condition, suggesting that individual differences in appraisal are most evident in appraisals of ambiguous situations (Boyes & French, 2009). Although NSSI has been positively associated with neuroticism (e.g., Claes et al., 2010; Hasking et al., 2010; You et al., 2016), we found no evidence that the NSSI group were more likely to appraise a milder, more ambiguous social exclusion as more threatening than the Control group. That is, we found no evidence that people who engage in NSSI have a more sensitive emotional response system than controls.

NSSI is a highly heterogenous behaviour and so group-level analyses (such as those described above) may be poorly suited to capture the true nature of the relationship between emotional responding and NSSI. A growing body of research documents that characteristics of NSSI (e.g., lifetime frequency, number of lifetime NSSI methods) are differentially associated with suicidal thoughts and behaviours (e.g., Kiekens et al., 2018a; Robinson et al., 2021; Victor et al., 2015), suggesting that these characteristics may be useful in differentiating among people who engage in NSSI. Exploratory analysis within the NSSI group revealed that, accounting for baseline negative mood and exclusion severity condition, neither lifetime number of NSSI methods, past-year NSSI frequency, or interpersonal functions were unique predictors of negative mood following social exclusion. However, intrapersonal functions uniquely predicted negative mood following exclusion (β = .20); the more a person reported engaging in NSSI to manage their internal experiences the greater their subjective reactivity to social exclusion. The foundations of individual differences in emotional lability are thought to be set early in development (e.g., Beauchaine, 2015; Crowell et al., 2009; Linehan, 1993), well *before* the onset of NSSI. Given this proposed developmental relationship, our pattern of results suggests that among people who engage in NSSI, those who experience amplified subjective reactivity are more likely to engage in NSSI as a way to manage their internal experiences. It is worth noting that in Study 2 intrapersonal functions were unrelated to reactivity to, or recovery from, acute stress across subjective, heart rate, and electrodermal channels of emotional responding. Given that Study 3 (n = 100) has almost double the NSSI sample of Study 2 (n = 51) and that these exploratory analyses rely on variability, these disparate results may reflect a lack of power in Study 2. Future

research should assess whether intrapersonal functions predict greater subjective reactivity to a variety of emotional challenges in a large sample of people with a history of NSSI.

Strengths and limitations

Study 3 has two key strengths. First, the majority of research utilising Cyberball inclusion and exclusion games to create emotional challenge have used a between-subjects manipulation (i.e., participants complete either the inclusion or the exclusion game; e.g., Boyes & French, 2009; Schatten et al., 2015; Williams et al., 2000). In contrast, Study 3 used a within-subjects manipulation in which participants completed the baseline inclusion game followed by one of two exclusion games, allowing for greater statistical power. Second, Study 3 replicated Study 2's subjective reactivity findings in a sample with more severe NSSI engagement. In particular, compared to Study 2, Study 3 NSSI participants reported more lifetime NSSI methods (Study 3: $M = 5.15$, $SD = 2.31$; Study 2: $M = 3.45$, $SD = 2.01$; $t(149) = 4.46$, $p < .001$, $g = 0.77$) and greater past-year NSSI frequency (38.0% of the Study 3 NSSI group reported engaging in NSSI more than 10 times in the past year, compared to only 17.7% of the Study 2 NSSI group; $z = 2.55$, $p = .011$). This increase in NSSI severity between Study 2 and 3 may reflect the detrimental impact of COVID-19 and associated lockdowns on mental health (e.g., Hasking et al., 2021), or the increased accessibly of online (Study 3) versus in-person (Study 2) studies for people with more severe NSSI. Taken together, Study 3 extends Study 2 findings using a well-powered design with a sample of young women with more severe NSSI.

Findings from Study 3 should be interpreted in light of two caveats. First, inspection of participants' belongingness ratings following both social exclusion conditions highlights the possibility of a floor effect—the modal rating was 0.00 (17.5% of participants responded 0) and more than a third (34.5%) of the sample rated their perceived belongingness between 0 and 10 (possible range 0–100). Other Cyberball studies have also reported zero-inflated ratings of belongingness following social exclusion (e.g., $M = 2.81$, $SD = 1.80$, scale range 1 to 9, Williams et al., 2000; $M = 3.7$, $SD = 2.3$, scale range 1 to 9, Zadro et al., 2004), suggesting that this issue may be widespread. These low ratings may reflect demand characteristics where participants, anticipating a prediction that social exclusion would decrease belongingness, chose to respond in a way they thought would support the hypothesis (e.g., Nichols & Maner, 2008). Another possibility is that the low variability in belongingness rates reflects that participants knew objectively that they were excluded from the game. Given the low variably in ratings, the belongingness results are difficult to interpret.

Second, we manipulated severity of social exclusion using a between-subjects manipulation in which participants completed either the Total Exclusion condition or the Partial Exclusion condition. The Partial Exclusion game created smaller increases in negative mood compared to the Total Exclusion game, suggesting that it was indeed perceived to be a milder emotional challenge. However, it seems unlikely that the Partial Exclusion game was truly an *ambiguous* event that could reasonably be interpreted as neutral and/or benign. Future research should use within-subjects designs of well-established ambiguous stimuli to test if NSSI is characterised by an appraisal system more sensitive to threat. For instance, cognitive psychology has developed paradigms which leverage lexical ambiguity to understand interpretation (i.e., appraisal) bias. For instance, the word '*stroke'* could mean a either 'a gentle caress' or 'a brain haemorrhage', with different emotional consequences depending on the resolution of the ambiguity (Blanchette & Richards, 2010). Thus, well-established lexical ambiguity tasks could be used to establish whether people who engage in NSSI are more likely to resolve lexical ambiguity in a negatively-valenced manner.

Conclusion

Study 3 found that young women with a past-year history of NSSI reported considerably poorer global emotional functioning compared to controls. However, when we assessed subjective reactivity to a well-established social exclusion manipulation, we found no difference in how people with and without NSSI responded to either overt social exclusion, or a subtle more ambiguous social exclusion. We found no evidence that people who engage in NSSI have either an amplified emotional response in general, or a more sensitive appraisal system compared to controls. Exploratory analyses suggest that people who engage in NSSI to manage their internal experiences show amplified subjective reactivity to social exclusion, although future research is needed to replicate this finding. Thus, across both Study 2 and 3 we see a disconnect between how people who engage in NSSI report their global experiences of emotional functioning and how they respond to real-time emotional challenges. Although it could be that the experimental manipulations used by research to date fail to capture the types of emotional challenges that people who engage in NSSI struggle with in daily life, it is also possible that people who engage in NSSI extrapolate differently from daily emotional challenges to global reports compared to controls. To test this possibility, Chapter Six assesses whether the association between real-time emotional responding and global reports of emotion functioning is moderated by NSSI status.

Chapter 6: Associations between global reports and real-time emotional responding

Global self-reports of emotion reactivity and emotion dysregulation are assumed to reflect an individuals' real-time emotional response. As a result, the consistent, large-scale differences in global emotion reactivity and emotion dysregulation by NSSI status have led, in part, to prominent theories that argue that an amplified emotional response or a failure to adequately regulate those responses lays the *foundation* for NSSI. However, in two large samples of young adults, Study 2 and 3 of this thesis found no difference in how people with a past-year history of NSSI and controls respond to acute social stress (TSST; Study 2), and both explicit or ambiguous social exclusion (Cyberball; Study 3). These findings contribute to a growing body of evidence that despite reporting consistently poorer global emotional functioning there are no systematic differences in real-time emotional responding by NSSI status (e.g., Glenn et al., 2011; Mettler et al., 2021; Schatten et al., 2015; Tatnell et al., 2018). It may be that (all) the emotional challenge manipulations used to date fail to capture the types of challenges people who engage in NSSI struggle with in daily life. However, it is also possible that we see large-scale differences in global reports by NSSI status because people who engage in NSSI extrapolate from their daily emotional responses to global reports in a different manner than controls.

Thus far, I have used an experimental lens to understand the role of real-time emotional functioning in NSSI. Study 2 and 3 compared how people with, and without, a history of NSSI respond to an emotional challenge manipulation, using between-subjects (quasi)manipulation to isolate the impact of NSSI on emotional functioning. In this last empirical chapter, I take a complementary, exploratory individual differences approach to consider if the relationship between real-time emotional responding and global self-reports of emotional functioning may differ by NSSI status. Individual differences approaches demonstrate the variability in a phenomenon within a population and help isolate factors that create that variability. If people who engage in NSSI extrapolate from daily emotional challenges to global reports of emotional functioning in a different manner to controls, then the association between global self-reports of emotional functioning and real-time responding should be moderated by NSSI status. In this chapter, I reanalyse Study 2 and 3 data to assess for a relationship between global self-reports of emotional functioning and real-time emotional responding, before assessing whether NSSI status moderates this relationship. Of course, before examining this relationship any further, it is important to first discount psychometric explanations.

One intuitive explanation for why we see large differences in global emotional functioning by NSSI status, but not in real-time responding, is that global self-report items are measuring a different construct among people who engage in NSSI compared to controls. Perhaps people who engage in NSSI interpret the items assessing global emotional functioning in a conceptually different manner to controls. Focusing on global emotion dysregulation, Kiekens, Hasking, and Boyes (2018) compared the measurement invariance of the 18-item short form of the Difficulties in Emotion Regulation Scale (DERS -SF; Kaufman et al., 2016) among emerging adults with and without a history of NSSI. Critically, Kiekens and colleagues (2018) ruled out measurement artifacts as an explanation for the large-scale differences we see in global emotion dysregulation by NSSI status, suggesting instead that these reflect substantive differences in global emotion dysregulation between groups. To date, the measurement invariance of global self-reports of emotion reactivity by NSSI status has yet to be determined.

Global self-reports of emotional functioning are largely assumed to provide some information about an individual's momentary emotional experience. However, global self-reports and real-time measures of emotional responding are unlikely to correspond one-to-one (i.e., a correlation of $r = 1$), even accounting for measurement error. Even if global reports reflect an accurate average of a person's emotional experiences, these experiences vary considerably by time and context. As a result, any individual 'snapshot' of emotional experience (such as responses to a laboratory manipulation of emotional challenge) is highly unlikely to have the same (ranked) value as a global report. Global reports are also subject to biases. Global self-report assessments typically require people to reflect on *past* emotional experiences and indicate how they typically feel and respond, making them subject to memory and inferential biases (Schwartz et al., 1999; Solhan et al., 2009). The Accessibility Model of Emotional Self-Report (Robinson & Clore, 2002) argues that when people make a self-report of their emotional experience, they rely on four sources of information: experiential knowledge (limited to self-reports of current experience); episodic memory; beliefs about what emotions are most likely to arise in a specific situation; and beliefs about their own emotions in general. These sources of information are prioritised, depending on the type of self-report being made and how accessible each source of information is in that moment (Robinson & Clore, 2002). Thus, real-time reports of current experience are thought to rely largely on experiential knowledge, whereas self-reports of global experiences rely more on episodic and beliefs-based information (Robinson & Clore, 2002).

The limited body of research investigating the correspondence between global self-reports and subjective channels of real-time emotional responding has done so using experience sampling methods. Focusing on affective instability among adults with and without a BPD diagnosis, three global measures of affective instability (e.g., the Affect Lability Scale; Harvey et al., 1989) showed weak to moderate agreement (*r*s range from -.01 to .43) with measures of variability in daily affect across a 28-day period (Solhan et al., 2009). Notably, these associations were largely similar for adults with and without a BPD diagnosis (Solhan et al., 2009), suggesting that BPD psychopathology was unrelated to the accuracy of global reports of affective instability. Focusing on global emotion dysregulation, Daros and colleagues (2020) assessed capture university students' instances of negative affect over a two-to three-week period as well as their global reports of emotion dysregulation. Participants' global emotion dysregulation reports were positively associated with negative affect in daily life, both when negative emotions were highest and more likely in need of regulation (i.e., the top 40% most negative affect ratings, β_p = .30),[35] as well as negative affect ratings more generally (the top 80% most negative ratings, β_p = .29; Daros et al., 2020). Critically, this study provides initial evidence that people may be drawing—in part—from their daily experiences when making self-reports of their global emotion dysregulation. However, experience sampling methods (e.g., Daros et al., 2020; Solhan et al., 2009) track subjective responding to *multiple* instances of emotional challenge in daily life. Thus, it remains to be seen whether global self-reports of emotional challenge map onto *discrete* experiences of emotional challenge (such as laboratory manipulations of emotional challenge).

Research assessing the relationship between global emotional functioning and real-time physiological responding has largely focused on global reports of emotion dysregulation and heart rate variability. Recall from Chapter 2 that respiratory sinus arrhythmia (RSA) captures momentary fluctuations in heart rate across the respiratory cycle that are controlled by the parasympathetic nervous system. Greater variability in RSA demonstrates greater cardiac regulation and greater responsivity to momentary changes. Although greater resting (i.e., tonic) RSA is typically associated with fewer emotion regulation difficulties (e.g., Crowell et al., 2017; Vasilev et al., 2009; although see Lin et al., 2019), here I focus on RSA responses to emotional challenge. Under emotional challenge, RSA typically decreases from baseline (i.e., vagal withdrawal), demonstrating withdrawal of the parasympathetic nervous

[35] β_p refers to the partial standardised regression coefficient, which can be interpreted as a partial correlation coefficient.

system under stress or in response to increased situational demands. Currently there is limited consensus on the nature of the relationship between RSA responses and global emotion difficulties. Lin and colleagues (2019) assessed how pregnant women (oversampled for greater emotion dysregulation) responded to a film clip of an infant crying. Women with greater global emotion dysregulation showed reduced RSA withdrawal to emotional challenge, as well as impaired recovery (Lin et al., 2019). In contrast, global self-reports of emotion dysregulation were unrelated to RSA responses to a sad film clip among chemically dependent young women (Crowell et al., 2017) or justice-involved youth (Lin et al., 2020). Both Crowell and colleagues (2017) and Lin and colleagues (2020) also assessed the relationship between EDR and global emotion dysregulation self-reports, finding no evidence of an association.

Study 2 and 3, reconsidered

Taken together, preliminary research has found that global self-reports of emotion dysregulation show moderate convergence with real-time subjective responses (Daros et al., 2020), but limited convergence with physiological responses (Crowell et al., 2017; Lin et al., 2019, 2020). This pattern of results suggests that people may draw from their real-time subjective experiences of emotional challenge, but not their physiological response, when making global emotion dysregulation judgements. However, to date no study has assessed whether these associations differ by psychopathology in general, or for NSSI in particular. Thus, it remains unclear whether people with and without a history of NSSI extrapolate from their real-time subjective experiences in the same way as controls do when making a global judgement of their emotion dysregulation. That people who engage in NSSI report much greater global emotion dysregulation than controls while showing no differences in real-time emotional responding (Study 2 and 3) already points to divergence in the relationship between these measures. We present an exploratory secondary analysis of Study 2 and 3 data to assess: i) the extent to which global self-reports of emotional functioning map on to real-time responses to emotional challenge; and ii) whether this relationship is moderated by NSSI status.

Study methods

Table 11 presents a summary of Study 2 and 3 design characteristics. To recap, Study 2 compared how young adults with a past-year history of NSSI and those with no lifetime history of NSSI responded to an acute laboratory-based stress induction. Study 3 compared how young women with a past-year history of NSSI and those with no lifetime history of

NSSI responded to online social exclusion. Across both studies, participants reported their global emotion reactivity and emotion dysregulation at the beginning of the trimester during a screening survey. Participants then took part in an experimental session 2–12 weeks later where they reported their negative mood over the course of emotional challenge. In Study 2 only, measures of physiological (heart rate, EDR) responding were also assessed over the course of emotional challenge. For each emotional response measure, a change score was created to capture real-time emotional reactivity (Emotional Challenge – Baseline) and, in Study 2 only, recovery (Emotional Challenge – Recovery). Higher real-time reactivity scores indicate a greater emotional response to emotional challenge. Higher real-time recovery scores indicate greater recovery from emotion challenge.

Analysis Plan

Data cleaning, and missing data imputation were conducted as described previously. Zero-order correlations tested for associations between NSSI status, global emotion reactivity, global emotion dysregulation, real-time emotional reactivity, and real-time emotional recovery. Significant associations between NSSI, global self-reports, and real-time responding were followed up using hierarchical linear regression models to test for evidence that NSSI status moderates the association between global self-report measures and real-time emotional responding. Within each model, NSSI status and global self-report were entered at Step 1 as predictors of real-time emotional responding. The interaction term (i.e., NSSI status × Global Self-Report) is entered as a predictor at Step 2. A significant interaction effect provides evidence that young adults with a recent history of NSSI have a different relationship between global emotional functioning and real-time emotional responding than do controls.

Table 11

Summary of Study 2 and 3 design characteristics

Design characteristics	Study 2	Study 3
Participants		
NSSI *n*	51	50 (per exclusion condition, total NSSI *n* = 100)
Control *n*	50	50 (per exclusion condition, total Control *n* = 100)
Eligibility criteria	NSSI: past-year history of NSSI behaviour Control: no lifetime history or thoughts of NSSI behaviour	NSSI: past-year history of NSSI behaviour Control: no lifetime history or thoughts of NSSI behaviour
Experimental manipulation		
Baseline	Vanilla baseline	Cyberball Inclusion game
Emotional challenge	Trier Social Stress Test arithmetic task	Total or Partial Cyberball Exclusion game
Recovery	Resting	-
Measures of emotion		
Subjective response	Average negative mood (anger, anxiety, embarrassment, frustration, happiness [RC], jitteriness, sadness, shame, and stress).	Average negative mood (alertness, anger, anxiety, confidence [RC], frustration, happiness [RC], interest, irritability, relaxation [RC], sadness, and shame).
Physiological response	Heart rate (BPM) Electrodermal response (μS)	-
Real-time responding		
Emotional reactivity	Emotional Challenge – Baseline	Emotional Challenge – Baseline
Emotional recovery	Emotional Challenge – Recovery	-
Global self-report measures		
Emotion reactivity	21-item Emotion Reactivity Scale	21-item Emotion Reactivity Scale
Emotion dysregulation	16-item Difficulties in Emotion Regulation Scale	16-item Difficulties in Emotion Regulation Scale

Note. BPM = Beats Per Minute, RC = reverse coded.

Results

Study 2: Emotional responding to acute stress

First, we investigate the zero-order correlations between NSSI status, global self-reports, and real-time emotional responding in Study 2 (see Table 12). The two global measures of emotional functioning showed a strong positive association with one another (r = .68). In terms of responding across emotional channels, change in negative mood was positively associated with change in heart rate, although this relationship was significant for recovery (r = .22) but not for reactivity (r = .20). Change in EDR was unrelated to change in negative mood or heart rate responses for both reactivity and recovery. Consistent with the group-level analyses reported in Chapter 4, NSSI status showed strong positive associations with global emotion reactivity (r = .41) and global emotion dysregulation (r = .53), but was unrelated to changes in negative mood, heart rate, or EDR in response to real-time emotional challenge. In a similar fashion, NSSI status was unrelated to change in negative mood or heart rate during recovery from emotional challenge. However, people with a history of NSSI were more likely to show greater EDR recovery following emotional challenge (r = .21).[36] Critically, global emotion dysregulation was positively associated with greater real-time subjective reactivity (r = .24). Counter to expectations, greater global emotion dysregulation was also associated with *greater* real-time subjective recovery (r = .21). Global emotion reactivity was unrelated to real-time subjective reactivity or real-time subjective recovery. Neither global emotion dysregulation nor global emotion reactivity were associated with real-time changes in heart rate or EDR in response to, or recovery from, acute stress.

NSSI status as a moderator

Given that global emotion dysregulation showed positive associations between both NSSI status and change in negative mood, we explore these relationships further to test whether NSSI status moderates the relationship between global emotion dysregulation and subjective real-time reactivity and recovery. Given that regression allows us to enter baseline negative mood as a predictor of negative mood following both acute stress and the recovery

[36] Counter to this association, recall from Chapter 4 that across baseline, stress, and recovery phases there was no evidence for a main effect of NSSI Status (F(1, 99) = 0.39, p = .343, η_p^2 <. 01) or an interaction between NSSI Status and Phase (F(1.51, 149.64) = 0.89, p = .389, η_p^2 = .01) on EDR. Exploratory re-analysis of EDR recovery from acute stress in a 2 (NSSI status: NSSI, Control) × 2 (Phase: Stress, Recovery) revealed the expected main effect of Phase (F(1, 99) = 87.82, p < .001, η_p^2 = .47) and no main effect of NSSI status (F(1, 99) = 11.55, p = .737, η_p^2 < .01). Consistent with the zero-order correlation reported here, there was a statistical trend towards an interaction between Phase and NSSI status (F(1, 99) = 2.87, p =.093, η_p^2 = .03), whereby the reduction in EDR during the Recovery phase (Stress Phase – Recovery Phase) was greater for the NSSI group (M = 5.00, SD = 4.30) than for the Control group (M = 3.47, SD = 4.78, t(99) = 1.69, p = .093, d = .34).

phase, we move away from change scores in favour of the raw data. To account for the high correlation between NSSI status and global emotion dysregulation (r = .53), we centred participants' global emotion dysregulation scores prior to analysis. See Table 13 for the results of the two hierarchical linear regression analyses.

In terms of real-time subjectivity reactivity, the first step of the model predicted subjective reactivity to acute stress. Accounting for baseline negative mood, global emotion dysregulation was positively associated with greater negative mood following acute stress, whereas NSSI status was unrelated. The addition of the global emotion dysregulation × NSSI Status interaction at the second step of the model explained significantly more of the variance in subjective reactivity (ΔR^2 = .04, $F(1, 95) = 5.47$, p = .021), suggesting that NSSI status moderates the relationship between global emotion dysregulation and real-time subjective responding. Given that NSSI status is a binary variable,[37] traditional simple slope analysis is not appropriate here (i.e., one standard deviation below the mean, the mean, and one standard deviation above the mean of NSSI status is not interpretable). Instead, we plot the association between global emotion dysregulation and change in real-time negative mood separated by NSSI status (see Figure 15). See Appendix P for the zero-order correlations between global self-reports, real-time reactivity, and real-time recovery, separated by NSSI status. Within the Control Group, there was a strong positive association (r = .43) between global emotion dysregulation and real-time subjective reactivity to acute stress. In contrast, the NSSI group showed no association (r = .02) between global emotion dysregulation and real-time subjective reactivity. This pattern of results suggests that global reports of emotion dysregulation predict greater subjective reactivity to acute stress in the Control group, but not in the NSSI group.

[37] We decided against using a continuous measure of NSSI status (e.g., frequency of past-year NSSI, number of lifetime methods, etc) for two reasons. First, we deliberately recruited a similar number of participants with no lifetime history of NSSI as we did people with a recent history of NSSI. Thus, any continuous measure of NSSI would be zero-inflated, creating problems for regression analyses. Second, attempting to get around this first issue by only assessing the NSSI group would reduce our sample size by half. We decided that n = 51 was too few to consider individual differences, even within exploratory analyses.

Table 12

Zero-order correlations between non-suicidal self-injury status, global self-reports, and real-time emotional responding in Study 2

Reactivity to acute stress

	2. DERS Score	3. ERS score	4. Change in negative mood	5. Change in HR	6. Change in EDR
1. NSSI Status [a]	**.53****	**.41****	.01	.13	.04
2. DERS score	-	**.68****	**.24***	-.02	.04
3. ERS score	-	-	.16	-.02	-.01
4. Change in negative mood	-	-	-	.20	-.12
5. Change in HR	-	-	-	-	-.16

Recovery from acute stress

	2. DERS Score	3. ERS score	4. Change in negative mood	5. Change in HR	6. Change in EDR
1. NSSI Status [a]	-	-	.06	.11	**.21***
2. DERS score	-	-	**.21***	-.08	.02
3. ERS score	-	-	.16	-.04	-.02
4. Change in negative mood	-	-	-	**.22***	>.01
5. Change in HR	-	-	-	-	>.01

Note. DERS = Difficulties in Emotion Regulation Scale, EDR = Electrodermal Responding, ERS = Emotion Reactivity Scale, HR = Heart Rate.
[a] Given that NSSI status is a binary variable (1 = Control group, 2 = NSSI group), we report nonparametric correlations (Spearman's rho) for analyses involving this variable. All other correlations are Pearson's *r*. ** p <.001, * p <.050. Significant correlations are bolded and duplicate correlations are not shown for clarity. n = 101.

Table 13

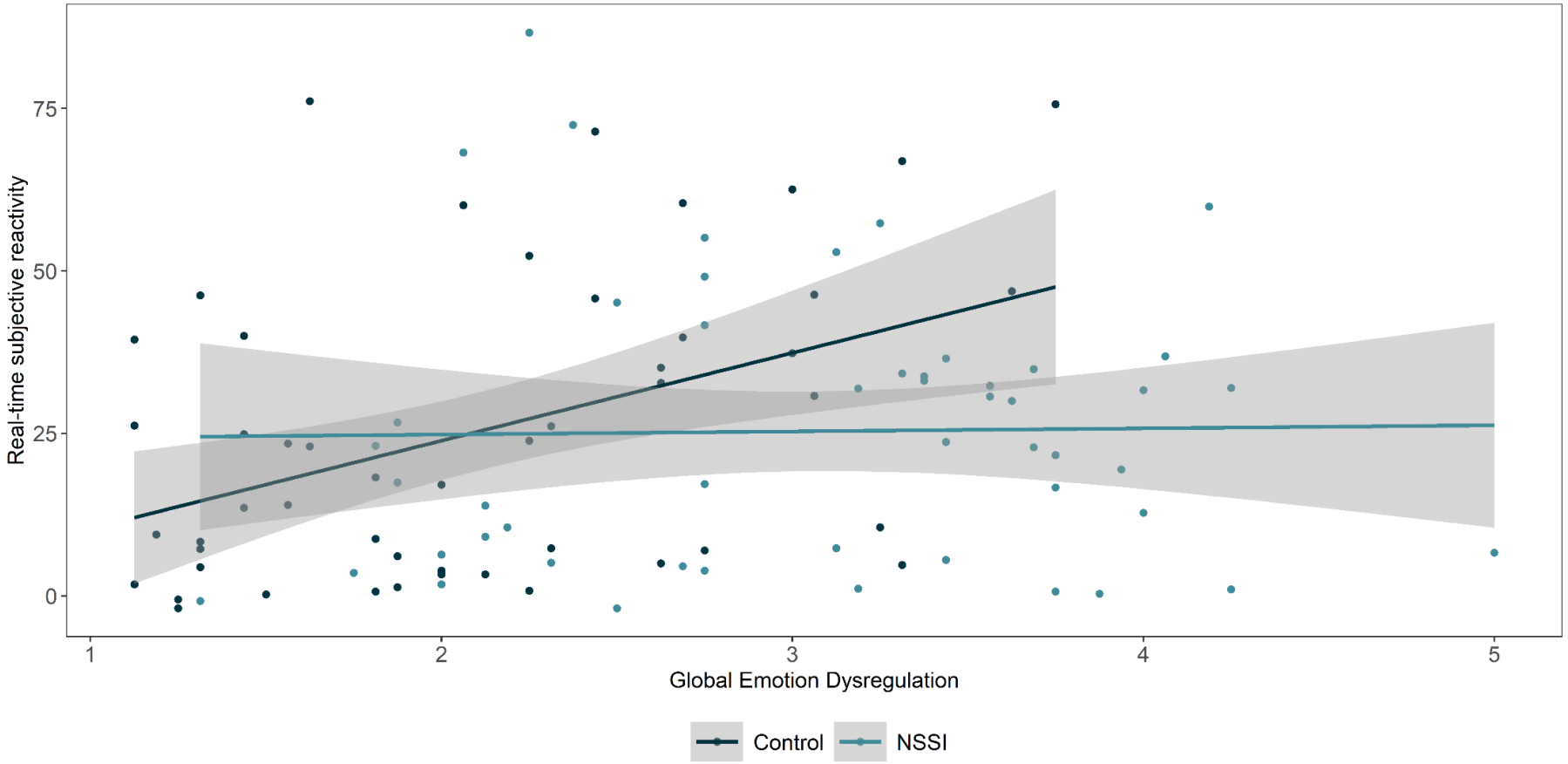
Hierarchical linear regression predicting real-time subjective reactivity to, and recovery from, acute stress in Study 2

	Subjective reactivity			Subjective recovery		
	β	95% CI	*p*	*β*	95% CI	*p*
Step 1	*F*(3, 96) = 11.45, *p* < .001 *Adjusted* R^2 = .26			*F*(4, 95) = 50.81, *p* <.001, *Adjusted* R^2 = .68		
Baseline negative mood	**0.43**	**0.24, 0.61**	**< .001**	**0.26**	**0.12, 0.39**	**< .001**
Stress negative mood	-		-	**0.68**	**0.55, 0.82**	**< .001**
NSSI status	-0.12	0.32, 0.09	.261	-0.01	-0.15, 0.13	.870
DERS	**0.22**	**< .01, 0.43**	**.047**	-0.05	-0.20, 0.09	.459
Step 2	*F*(4, 95) = 11.10, *p* < .001 *Adjusted* R^2 =.30			*F*(5, 94) = 40.22, *p* <.001, *Adjusted* R^2 = .68		
Baseline negative mood	**0.44**	**0.26, 0.62**	**< .001**	**0.26**	**0.12, 0.40**	**< .001**
Stress negative mood	-		-	**0.69**	**0.55, 0.83**	**< .001**
NSSI status	-0.13	-0.33, 0.07	.191	0.01	-0.15, 0.13	.868
DERS	**0.96**	**0.29, 1.61**	**.005**	-0.04	-0.51 0.43	.854
NSSI status x DERS	**-0.76**	**-1.41, -0.12**	**.021**	-0.01	-0.46, 0.44	.964

Note. NSSI status is a binary variable where 1 = Control group and 2 = NSSI group. DERS = Difficulties in Emotion Regulation Scale. Significant predictors are bolded for clarity. *n* = 101.

Figure 15

Association between global emotion dysregulation and real-time subjective reactivity to acute stress separated by non-suicidal self-injury status in Study 2



Note. Scatter represents individual's responses at each phase, shading indicates 95% confidence interval. NSSI n = 51, Control n = 50.

Turning to focus on real-time subjective recovery, the first step of the model significantly predicted subjective recovery from acute stress. Accounting for both negative mood during the baseline and stress phases, global emotion dysregulation was unrelated to negative mood following recovery, suggesting that the zero-order association between global emotion dysregulation and greater subjective recovery is explained by greater subjective reactivity. NSST Status was also unrelated to negative mood following recovery. The addition of the global emotion dysregulation × NSSI Status interaction at the second step of the model did not explain additional variance in subjective recovery ($\Delta R^2 < .01$, $F(1, 94) < 0.01$, $p = .964$), providing no evidence that NSSI status moderates the association between global emotion dysregulation and real-time subjective recovery from emotional challenge.

Study 3: Emotional responding to social exclusion

Next, we test whether NSSI status moderates the relationship between global self-reports and real-time subjective reactivity to social exclusion in Study 3. Given that Study 3 demonstrated that the two social exclusion conditions (Total Exclusion and Partial Exclusion) created different degrees of negative mood, we split our analyses by Exclusion Severity. Table 14 presents the zero-order correlations between NSSI status, global self-reports of emotional functioning, and real-time emotional responding in Study 3, separated by the Exclusion Severity. As in Study 2, global self-reports of emotion reactivity and emotion dysregulation were positively correlated in both exclusion conditions (Total Exclusion: $r = .70$, Partial Exclusion: $r = .84$). Across both exclusion conditions, NSSI status showed strong positive associations with global emotion reactivity (Total Exclusion: $r = .57$, Partial Exclusion: $r = .58$) and global emotion dysregulation (Total Exclusion: $r = .62$, Partial Exclusion: $r = .66$). Consistent with the group-level analyses reported in Chapter 5, NSSI Status was unrelated to real-time subjective reactivity in either exclusion condition. Counter to the reanalysis of Study 2 described above, neither global emotion reactivity nor global emotion dysregulation were related to real-time subjective reactivity to social exclusion.

NSSI status as a moderator

Although global emotion dysregulation was not associated with real-time subjective reactivity in either exclusion condition, in light of the findings from Study 2 we continued with our proposed exploratory moderation analyses to assess for an interaction in the absence of a main effect. As in Study 2, we conducted two hierarchical linear regression analyses predicting negative mood after social exclusion from baseline negative mood, NSSI status, and centred global emotion regulation scores entered at Step 1, and the interaction between

centred emotion dysregulation scores and NSSI status entered at Step 2. See Table 15 for the results of the hierarchical linear regression for the Partial Exclusion and Total Exclusion conditions. We plot the associations between global emotion dysregulation and real-time subjective reactivity by NSSI status for each exclusion condition in Figure 16. See Appendix Q for the zero-order correlations between global self-reports and real-time reactivity separated by exclusion condition and NSSI status.

In the Partial Exclusion condition, the first step of the reactivity model predicted subjective reactivity to social exclusion. Notably, only baseline (inclusion game) negative mood predicted negative mood following social exclusion, whereas global emotion dysregulation and NSSI status did not. Counter to Study 2, the addition of the global emotion dysregulation × NSSI Status interaction term at Step 2 failed to explain additional variance in subjective reactivity (ΔR^2 = .01, F(1, 95) = 0.14, p = .711), providing no evidence that NSSI status moderated the relationship between global emotion dysregulation and real-time subjective reactivity in the Partial Exclusion condition.

In the Total Exclusion condition, the first step of the model predicted subjective reactivity to social exclusion. Again, only baseline negative mood predicted negative mood following social exclusion, whereas global emotion dysregulation and NSSI status did not. However, the addition of the global emotion dysregulation × NSSI Status interaction term in Step 2 explained significantly more of the variance in subjective reactivity (ΔR^2 = .04, F(1, 95) = 9.24, p = .003), suggesting that NSSI status moderated the relationship between global emotion dysregulation and subjective reactivity to explicit social exclusion. Counter to Study 2 findings, in Study 3 the Control group showed no association (r = -.06) between global emotion dysregulation and real-time subjective reactivity to overt social exclusion whereas the NSSI group showed a positive association (r = .25). Together this suggests that global reports of emotion dysregulation predict greater subjective reactivity to explicit social challenge (but not ambiguous social challenge) in the NSSI group, but not in the Control group.

Table 14

Zero-order correlations between NSSI status, global self-reports, and real-time reactivity by Exclusion Condition in Study 3

Total Exclusion Condition

	2. DERS Score	3. ERS score	4. Change in negative mood
1. NSSI Status [a]	**.62****	**.57****	-.05
2. DERS score	-	**.70****	-.01
3. ERS score	-	-	.13

Partial Exclusion Conditions

	2. DERS Score	3. ERS score	4. Change in negative mood
1. NSSI Status [a]	**.66****	**.58****	.08
2. DERS score	-	**.84****	< .01
3. ERS score	-	-	-.02

Note. DERS = Difficulties in Emotion Regulation Scale, ERS = Emotion Reactivity Scale. [a] Given that NSSI status is a binary variable (1= Control group, 2 = NSSI group), we report nonparametric correlations (Spearman's rho) for analyses involving this variable. All other correlations are Pearson's *r*. ** $p < .001$, * $p <. 050$. Significant correlations are bolded and duplicate correlations are not shown for clarity. Total Exclusion Condition $n = 100$, Partial Exclusion Condition $n = 100$.

Table 15

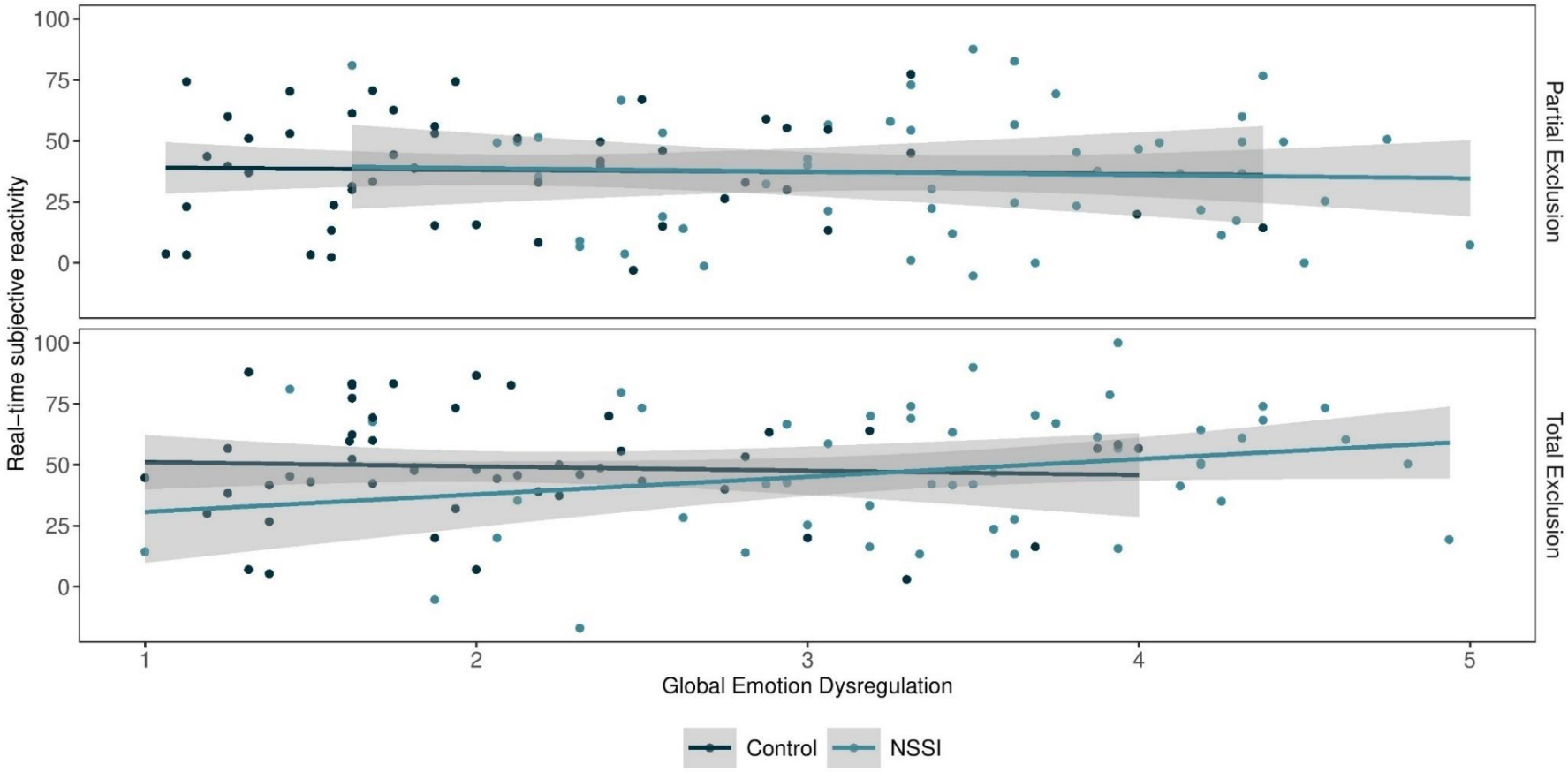
Hierarchical linear regression predicting real-time subjective reactivity to partial and total exclusion in Study 3

	Partial Exclusion			Total Exclusion		
	β	95% CI	*p*	*β*	95% CI	*p*
Step 1	$F(3, 96) = 21.33$, $p < .001$ *Adjusted* $R^2 = .38$			$F(3, 96) = 27.86$, $p < .001$ *Adjusted* $R^2 = .47$		
Baseline negative mood	**0.53**	**0.35, 0.70**	**< .001**	**0.64**	**0.47, 0.80**	**< .001**
NSSI status	0.15	-0.06, 0.36	.155	-0.01	-0.20, 0.18	.911
DERS	0.07	-.14, 0.29	.503	0.10	-0.10, 0.30	.312
Step 2	$F(4, 95) = 15.89$, $p <.001$, *Adjusted* $R^2 =.38$			$F(4, 95) = 25.00$, $p < .001$ *Adjusted* $R^2 = .51$		
Baseline negative mood	**0.52**	**0.35, 0.70**	**< .001**	**0.59**	**0.43, 0.76**	**< .001**
NSSI status	0.15	-0.06, 0.36	.153	0.03	-0.16, 0.21	.781
DERS	-0.04	-0.72, -0.62	.890	**-0.79**	**-1.40, -0.18**	**.012**
NSSI status x DERS	0.12	-0.53, 0.78	.711	**0.91**	**0.32, 1.51**	**.003**

Note. DERS = Difficulties in Emotion Regulation Scale. NSSI status is a binary variable where 1= Control group and 2 = NSSI group. Exclusion condition is a binary variable where 0 = Partial Exclusion and 1 = Total Exclusion. Significant predictors are bolded for clarity. $n = 200$.

Figure 16

Association between global emotion dysregulation reports and real-time subjective reactivity separated by exclusion condition and non-suicidal self-injury status in Study 3



Note. Scatter represents individual's responses at each phase, shading indicates 95% confidence interval. Partial Exclusion n = 100 (NSSI n = 50, Control n = 50), Total Exclusion n = 100 (NSSI n = 50, Control n = 50).

Discussion

To summarise, Chapter 4 and 5 of this thesis concluded that there is a disconnect between global reports of emotional functioning and real-time measures of emotional responding. Although people who engage in NSSI consistently report considerably greater global emotion reactivity and dysregulation than controls, a growing body of evidence suggests that they show a similar pattern of reactivity and recovery to real-time emotional challenge. One possibility for this disconnect discussed in Chapter 4 and 5, and one that I will return to in Chapter 7, is that laboratory-based methods fail to adequately capture the types of emotional challenges that people who engage in NSSI struggle with in their daily lives. This chapter tests an alternative explanation; that people who engage in NSSI extrapolate differently from their daily emotional challenges when making a global report of their emotional functioning than do controls. Revisiting data from Study 2 and 3 of this thesis, I considered the association between global reports and real-time emotional responding to acute stress and social exclusion, before testing whether NSSI status moderated this association.

Reanalysis using an individual differences approach largely replicated the group-level analyses presented in Chapter 4 and 5. Consistent with previous research (Wolff et al., 2019; You et al., 2018) the NSSI group reported considerably greater emotion reactivity (*r*s range from .41 to .57) and dysregulation (*r*s range from .53 to .66) than did the Control group. In terms of real-time emotional challenge, NSSI status was unrelated to subjective (Study 2 and 3) or physiological channels of emotion reactivity (Study 2), again replicating the group-level analyses. In terms of recovery from emotional challenge (Study 2), NSSI status was unrelated to subjective or heart rate recovery. Counter to the group-level analyses, NSSI status was positively associated with EDR recovery such that the NSSI group showed *greater* EDR recovery over the course of the recovery phase. Given that this pattern of increased EDR recovery in NSSI was not evident in the group-level analyses accounting for baseline EDR ($p = .093$; see Chapter 3), this finding should be interpreted with caution.

Global emotional functioning and real-time subjective responding

Next, we focus on the extent to which global self-reports capture subjective responses to instances of emotional challenge by assessing the relationship between global self-reports and real-time subjective responding. In Study 2, we found a positive association between global emotion dysregulation and real-time subjective reactivity to acute stress ($r = .24$), whereby people who reported more difficulties in their emotional lives also experienced

greater increases in negative mood in response to the TSST emotional challenge. In contrast, in Study 3 we found no evidence of an association between global emotion dysregulation and subjective reactivity to social exclusion (either Partial Exclusion or Total Exclusion). Despite strong, positive correlations among global emotion reactivity and global dysregulation across Study 2 and 3 (*r*s range from .68 to .84), global emotion reactivity was unrelated to any measures of real-time emotional responding in either study. Consistent with Study 2, but not Study 3, Daros and colleagues (2020) found university students not selected for NSSI who reported greater global emotion dysregulation were more likely to report both greater negative affect in general (the top 80% most negative ratings, $\beta_p = .29$) as well as greater intense negative affect (i.e., the top 40% most negative affect ratings, $\beta_p = .30$) over a two-to-three week period. Note that Study 2 and 3 (by design) captured only one instance of emotional challenge, whereas Daros and colleagues (2020) captured multiple instances of stronger and weaker emotional challenge. Taken together, these studies provide preliminary evidence that when reporting their global emotion dysregulation people draw from their subjective experience of isolated instances of acute (but not mild) emotional challenge, as well as from their subjective response in general across multiple instances of stronger and weaker emotional challenge.

In addition to assessing real-time subjective reactivity to emotional challenge, Study 2 assessed how global emotion dysregulation was associated with real-time subjective *recovery* from acute stress. Counter to expectations, participants' global emotion regulation scores were positively associated with recovery from stress, suggesting that people who report more difficulties in their emotional lives also reported greater subjective recovery following stress. This relationship became nonsignificant when accounting for negative mood during baseline and stress phases. Thus, the relationship between global emotion dysregulation reports and real-time subjective recovery appears to be driven primarily by the initial reactivity to emotional challenge.

Critically, we found initial evidence that NSSI status moderates the association between global emotion dysregulation and real-time subjective responding. In Study 2, Control participants who reported greater emotion dysregulation showed greater reactivity to acute stress ($r = .43$), suggesting that among the Control group global emotion dysregulation scores are reflective of the real-time subjective response. In contrast, participants with a recent history of NSSI showed no association between global emotion dysregulation and real-time subjective reactivity ($r = .02$). Investigation of the zero-order correlations between global emotion dysregulation and subjective recovery from acute stress appeared to show a

similar pattern; within the Control group, people who reported more challenges globally in their emotional lives also experienced greater negative mood recovery (r = .38), whereas within the NSSI group global emotion dysregulation was unrelated to negative mood recovery (r = .09). However, after we accounted for emotional reactivity, there was no evidence for a moderation by NSSI status. Any differences by NSSI status in the relationship between global emotion dysregulation and real-time subjective recovery are likely the downstream consequences of differences in emotional reactivity.

In contrast, in Study 3 we found no evidence for a 'main effect' (i.e., an association) between global emotion dysregulation and negative mood reactivity to overt or subtle social exclusion. We found tentative evidence that participants in the NSSI group showed a stronger positive association between global emotion dysregulation and real-time subjective reactivity to overt social exclusion than did the Control group, but inspection of Figure 15 and the zero-order correlations suggests that these associations were weak and opposite to the relationship in Study 2 (NSSI: r = .25; Control: r = -.06). Given that the association between global emotion dysregulation and real-time subjective reactivity for the NSSI group is weak in the Total Exclusion condition, and not replicated in the Partial Exclusion condition, caution should be taken before making strong interpretive claims.

Global emotional functioning and real-time physiological responding

Moving to physiological channels of emotional responding, in Study 2 we tested the extent to which global self-reports capture physiological reactivity to, and recovery from, real-time emotional challenge. Global emotion dysregulation was unrelated to electrodermal reactivity to, and recovery from, acute stress. In a similar manner, Crowell and colleagues (2017) showed that global emotion dysregulation reports were unrelated to electrodermal responding to a sad film clip among chemically dependent young women. Most of the previous research investigating the relationship between global emotion dysregulation and real-time physiological responses to emotional challenge has focused on changes in heart rate variability. Greater global emotion dysregulation has been associated with reduced RSA reactivity to emotional challenge and impaired RSA recovery among pregnant women (Lin et al., 2019), but not with RSA responses to emotional challenge among chemically dependent young women (Crowell et al., 2017). Among pre-adolescents, those who showed improvements in RSA responses to distress over a three-year period also reported fewer global emotion dysregulation difficulties, whereas those who showed no such improvements reported more global emotion dysregulation (Vasilev et al., 2009). In contrast, we found no

association between global emotion dysregulation and heart rate reactivity to, or recovery from acute stress. Taken together, this suggests that global emotion dysregulation may capture aspects of cardiac regulation (i.e. RSA), rather than the cardiac response to challenge in general. As we found for real-time subjective responses, emotion reactivity was unrelated to either electrodermal or heart-rate responses to real-time emotional challenge.

Strengths, limitations, and future directions

Drawing across channels of emotional responding, global self-reports of emotion reactivity were unrelated to real-time emotional responding. In contrast, global emotion dysregulation was associated with a greater subjective response to acute stress (but not social exclusion) among the Control group only and was unrelated to physiological responding. Consistent with a growing body of evidence from different domains of psychology (e.g., Dang et al., 2020), the inconsistent associations between global self-reports and observational measures (i.e., real-time subjective and physiological emotional responding) suggests that these measures should not be used interchangeably, but rather reflect distinct psychological phenomena. The discrepancy between global reports and real-time measures does not invalidate either the large-scale difference in global reports of emotional functioning by NSSI status *or* the null effects of NSSI status we see in real-time emotional responding.

There are three key strengths underlying the reanalysis of Study 2 and 3 reported here. First, an individual differences approach takes advantage of the variability within both global self-reports and real-time emotional responses to investigate the role of emotion in NSSI, particularly how people with and without NSSI make global, evaluative reports of their emotional experiences. Second, the multi-channel assessment of emotional responding in Study 2 allows for comparison of how global self-reports are associated with changes in negative mood, heart, and EDR in response to emotional challenge. Finally, reanalysis of Study 2 investigated how global self-report measures are associated with emotional *recovery*, a critical aspect of real-time responses to emotional challenge that has to date has been largely ignored in the literature.

There are three primary limitations that constrain these conclusions. First, we are unable to directly compare the magnitude of subjective reactivity across Study 2 and 3. Study 2 and Study 3 used slightly different feelings labels[38] to assess negative moods, limiting our

[38] Study 2 asked participants to report the extent to which they currently felt angry, anxious, ashamed, *embarrassed*, frustrated, happy, *jittery*, sad, and *stressed*. Study 3 asked participants to report the extent to which they currently felt *alert*, angry, anxious, ashamed, *confident*, frustrated, happy, *interested*, *irritable*, *relaxed*, and sad (italics indicate differences across studies).

ability to compare participants' experiences across studies. The TSST reliably induces acute subjective and physiological stress (e.g., Kudielka et al., 2007), while Cyberball appears to be a considerably 'milder' emotional challenge in that physiological channels of emotion are not sensitive to Cyberball social exclusion (e.g., Iffland et al., 2014a; Kelly et al., 2012). Despite these differences in the intensity of emotional challenge, across both Study 2 and 3 participants used the whole range of the negative mood scale. Again, this means that we are unable to directly compare subjective reactivity across studies. Future researchers should more directly investigate if the intensity of emotional challenge influences the relationship between global emotional dysregulation and real-time subjective reactivity by exposing participants to a series of different emotional challenges. This data is already available from studies which have assessed both global self-reports and real-time emotional challenge (e.g., Boyes et al., 2020; Glenn et al., 2011; Kaufman et al., 2019; Mettler et al., 2021), and so secondary analyses of existing data may be a valuable next step.

Finally, in spite of the relatively large samples employed in this research, the size of the NSSI group in both studies (Study 1 n = 51, Study 2 n =100) meant that we were unable to assess whether characteristics of a person's NSSI might moderate the association between subjective reactivity and NSSI (for a discussion regarding calculating appropriate power in moderation analyses, see Shieh, 2009). Recall that in Study 2 (but not for Study 3) we found that, accounting for baseline negative mood, intrapersonal functions of NSSI predicted greater negative mood reactivity to emotional challenge. Preliminary evidence suggests that intrapersonal functions of NSSI, especially affect regulation, may be an important factor to consider in combination with global emotion dysregulation. University students who reported a limited range of emotion regulation strategies engaged in more frequent NSSI, and this relationship was particularly strong for those who reported using NSSI to regulate their emotions (Zelkowitz et al., 2016). This suggests that the relationship between NSSI and aspects of global emotion dysregulation is influenced by the extent to which a person engages in NSSI to fulfil intrapersonal functions. Thus, future research should investigate whether and how the association between global emotion dysregulation and real-time subjective reactivity is moderated by the extent to which a person endorses interpersonal functions of their NSSI in a large sample of people who engage in NSSI.

Conclusion

Typically, evaluative judgements of global emotion reactivity and emotion dysregulation are assumed to, in part, reflect an individuals' emotional responding in real-

time. However, despite consistently reporting greater global emotion reactivity and emotion dysregulation compared to controls, people who engage in NSSI fail to show systematic differences in real-time emotional responding. Chapter 6 investigated the extent to which global self-reports of emotional functioning map on to real-time responses to emotional challenge, before assessing whether this relationship is moderated by NSSI status. Exploratory reanalysis of Study 2 and 3 provide preliminary evidence that, although people generally draw from their subjective experience of acute (but not mild) instances of emotional challenge to report their global emotion dysregulation, people who engage in NSSI do so using different sources of information. In Chapter 7, I link the empirical research of this thesis with the NSSI and affective science fields more generally to consider what the disconnect between global reports of emotional functioning and real-time emotional responses can (and cannot) tell us about emotional responding in NSSI.

Chapter 7: General discussion

The majority of people who engage in NSSI report doing so in order to gain (temporary) relief from overwhelming emotions (Edmondson et al., 2016; Klonsky & Glenn, 2009)—the so-called "affective engine" of NSSI (Hooley & Franklin, 2018, p. 443). NSSI behaviours are often preceded by highly negative affective states; particularly guilt, anger, and shame (Armey et al., 2011; Muehlenkamp et al., 2009; Nock et al., 2009). In conjunction, laboratory studies find that the offset of a painful stimulus reduces subjective negative affect (Bresin & Gordon, 2013; Bresin et al., 2010; Franklin et al., 2010), especially for people who report high self-criticism (Fox et al., 2017). Given these findings, prominent theories of NSSI (e.g., the Experiential Avoidance Model: Chapman et al., 2006; the Cognitive–Emotional Model: Hasking et al., 2016; the Integrated Theoretical Model: Nock, 2009) propose that an amplified emotional response system, in part, creates the context in which an individual chooses to regulate their emotions by engaging in NSSI.

To date, the majority of research assessing the role of emotion in NSSI has done so using global self-reports of emotional functioning. These global self-reports appear to have significant value in understanding NSSI. Meta-analyses demonstrate that NSSI is consistently associated with global self-reports of greater emotion reactivity and emotion dysregulation across adult and adolescent samples (Wolff et al., 2019; You et al., 2018). In addition, global self-reports of poorer emotional functioning prospectively predict the onset of NSSI (e.g., Robinson et al., 2019), although this relationship is small (Fox et al., 2015). Critically, therapeutic interventions designed to scaffold a client's emotion regulation skills lead to reductions in self-injury behaviour (Kothgassner et al., 2020, 2021); a longitudinal relationship in which improved in global emotional functioning appears to be the mechanism of change (Adrian et al., 2019; Asarnow et al., 2021; Gratz et al., 2012).

There are four critical limitations of relying *exclusively* on global self-reports to understand emotional responding in NSSI. First, global self-reports provide an overall evaluation of an individual's *average* experience of a dynamic, highly variable phenomenon. Second, global self-reports are retrospective judgements of experience that are made with the aid of heuristics which may introduce bias. Third, global self-reports of emotional functioning capture only subjective channels of emotion, leaving unclear how physiological and behavioural channels respond to and recover from emotional challenge in people who engage in NSSI. Finally, global self-reports of emotional functioning are likely confounded by the frequency and intensity of emotional challenges in an individual's life. Given that

people who engage in NSSI are disproportionately likely to experience adverse life events that generate intense emotional experiences (e.g., childhood maltreatment, bullying, trouble with parents) than those with no history of NSSI (Brown et al., 2018; Kaess et al., 2019), a greater frequency of intense negative emotions may be misinterpreted as poorer global emotional functioning. Taken together, these limitations mean that global self-reports cannot disentangle the precise nature of the emotional response which is critical for discovering the mechanisms that underlie the onset and maintenance of the behaviour. Instead, to test whether NSSI is characterised by amplified emotion responding, multi-channel assessment of emotional responding to *real-time* emotional challenge is needed.

Major findings of this research programme

The empirical research in this thesis opens by considering the convergence between two of the most common assessments of lifetime NSSI to establish the best way to operationalize NSSI in subsequent experiments. In two large studies of university students (Study 1a n = 626, Study 1b n = 738) participants reported their lifetime NSSI history using both a single-item *and* a behavioural checklist, with presentation order randomised. Across Study 1a and 1b, we found limited agreement between checklists of common NSSI behaviours and a single-item; more than a third of participants reported engaging in one or more behaviours *and* reported no history of NSSI on the single-item. This discrepancy was evident even when participants completed the checklist first, suggesting that the increased prevalence estimates captured by checklists are unlikely to simply reflect memory facilitation. As in the broader NSSI field (e.g. Muehlenkamp et al., 2012; Swannell et al., 2014), single-item and two-step assessments are common among studies which assess emotional responding in NSSI (e.g., Boyes et al., 2020; Davis et al., 2014; Mettler et al., 2021; Ziebell et al., 2020). Across both Study 1a and 1b, 12.5% of participants would have been incorrectly screened out in single-item or two-step assessments; these participants were more likely to have engaged in NSSI historically, and were less likely to self-injure by cutting, and (in Study 1b only) be men. In light of these findings, I decided that 'reported engagement in NSSI behaviours' was the best way to classify whether or not a participant had a history of NSSI in this thesis.

Although not central to my research questions (and thus, not a focus of this chapter), Study 1a and 1b represent an important contribution to the field. Study 1a and 1b suggest that much of what we currently know about NSSI comes from a literature base that is *systematically* missing a proportion of the population who engages in NSSI. In particular,

two-step and single-item assessments likely overestimate both gender differences and the predominance of cutting as a method of NSSI, as well as capturing only a 'more severe' NSSI population. Study 1a and 1b add to growing evidence from young adult, adolescent, and military samples that between 9% and 35% of participants report inconsistent self-injury histories across assessments (Fliege et al., 2006; Gratch et al., 2020; Hom et al., 2016, 2019; Mars et al., 2016), raising substantial psychometric concerns for self-injury research more generally. A literature base which measures NSSI poorly constrains our ability to understand the behaviour, and risks resulting in recommendations that will, at best, make a less positive impact than we hope and, at worst, harm our communities of interest.

Having established how best to assess NSSI for subsequent experiments, this thesis then drew from prominent theories of NSSI to test two 'families' of possibilities for *why* we consistently see elevated global emotion reactivity and emotion dysregulation in people who engage in NSSI compared to controls. The first possibility I tested was that these differences in global self-reports reflect an amplified response to emotional challenge among people who engage in NSSI. The second possibility I tested was that factors which generate and shape the emotional experience (e.g., appraisal, choice of emotion regulation strategies, and recovery from emotional challenge) are altered in NSSI. By assessing both possibilities, this thesis provided a comprehensive description of how people who engage in NSSI respond to real-time emotional challenges and tested the argument shared across prominent theories that NSSI is marked by alteration(s) in responding to negative emotional events.

To test these two possibilities, we recruited young people who reported engaging in NSSI in the past-year (lifetime NSSI behaviours with past-year engagement) and those with no history of NSSI (no lifetime history of NSSI behaviours) to take part in Study 2 and 3. Across both studies, we replicated the well-established differences in global reports of emotion reactivity and emotion dysregulation by NSSI status (for meta-analytic reviews, see Wolff et al., 2019; You et al., 2018). As in previous research, these differences by NSSI-status were large for both global emotion reactivity (Study 2: $d = 0.93$; Study 3: $d = 1.40$) and emotion dysregulation (Study 2: $d = 1.21$; Study 3: $d = 1.63$), with the NSSI groups reporting scores more than one standard deviation higher than their respective control groups. Focusing within the NSSI group, the lifetime number of NSSI methods and past-year frequency of NSSI were positively associated with greater global emotion dysregulation across both studies. Taken together, and consistent with a robust literature, these findings indicate that people who engage in NSSI report experiencing extensive patterns of greater emotion reactivity and dysregulation in daily life. Despite replicating these well-established

differences in global self-reports of emotional functioning, both Study 2 and 3 failed to find any evidence that people with a past-year history of NSSI responded differently to real-time emotional challenge compared to controls.

In Study 2, I took a wide-ranging approach to understand how people with and without a history of NSSI respond to, recover from, and later remember acute stress induced with the gold-standard TSST (Kirschbaum et al., 1993; Kudielka et al., 2007). In order to evaluate the amplified emotional responding account, I tested the hypotheses that, relative to controls, people who engage in NSSI would: (i) generate a more intense subjective and physiological response to emotional challenge; or (ii) generate a similar physiological response, but appraise it as more intense. In order to evaluate other factors that shape emotional experience we tested the hypotheses that, compared to controls, people who engage in NSSI are less effective at recovering from emotional challenge; and/or later go on to remember their emotional experience as more intense. Contrary to predictions we found no systematic difference in how people who engage in NSSI physiologically or subjectively respond to acute stress compared to controls. In addition, people with and without NSSI histories showed a similar pattern of subjective and physiological recovery from stress and were equally likely to report engaging in cognitive reappraisal and expressive suppression strategies following stress. Exploratory analysis suggested that two weeks later participants tended to remember the acute stress as more intense than they reported during the laboratory session. However, we found no evidence to suggest that people who engage in NSSI amplify their emotional experience in memory any differently than do controls.

In Study 3, I took a more fine-grained approach to focus on the subjective response to emotional challenge in NSSI. Perhaps strong emotional challenges such as the TSST create ceiling effects in emotional responding that mask individual differences by NSSI status. In particular, people with depression, social anxiety, and post-traumatic stress disorder—forms of psychopathology which commonly present with NSSI (Kiekens et al., 2018b; Nock et al., 2006)—are more likely to appraise ambiguous stimuli as negative than those without psychopathology (Chen et al., 2020; Everaert et al., 2017; Kimble et al., 2002, 2012). Thus, perhaps people who engage in NSSI report poorer global emotional functioning not because they have a more intense response to emotional challenge, but because they have a more sensitive appraisal system in which benign and/or neutral stimuli are appraised as threatening. We tested both the amplified emotional response account and the sensitive appraisal account using two social exclusion challenges (Cyberball; Williams & Jarvis, 2006). Following a baseline Inclusion game, participants took part in either a ball-tossing game where the other

'players' completely excluded them, or a ball-tossing game where the other 'players' included them less often than would be fair. In general, the Total Exclusion game created greater decreases in ratings of belongingness and greater increases in negative mood than the Partial Exclusion game, suggesting that the more subtle social exclusion was experienced as a more ambiguous emotional challenge than overt social exclusion. Once again counter to predictions, the NSSI and Control groups showed a similar pattern of subjective reactivity to both overt and subtle emotional challenges, providing no evidence that NSSI is characterised by either an amplified subjective response to emotional challenge, or a more sensitive appraisal system.

Drawing across Study 2 and 3, we see a disconnect between global self-reports of emotional functioning and real-time emotional responding among people who engage in NSSI. One possibility for this disconnect between self-reports and real-time emotional responding is that people who engage in NSSI extrapolate in a different manner from instances of emotional challenge in daily life to global reports, than do controls. Although global self-reports are assumed to reflect an individuals' emotional responding in real-time, limited research has investigated the extent to which the two are related. Taking an individual differences approach, I conducted exploratory reanalysis of Study 2 and 3 to assess: i) the relationship between global self-reports and real-time emotional responding, and ii) whether this relationship is moderated by NSSI status.

Reanalysis of Study 2 demonstrated that people who reported more dysregulation in their emotional lives also experienced greater increases in negative mood when faced with acute stress (r = .24). Critically, NSSI status moderated this relationship; the Control group showed a strong positive relationship between global emotion dysregulation and subjective reactivity (r = .43), whereas there was no association among the NSSI group (r = .02). Global emotion dysregulation was unrelated to real-time physiological responding, and global emotion reactivity was unrelated to either subjective or physiological measures of real-time responding. In contrast, reanalysis of Study 3 found no association between global emotion dysregulation and subjective reactivity in either social exclusion condition (rs < .01 and -.01) and inconsistent evidence across social exclusion conditions that NSSI status moderated this association. Again, global self-reported reactivity was unrelated to real-time subjective responses to emotional challenge. These findings provide preliminary evidence that, although people generally draw from their subjective experience of acute (but not mild) instances of emotional challenge when reporting their global emotion dysregulation, people who engage in NSSI do not.

Strengths and limitations of this research programme

This thesis has four key strengths which give confidence in its findings. First, Study 2 and 3 take multiple approaches to maximise their statistical power to find the proposed difference in emotional responding by NSSI status. Both studies use large samples (Study 2 n = 101; Study 3 n = 200; M n in this literature = 82.22, SD = 42.51) with stringent eligibility criteria validated in Study 1 for both the NSSI (i.e., lifetime history of NSSI behaviour with NSSI engagement in the past year) and Control groups (i.e., no lifetime history of NSSI behaviour or NSSI thoughts) to reduce the variability in NSSI within groups. Second, I replicated the well-established differences in global emotional functioning by NSSI status in Study 2 and 3, demonstrating the disconnect between global self-reports and real-time responding within the same people and providing the context in which to interpret the null effects. Third, Study 2 assessed both emotional reactivity and recovery across three channels of emotion (negative mood, heart rate, electrodermal responding), providing a more nuanced picture of the real-time emotional response. Finally, I compared how people with and without NSSI respond to two well-established paradigms for creating socially relevant emotional challenge (Hartgerink et al., 2015; Kudielka et al., 2007). Given these strengths, if my conclusion that people who engage in NSSI have a largely typical emotional response reflects numerous Type II errors (i.e., failing to reject the null hypothesis when it is actually false), then the size of the true effect is likely too small to create the context for NSSI in the manner proposed by prominent theories.

The major findings of this thesis should be interpreted in light of four key caveats. First, Study 2 and 3 assessed negative mood at the end of each phase of the experiment, rather than providing a continuous measure *during* each phase (e.g., turning a dial to indicate valence and/or arousal of the ongoing response; Ruef & Levenson, 2007). Thus, our measures of negative mood are retrospective, albeit on a much shorter timescale than provided by global self-reports. Second, in Study 2 I was unable to capture the rise and fall of autonomic arousal with continuous measures of physiological responding due to substantial noise in the signal created by the participant standing up, moving chairs, and completing the negative mood measures between each experimental phase. Third, it is unlikely that the Partial Exclusion Cyberball game in Study 3 was truly an *ambiguous* stimulus that could reasonably be interpreted as neutral and/or benign. A more cautious interpretation is that partial social exclusion was experienced as a milder emotional challenge than explicit (i.e., total) social exclusion. Finally, I did not assess Borderline Personality Disorder (BPD) symptomology in either Study 2 or 3. BPD is often associated with greater affect instability and more intense

negative emotions in daily diary studies and studies that manipulate real-time emotional challenge (for a review see, Schmahl et al., 2014). Given that BPD often presents with NSSI (Nock et al., 2006; Soloff et al., 1994), researchers have argued that variability in BPD symptoms among NSSI groups may explain the mixed results evident in the literature (Hooley & Franklin, 2018). Thus, BPD symptomology is an important moderator to consider in real-time emotional responding among people who engage in NSSI. Although no participants in Study 2 and 4.0% of the NSSI group in Study 3 (compared to none of the Control group) reported having received a BPD diagnosis, this binary variable is unable to capture the extent and variability of BPD symptoms necessary for statistical analysis in these samples.

The current state of the evidence

This thesis adds to the growing consensus in the field that, despite consistently reporting poorer global emotional functioning than controls, people who engage in NSSI show a largely similar emotional response to real-time challenge. Counter to the amplified emotional responding account, people who self-injure show similar subjective responses across a wide variety of emotional challenge manipulations, including acute stress (Study 2; and Kaess et al., 2012), social exclusion (Study 3; and Groschwitz et al., 2016; Schatten et al., 2015), sad film clips (Davis et al., 2014; Mettler et al., 2021), and personalised manipulations of distress (Gratz et al., 2011), rejection (Gratz et al., 2019), criticism (Allen et al., 2019), and anger (Weinberg & Klonsky, 2012). In a similar manner, and again counter to the amplified emotional responding account, a growing body of research demonstrates that people who self-injure show similar physiological responses to emotional challenge across electrodermal (Study 2; and Crowell et al., 2005; Tatnell et al., 2018), heart rate (Study 2; and Kaess et al., 2012), RSA (Kaufman et al., 2019; although see Crowell et al., 2005), and cortisol channels (Plener et al., 2017; although see Kaess et al., 2012). The studies that find amplified emotional reactivity among people who self-injure (Kaufman et al., 2019; Nock & Mendes, 2008) are as few in number as those that find *reduced* emotional reactivity among people who self-injure (Boyes et al., 2020; Bresin & Gordon, 2013), suggesting that they likely reflect spurious findings.

This thesis also adds to a small but growing body of evidence that the factors that shape the emotional response are largely typical in NSSI. People who self-injure show similar patterns of subjective (Study 2 and 3; and Mettler et al., 2021; although see Boyes et al., 2020) and physiological recovery from negative challenge (Study 2; and Crowell et al., 2005;

Plener et al., 2017) as do controls. In addition, Study 2 provides no evidence that people who engage in NSSI utilise different emotion regulation strategies following acute stress, or later go on to remember their emotional experience in a different manner than do controls. Likewise, Study 3 provides no evidence that people who engage in NSSI have a more sensitive appraisal system. Focusing on global self-reports of emotional functioning, preliminary evidence suggests that people without a history of NSSI draw, in part, from their subjective experience of instances of stress (but not milder social exclusion) when reporting their global emotion dysregulation. In contrast, people who engage in NSSI appear to rely on different sources of information when making these reports.

Where to next for the amplified emotional responding account?

The dissociation between global self-reports and real-time emotional responding suggests that the relationship between emotional responding and NSSI is more complex than currently described by prominent theoretical models (Chapman et al., 2006; Hasking et al., 2016; Nock, 2009). Given that the current body of evidence suggests that people who engage in NSSI show largely typical patterns of emotional responding to real-time emotional challenge, the question becomes 'under which circumstances might people who self-injure show amplified emotional responding?' Focusing on this line of questioning, I offer four different avenues for exploration to drive this area of research forward, before ending with a reflection on why the amplified emotional response account offered by prominent theories of NSSI may be particularly attractive for the NSSI field.

NSSI severity

NSSI is a highly variable behaviour: some people engage in the behaviour only once or twice, others engage sporadically, and still others engage in the behaviour chronically over a long period of time (Klonsky & Olino, 2008; Whitlock et al., 2011; Wilkinson et al., 2018). One possibility is that an amplified emotional response underlies only severe and chronic engagement in NSSI. However, it is currently not clear what the criteria for 'severe NSSI' might entail. One promising option for quantifying NSSI severity comes from the proposed criteria for Non-Suicidal Self-Injury Disorder (NSSI-D) included as a condition for further study in the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2013).

The proposed criteria for NSSI-D include: NSSI engagement on five or more days in the past year (Criterion A); the expectation that the behaviour will provide relief from negative feelings or cognitive states, resolve interpersonal difficulties, and/or lead to positive

feelings (Criterion B); the behaviour is preceded by interpersonal difficulties or negative feelings, difficult to control urges to self-injure, and/or frequent thoughts of NSSI (Criterion C); excludes socially sanctioned behaviours (Criterion D); results in distress and/or impaired functioning (Criterion E); and does not occur solely in the context of another mental disorder (Criterion F; American Psychiatric Association, 2013). However, the clinical utility of these NSSI-D criteria has been questioned (e.g., Buelens et al., 2020) with calls, for instance, to increase the frequency cut-off to 10 or more days in the past year (Ammerman et al., 2017; Muehlenkamp & Brausch, 2016).

Future research should test whether severe NSSI is characterised by amplified emotional responding by assessing how people who meet the NSSI-D criteria, people with a history of NSSI behaviours *without* NSSI-D, and people with no history of NSSI, respond to emotional challenge. If an amplified emotional response creates the context for severe NSSI, but not NSSI engagement in general, then participants with NSSI-D should show a greater subjective and/or physiological response to emotional challenge than No NSSI and NSSI without NSSI-D groups, while NSSI without NSSI-D and No NSSI groups should show a similar response to one another. However, focusing only on the current Criterion A frequency cut-off, it is worth noting that 39.3% of the Study 2 NSSI group and 53% of the Study 3 NSSI group reported engaging in more than five instances of NSSI in the past year. That is, the NSSI samples in this thesis are likely to contain a relatively high proportion of people who would meet criteria for NSSI-D. It is worth noting that if amplified emotional responding is unique to people with severe NSSI, then the size of the effect is considerably smaller than that proposed by prominent NSSI theories (Chapman et al., 2006; Hasking et al., 2016; Nock, 2009).[39]

Behavioural channels of emotional responding

A second possible explanation for the dissociation between global self-reports and real-time emotional responding is that we are simply failing to measure the channel of emotion which shows disrupted responding in NSSI. Given that NSSI itself is a behavioural response to manage emotional challenge (e.g., Edmondson et al., 2016; Klonsky & Glenn, 2009), it may be the case that altered emotional responding in NSSI is limited only to behavioural channels of emotion. This thesis did not include behavioural measures of

[39] Indeed, neither the Experiential Avoidance Model (Chapman et al., 2006), the Integrated Theoretical Model (Nock, 2009), nor the Cognitive–Emotional Model of NSSI (Hasking et al., 2016) provide much theorising regarding how varaiblity in NSSI frequency and/or severity develops, or how people come to stop engaging in the behaviour.

emotion, and reviews of the emotion field more generally find fewer studies assess behavioural channels of emotion responding compared to subjective and physiological channels (e.g., Webb et al., 2012).

As reviewed in Chapter 2, research investigating emotional behaviour among people who self-injure is sparse. Nock and Mendes (2008) found that adolescents who engage in NSSI chose to quit a frustrating task earlier than did controls. Adolescents who engage in self-injury were rated by observers as demonstrating less positive and more negative affect (Crowell et al., 2008) and more anger/frustration and opposition/defiance (Kaufman et al., 2019) during parental conflict discussions than were controls. However, these three studies did not include a baseline measure of behavioural responding, making it difficult to determine if these differences by self-injury status reflect altered emotional *responding*, or rather a more habitual difference in behaviour in general.

The three studies which included baseline measures of behaviour have focused on responding to emotional images. Among Canadian young adults, those with a history of five or more instances of NSSI showed reduced corrugator EMG reactivity to angry and happy facial expressions (but not disgust, fear, sadness, or surprise facial expressions) compared to controls (Ziebell et al., 2020). In contrast, Swedish adolescents who had engaged in NSSI five or more times in the past month showed *greater* corrugator reactivity to negative images than did controls (Mayo et al., 2021). In a different pattern of results again, American young adults with and without a lifetime history of NSSI showed similar emotional modulation of startle eye blink (a behavioural index of emotional reactivity; Glenn et al., 2011). Taken together, there is limited evidence from which to make conclusions regarding emotional behaviour in NSSI. Future research should use multiple, well-established measures of behavioural responding to emotional challenge such as facial behaviour, vocal characteristics, and body posture (Mauss & Robinson, 2009), to test whether NSSI is characterised by amplified emotional responding in behavioural channels (only).

Emotional responding to positive stimuli

This thesis, consistent with the majority of research in this field, focused exclusively on responses to negatively-valenced emotion manipulations. Theoretical models arguing that altered emotional responding (in part) creates the context for NSSI have tended to focus on emotional responding to negatively valanced stimuli, and have largely failed to consider reactivity to positively valenced stimuli (Chapman et al., 2006; Nock, 2009, although see Hasking et al., 2016). Recently there have been calls to investigate how people who engage in

NSSI respond to positively valenced emotion manipulations (Boyes et al., 2020; Mettler et al., 2021; Perini et al., 2021). In particular, some researchers have suggested that NSSI may be characterised by a *blunted* emotional response to positive stimuli (Boyes et al., 2020), whereas others have proposed that NSSI may be characterised by an *amplified* emotional response to positive stimuli (Perini et al., 2021). It is worth noting that the neurobiological architecture of positive and negative affect show considerable overlap (Burgdorf & Panksepp, 2006), suggesting that experiences of positive and negative affect might not reflect unique neurobiological processes. However, research into emotion disorders (e.g., depression, anxiety, and bipolar disorder) highlights alterations in the regulation of positive stimuli (Carl et al., 2013), suggesting that distinguishing between positive and negative valenced stimuli could yield useful insight into the role of emotion in NSSI.

To date, research investigating emotional responding to positive stimuli among people who engage in NSSI is limited. Mettler and colleagues (2021) found that Canadian undergraduates who had engaged in NSSI within the past two years showed a similar subjective response to a humorous video clip as did controls. Similarly, Boyes and colleagues (2020) reported that Australian undergraduates with a lifetime history of NSSI reported less positive mood *in general* than controls but showed the same disconnect between global reports and real-time responses to a humorous video clip. Turning to behavioural channels of emotion, Ziebell and colleagues (2020) found that the NSSI group displayed reduced corrugator activity when observing happy emotional expressions compared to controls. In contrast, Mayo and colleagues (2021) found no difference in corrugator reactivity to positive images by NSSI status but found that the NSSI group showed increased zygomatic reactivity to positive images compared to controls. Thus, it remains unclear *if* and *how* positive emotional responding may be altered in NSSI. Future research should use multichannel assessments of real-time emotional responding to positive emotion manipulations to investigate how people who engage in NSSI react to, and recover from, positive emotional instances.

Patterns of emotional challenge

Moving beyond discrete emotional challenges, perhaps altered emotional responding in NSSI is only observable at a latent level across multiple emotional events. Global emotion dysregulation has been conceptualised as a dynamic pattern in which emotions change abruptly, intensely, and unexpectedly (Cole et al., 2019). That is, emotion dysregulation is more than just poor regulation (Gross & Jazaieri, 2014). Perhaps assessing how people who

engage in NSSI respond to *one* emotional event in isolation fails to adequately capture this dynamic process. For instance, perhaps people who engage in NSSI are less resilient to multiple instances of emotional challenge than controls. If this is the case, then alterations in emotional responding should increase over time as people who engage in NSSI move through a series of emotional challenges. Experience sampling methods offer greater insight into how people who engage in NSSI respond to daily challenges, with a growing body of research focusing on how affective dynamics predict instances of NSSI thoughts and behaviour (e.g., Kiekens et al., 2020; Victor et al., 2021, for review, see Chapter 2). However, until recently, experience sampling methods have been largely restricted to subjective channels of emotion. Recent advances combining ambulatory physiology measures and experience sampling methods show greater feasibility and acceptability of assessing subjective and physiological responses across relatively long (e.g., several weeks) periods of time (e.g., Van Doren et al., 2021), including among people who self-injure (Kleiman et al., 2019). Future research should assess real-time subjective and physiological responses to daily challenges as they unfold among people with and without a history of NSSI to better understand emotion, and emotion dysregulation, in NSSI.

A reflection on the attractiveness of the amplified emotional responding account

I end this section with a reflection on why the amplified emotional response account may be so attractive in the field of NSSI. To date, there is limited evidence for a widespread, systematic difference in how people who engage in NSSI respond to emotional challenge in either laboratory-based or experience sampling studies compared to those with no history of NSSI. Despite this lack of evidence for differences in real-time responding, global self-reports of emotion reactivity and emotion dysregulation are often interpreted as reflecting an amplified emotional response that creates the context for NSSI (e.g., Buser et al., 2019; Hamza, Goldstein, et al., 2021; Perini et al., 2021). Thus, the idea that people who engage in NSSI have an amplified emotional response is at risk of becoming a 'zombie idea'—an argument that has been empirically refuted, but that refuses to 'die' (Feldman Barrett, 2019; Krugman, 2013). One imperative likely keeping the amplified emotional response account 'alive' is that positive results tend to be cited more frequently than negative/null results, although evidence for this effect differs by discipline (Duyx et al., 2017; Fanelli, 2013). A second possibility that I focus on here is that the attractiveness of the amplified emotional response hypothesis may lie in anti-stigma efforts of researchers, clinicians, and advocates.

NSSI is a stigmatised behaviour that often is labelled as 'manipulative' or 'attention-seeking' (Staniland et al., 2020). This stigma—enacted and anticipated, held by others and turned on one's self—causes distress for people who self-injure and is a barrier to help-seeking (Hasking, Rees, et al., 2015; Long et al., 2015). Many prominent NSSI researchers and clinicians also engage in NSSI outreach and advocacy (for examples of online evidence-informed outreach and advocacy resources, see http://icsesgroup.org/resources). In my seven years of experience facilitating NSSI psychoeducation workshops, unpacking the role that functions, particularly intrapersonal functions, play in reinforcing NSSI is a highly effective way of building understanding of why people may choose to engage in NSSI, and thus a critical tool in combatting stigmatising NSSI myths. Indeed, university students with better knowledge of NSSI well-established facts (including the functions of NSSI) reported fewer stigmatised beliefs about NSSI (Hamza, Robinson, et al., 2021).

Perhaps the amplified emotional response account is so attractive because it builds on and complements the importance of intrapersonal functions of NSSI. Thus, the messaging becomes: 'People who engage in NSSI do so to gain relief from overwhelming emotional experiences, *and these experiences are overwhelming because their emotional response system is heightened*.' Reviews of mental illness stigma more generally have found that endorsement of biogenetic causes of mental illness (i.e., in the case of NSSI, an amplified emotional response system) is associated with a reduction in personal blame of the person experiencing mental illness, but *greater* desire for social distance (Kvaale, Gottdiener, et al., 2013; Kvaale, Haslam, et al., 2013). In addition to being a misrepresentation of the evidence, the communication of the amplified emotional account of NSSI may unintentionally *increase* some aspects of NSSI stigma.

Reconsidering the role that emotional responding plays in NSSI

Given the growing consensus that people who engage in NSSI largely show typical emotional responses, moving beyond tests of moderators and boundary conditions (described above), it may be time to move away from experiments focusing on assessing group-level differences in emotional responding in NSSI altogether. Recall from Chapter 2 that the Experiential Avoidance Model of NSSI (Chapman et al., 2006), the Integrated Theoretical Model of NSSI (Nock, 2009), and the Cognitive–Emotional Model of NSSI (Hasking et al., 2016) all propose that individual differences in emotional responses play a role in creating the context in which a person may enagage in NSSI to manage their emotion experience. In light of the current body of evidence, new theoretical conceptualisations of NSSI are needed.

Counter to most prominent theories of NSSI, the Benefits and Barriers Model (Hooley & Franklin, 2018) argues that individual differences in emotional responding play a limited and indirect role in NSSI. Rather, Hooley and Franklin (2018) argue that NSSI engagement arises out of a balance between the benefits offered by the behaviour and the barriers to engaging in NSSI. The model proposes that the momentary benefit of pain for regulating mood (i.e., the affective benefit) is a key mechanism that maintains NSSI behaviour. NSSI may also provide benefits to an individual by gratifying their self-punishment beliefs, maintaining or improving their affiliation with peers, and providing a way of communicating distress and/or strength to others. Critically, Hooley and Franklin (2018) emphasize that the self-punishment, affiliation, and communication benefits of NSSI may also provide affective benefits. For instance, satisfying self-punishment motivations may simultaneously work to repair negative mood. Recall from Chapter 2 that the *offset* of a painful stimulus reduces subjective negative affect among people with and without a history of NSSI (Bresin & Gordon, 2013; Fox et al., 2017; Franklin et al., 2014), suggesting that the affective benefit of NSSI operates through a generalised mechanism shared among people with and without psychopathology.

Most people do not engage in NSSI because of five instinctive barriers to the behaviour (Hooley & Franklin, 2018). In particular, a lack of awareness of NSSI (the concept or the methods), the aversiveness of physical pain, aversion to NSSI stimuli (e.g., blood, open wounds), social norms against self-injury, and feelings of self-worth all work to prevent NSSI. Hooley and Franklin (2018) argue that any one barrier is sufficient to prevent an instance of NSSI, and an individual must first overcome all five barriers, either chronically or transiently, to engage in NSSI. People with chronically lowered barriers to NSSI are thought to engage in the behaviour more frequently, while people with transiently lowered barriers to NSSI are thought to do so more episodically. Research testing these assertions is currently in progress (e.g., Fox et al., 2019)

Hooley and Franklin (2018) then argue that although the affective benefit of NSSI plays only a minor role in the onset of NSSI, it plays a major role in the *maintenance* of NSSI. As discussed in Chapter 2, NSSI appears to restore negative mood largely because the offset of a painful stimulus reduces negative affect compared to pre-pain levels (Bresin & Gordon, 2013; Franklin et al., 2014), especially for people who report greater self-criticism (Fox et al., 2017) and greater global emotion reactivity (Bresin et al., 2010). The complex interaction between the benefits and barriers of NSSI means that the affective benefit that accompanies all episodes of NSSI may then further reduce barriers to NSSI. For instance, an

individual may decide that the mood repair benefits of NSSI are worth the physical pain of engaging in NSSI. Thus, although emotion appears to play a key role in negatively reinforcing NSSI behaviour this mechanism is universally shared, rather than the result of individual differences in emotional responding.

Resolving the disconnect between global self-report and real-time responding

Despite consistently reporting substantially greater global emotion reactivity and emotion dysregulation than controls, growing consensus suggests that people who engage in NSSI show largely typical responses to real-time emotional challenge. But global self-reports appear to be important in understanding NSSI engagement (e.g., Fox et al., 2015; Robinson et al., 2019) and cessation (e.g. Adrian et al., 2019; Asarnow et al., 2021; Gratz et al., 2012), and so it would be foolish to dismiss these large-scale group-level differences. The disconnect between global self-reports and real-time emotional responses does not invalidate global self-reports. The current body of evidence should not be interpreted as suggesting that the emotional traits of people who engage in NSSI are unimportant in explaining the behaviour, but rather that the large-scale differences in global reports are not the result of systematic differences in real-time emotional reactivity or recovery. Future research resolving the disconnect between global self-reports and real-time responding is critical for improving our understanding of NSSI. One potential avenue for exploration is to consider beliefs about emotions.

Preliminary theoretical work has suggested that there are two fundamental beliefs about emotions: the extent to which emotions are good or bad, and the extent to which emotions are controllable or uncontrollable (Ford & Gross, 2019). These superordinate beliefs may also include subordinate beliefs about specific emotions, emotion intensities, contexts, emotion channels, time courses or targets (Ford & Gross, 2019). For instance, a person may believe that emotions in general are relatively bad (superordinate belief) and that it is bad for young women, but not young men, to feel angry (subordinate belief about a specific target).

The beliefs a person holds about emotions influence the emotional regulation choices they make. Gutentag and colleagues (2017) tracked university students' reappraisal use and controllability beliefs over four years. Students who came to believe emotions are more controllable used more cognitive reappraisal by the end of the study. Critically, beliefs about the controllability of emotion and use of reappraisal appeared to mutually reinforce each other; students who came to use reappraisal more frequently believed that emotions are more

controllable by the end of the study (Gutentag et al., 2017). Among adolescents, the extent to which a young person believed that emotions are uncontrollable also predicted less subsequent reappraisal use, which in turn predicted greater subsequent depressive symptoms (Ford, Lwi, et al., 2018). In particular, a person's beliefs about their ability to control their own emotions (i.e., emotion regulation self-efficacy beliefs) appears to be critical. A perceived lack of control over one's own emotions is cross-sectionally associated with poorer psychological health and avoidance-based emotion-regulation strategies (De Castella et al., 2018). People made to believe that they have low regulation self-efficacy reported greater intentions to engage in avoidance strategies over the next month compared to those made to believe that they have high regulation self-efficacy (De Castella et al., 2018). Thus, emotion beliefs influence how people choose to regulate their emotions, choices which in turn have downstream effects on their emotional experiences and psychological wellbeing.

Retrospective reports of emotional experiences are thought to rely largely on episodic memory, beliefs about what emotions are most likely in a specific situation, and beliefs about a person's own emotions in general (Robinson & Clore, 2002). On the face of it, it is likely that in the case of global emotion reactivity and emotion dysregulation this framework should be extended to include Ford and Gross' (2019) beliefs about emotions more generally. As highlighted in Chapter 2, the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) and the Emotion Reactivity Scale (ERS; Nock et al., 2008) are, respectively, the most common measures of global emotion reactivity and emotion dysregulation used in the NSSI literature (Wolff et al., 2019; You et al., 2018). Both scales include items which appear to capture beliefs about emotion. Focusing on the DERS, items ask about emotions in general (e.g., *'When I am upset, my emotions feel overwhelming'*), as well as evaluations of emotions (e.g., *'I have difficulty making sense out of my feelings'*). Several DERS items directly assess controllability beliefs specific to experiences of negative affect (e.g., *'When I am upset, I believe that I will remain that way for a long time'* and *'When I am upset, I believe that there is nothing I can do to make myself feel better'*). Finally, the items of the non-acceptance subscale of the DERS appear to indirectly assess beliefs that (some) emotions are bad. For instance, *'When I am upset, I feel ashamed with myself for feeling that way'* seems to capture the belief that experiencing negative affect is something to be ashamed about.

Focusing on the ERS, some items appear to indirectly assess people's beliefs about how controllable their emotions are (e.g., *'If I have a disagreement with someone, it takes a long time for me to get over it'*, and *'I often get so upset that it's hard for me to think*

straight'). Several items first require a judgement of what a 'normal' emotional response is (e.g., *'When I'm angry/upset it takes me much longer than most people to calm down'*, and *'I am often bothered by things that other people don't react to'*), while other items indirectly capture another person's judgements of what emotional responses are typical or appropriate (e.g., *'Other people tell me I'm overreacting'*, and *'People tell me that my emotions are often too intense for the situation'*. Given that global self-reports are likely to capture aspects of a person's beliefs about their emotions, one possibility for why we see large-scale differences in global reports by NSSI status with no corresponding differences in real-time responding is that people who engage in NSSI hold different beliefs about their emotional experiences than do controls.[40]

Reanalysis of Study 2 and 3 provides preliminary evidence that people with no history of NSSI draw from their real-time experiences of intense emotional challenge when making global reports of emotion dysregulation, whereas people who engage in NSSI do not. Perhaps when making global reports of emotion dysregulation people who engage in NSSI rely more on their beliefs about emotions than do controls. Future research should test how well emotion beliefs explain the disconnect between global reports and real-time emotional responding among people who self-injure. For instance, participants with and without a history of NSSI could take part in an acute emotion challenge while measures of their real-time subjective and physiological emotional response are recorded. Following acute challenge participants could report their regulation self-efficacy beliefs (e.g., *'Efforts to change my thoughts/feelings* [during the manipulation] *made me feel…'*, with anchors ranging from *'0 – Much worse'* to *'10 – Much better'*; Daniel et al., 2020) and the extent to which they thought their emotional response was less, the same, or greater than the typical person's response. If beliefs about emotions explain why we see a disconnect between global reports and real-time emotional responding in people who self-injure, the NSSI group should show no differences in their real-time emotional response compared to controls, but report lower regulation self-efficacy and be more likely to perceive their experience as greater than the typical response.

[40] It is also worth noting the growing body of research demonstrating that the beliefs people hold regarding the utility of NSSI for repairing negative mood and their self-efficacy to resist NSSI urges play a role in NSSI engagement (e.g., Dawkins et al., 2019, 2021; Kiekens et al., 2020). Thus, understanding the interaction between NSSI—emotion beliefs may be critical to understanding the role of emotion in NSSI.

Implications for affective science

In addition to improving our understanding of NSSI, the disconnect between global reports and real-time emotional responses among people who engage in NSSI also offers insights into the different 'levels' at which emotion can be conceptualised. Explaining complex psychological phenomena, including self-injurious behaviours such as NSSI and suicide, requires both higher-level explanations (e.g., systematic societal disenfranchisement) and lower-level explanations (e.g., motivations to escape from distress). Eronen (2019) offers three ways to distinguish between levels of a phenomenon. First, part-whole relationships capture hierarchies in scientific organisation. For instance, a brain is comprised of networks, which are comprised of neurons, which are comprised of organelles, which are comprised of molecules, which are comprised of atoms. Second, levels may differ along a spatial scale constituting the 'size'[41] of things under investigation. For instance, neuroimaging investigates the activity of neurons across millions of neurons per voxel, whereas cellular neuroscience investigates the activity of a single neuron. Third, levels may differ along a temporal scale constituting the timescale along which processes unfold. For instance, the action of a neurotransmitter on a receptor is faster than the interaction between neurons, which is faster than the interaction between brain circuits. As opposed to capturing clear ontological aspects of the world, distinguishing between levels of a phenomenon provides a conceptual framework to guide inquiry (Eronen, 2019).

Global self-reports of emotion dysregulation are assumed to be the 'larger' sum of many interacting psychological processes overtime, whereas the moment-to-moment emotional responses during a specific (i.e., 'shorter') instance reflects a set of processes that unfold over a (relatively) shorter time scale. However, the re-analysis of Study 2 and 3 (Chapter 6) highlighted that these different levels of emotional functioning are more different than they are similar. In particular, the inconsistent associations between real-time emotional reactivity and both global emotion dysregulation (*r*s arrange from .42 to -.01) and global emotion reactivity (*r*s range from .16 to -.02) suggest that global self-reports and measures of real-time emotional responding should not be considered interchangeable constructs, but rather reflect unique aspects of emotion. That is not to say that measures of real-time emotional responding are more *objective* than global self-reports, but rather that the different measures index aspects of emotions at different levels of resolution. Given that global emotion dysregulation is considered to be a transdiagnostic risk factor for psychopathology

[41] Eronen (2019) notes that for psychological phenomena, spatial 'size' is often metaphorical and based on assumptions rather than measurable constructs.

more generally (e.g., Beauchaine, 2015a; Beauchaine & Zisner, 2017; Gross & Jazaieri, 2014), future research should consider whether the disconnect between global emotion dysregulation and real-time emotional responding found in this thesis is also observed for other clinical conditions (e.g., depression, anxiety). Taken together, this disconnect between global reports and real-time responding can lead to new insights into the ways in which emotion processes may be altered in psychopathology.

Implications for clinical science and practice

Theoretical arguments that an amplified emotional response creates the context in which people engage in NSSI to regulate their emotional experiences has led to the development of clinical interventions for NSSI that target emotional responding (e.g., Dialectical Behaviour Therapy [DBT], Chapman, 2006; Emotion Regulation Group Therapy [ERGT], Gratz & Tull, 2011). Given the lack of evidence for a systematic difference in emotional responding among people who engage in NSSI, it is perhaps unsurprising that meta-analyses find that current treatments are only marginally more effective than treatment-as-usual for reducing self-injury (Fox, Huang, et al., 2020; Kothgassner et al., 2020). Global self-reports longitudinally predict NSSI engagement (e.g., Fox et al., 2015; Robinson et al., 2019) and treatment efficacy (e.g. Adrian et al., 2019; Asarnow et al., 2021; Gratz et al., 2012), demonstrating that these self-reports capture *some* aspect(s) important for understanding NSSI. Understanding the psychological processes which underlie the disconnect between global self-reports and real-time emotion responding is thus critical to develop more effective therapeutic interventions.

If people's beliefs about emotions prove to be important, then emotion psychoeducation may hold particular promise for targeting these beliefs. To date, several therapeutic approaches for NSSI include components of emotion psychoeducation (e.g., DBT, Chapman & Gratz, 2006; ERGT, Gratz & Tull, 2011). For instance, ERGT (Gratz & Tull, 2011) includes discussion of a person's beliefs about their emotions (particularly negatively-valenced emotions) and encourages challenging unhelpful beliefs. This kind of psychoeducation may be helpful to support clients to see their emotional responses as typical. In addition, some clients (and their whānau) may benefit from psychoeducation regarding the well-established biases that impact how we make retrospective judgements about our global emotional functioning, such as being influenced by current experiences and emphasising some experiences over others (Kahneman et al., 1993; Mayer et al., 1995).

When working with clients who engage in NSSI, it would be a mistake to interpret the disconnect between global self-reports and real-time emotion responses as suggesting that people who engage in NSSI inaccurately make global judgements, particularly as this has the potential to invalidate the client's experience. Instead, mental health professionals may find it beneficial to keep in mind that even clients who experience extensive and persistent global emotion reactivity and/or emotion dysregulation are likely to have instances where they responded in an appropriate and 'well regulated' manner. Tracking daily mood over time and isolating emotional responses the client identifies as 'appropriate' or having gone 'well' can help to facilitate conversations about what aspects of the client's internal and external environment make value and/or goal-consistent emotional responses more or less possible. Conversely, unpacking instances where the client feels that their emotional response did not go 'well' may be key in highlighting overly self-critical evaluations. In particular, normalising *having* a response to emotional challenge may be helpful for clients and work to lessen beliefs that they cannot cope with their emotions. Looking to the future, a more comprehensive understanding of the role of emotion in NSSI is needed to inform prevention and intervention strategies to better support people who struggle with NSSI.

Conclusions

This thesis assessed how people who engage in NSSI respond to real-time emotional challenges. Despite reporting considerably greater difficulties in global emotional functioning, people who engage in NSSI show a largely typical response to real-time emotional challenge across two studies. Furthermore, I found no evidence that emotional recovery, emotion regulation strategy use, memory of emotional experience, or appraisal—all factors which shape the emotional response—operate differently in NSSI. Initial evidence suggests that people who engage in NSSI do not draw from their real-time subjective experience of emotional challenge when making judgements about their global emotion dysregulation, whereas people with no history of NSSI draw from their real-time experiences of acute (but not mild) emotional challenge. Given that global self-reports of emotional functioning appear to be critical for understanding NSSI onset and cessation, the contradiction between global self-reports and real-time emotional responding highlights the complexity of the relationship between emotion and NSSI. To advance our understanding of emotional responding in NSSI, research should: a) establish the conditions (if any) under which people who engage in NSSI show amplified emotional responding, and b) isolate the psychological processes which underlie people who engage in NSSI's experience of poorer

global emotion functioning. Chapter 8 concludes this thesis with a reflection on the process of doing this programme of research.

Chapter 8: Afterword

In bringing this thesis to a close, I reflect briefly on the process of *doing* this programme of research. Although reflexivity is a well-established tool in other domains of health research (e.g., Rae & Green, 2016; Rager, 2005) and social science more generally (e.g., Berling & Bueger, 2013; Gewirtz & Cribb, 2006), publicly shared written reflections are not common practice in experimental NSSI or affective science domains. Despite this lack of an established process, in my training as an experimental psychologist I have had numerous conversations with supervisors and mentors about aspects of reflexivity—conversations that have been critical in my professional development as a scientist. In sharing my reflections on the process of this thesis, I hope to make explicit the context in which this work and its interpretations fit, and to share my experiences with any students who may read this thesis for inspiration and/or procrastination in their own work (if that's you—kia ora!).[42]

The emotional weight of doing research on sensitive topics

As a teenager, I supported several friends who managed intense distress with self-injury. I was also part of a school community bereaved by suicide, including the death of a young person my own age and of a similar cultural background (a first-generation migrant to Aotearoa New Zealand from Zimbabwe). I initially came to NSSI research at the end of my undergraduate degree in part because I wanted to better understand these experiences. Researchers investigating sensitive topics like NSSI and self-injury often experience big and/or intense emotional responses such as distress, sadness, and anger (e.g., Dickson-Swift et al., 2008; Riger, 2016). Experimental NSSI research proved no different. As a postgraduate student, I have well-established professional and personal relationships with other students. These relationships meant that greater awareness of the mental health difficulties that many students manage in their day-to-day lives made me feel sad and worried at times, as well as angry at a broader system that fails to adequately address the mental health needs of all New Zealanders.[43] Despite being 'well enough' to be university students engaging in research for course credit, the people in the Study 2 and 3 NSSI groups reported relatively severe lifetime histories of NSSI. Findings from my research group suggest that young people who have engaged in four or more NSSI methods are at greater risk of experiencing clinically elevated

[42] Interjection meaning hello, cheers, and/or good luck!
[43] For an overview of the state of mental health services at the beginning of this PhD, see *He Ara Oranga: Report of the Government Inquiry into Mental Health and Addiction* (2018; https://mentalhealth.inquiry.govt.nz/).

suicidal thoughts and behaviours (Robinson et al., 2021). Within this thesis, the average number of NSSI methods reported by participants in the NSSI group was 3.45 (*SD* = 2.01) in Study 2 and 5.15 (*SD* = 2.31) in Study 3, suggesting many may also be experiencing suicidal thoughts and behaviours. The weight of the emotions that accompanied such findings varied along my thesis journey but were particularly close to the surface when people in my personal life were struggling with their mental health and self-injury.

Recommendations for conducting NSSI research include regular debriefing, supervision, and opportunities for reflection to ensure researchers' safety (Hasking, Lewis, Robinson, et al., 2019; Kiekens et al., 2021; Lloyd-Richardson et al., 2015). During this PhD I found it particularly helpful to engage in such supervision and debriefing with other researchers, researcher–clinicians, and mental health advocates as well as researchers focused on areas beyond mental health. Receiving support from people strongly embedded in mental health research and practice helped validate my day-to-day work and experiences, while support from researchers outside mental health helped me to work through challenges at a conceptual level, informed by broader psychological research. Although it required precise time management, I also found it emotionally restorative to 'take breaks' from my thesis to work on different projects, including other NSSI-related projects (e.g., guidance counsellors' experiences responding to NSSI in schools; Garisch et al., 2020), as well as wellbeing-related projects more generally (e.g., the role of emotion in behavioural compliance to lockdown polices; Broodryk & Robinson, 2021). Research is also fun and inherently rewarding. There is immense enjoyment and satisfaction in moving from messy confusion to insight (and back again). At times during this thesis I simultaneously held the joy of discovering something *and* my worry for participants. If I had my time again, I would read other researchers' reflections on researching sensitive topics (e.g., Fincham et al., 2008; Rager, 2005) in order to learn from their experiences much earlier in my PhD journey. Going forward, I have started a reflexivity journal to provide a written record as I explore the active role of the researcher in the questions, design, and interpretation of my research.

Ethical considerations in manipulating emotional challenge

Throughout Study 2 and 3 I was conscious that the difference in power between myself (the researcher) and participants might prevent participants from choosing to withdraw their consent—especially given that participants took part for course credit. Given that this research intentionally creates emotional challenge, it was critical that participants felt able to withdraw their consent at any time during the study without consequence. I tried

explicitly to deconstruct some of the distance between researcher and participant, positioning myself as a fellow psychology student, informally explaining the informed consent process verbally,[44] and asking for active consent to continue at each phase of study. This process of connecting with each participant was easier (and arguably more important) in Study 2's face-to-face stress induction than in Study 3's mild online social exclusion.

In Study 2, I relied strongly on interpersonal skills that may not typically be seen (or taught) as critical in an experimenter's 'tool kit'. Initially, I had scheduled 15–20 minutes for active, conversational-style debriefing at the end of the laboratory session. Unexpectedly, many participants chose to stay longer to discuss the broader context of mental health needs in Aotearoa New Zealand, and/or studying psychology at Victoria University of Wellington. These conversations required me to have a much broader understanding of the social and political context of mental health in Aotearoa New Zealand than would have been strictly necessary for the theoretical rationale of this programme of research. The process of building rapport with participants throughout the study involved humour, sharing appropriate personal details, explaining the process (e.g., how electrical signals can tell us about the activity of a person's heart), and non-verbal communication such as making eye-contact and smiling to signal my attentiveness. These interpersonal skills were also important in working with the confederates who volunteered their time to help administer the stress induction. Following each session with a participant, I would check how the confederate felt the stress induction had gone and give them an opportunity to debrief. This process of caring for confederates was particularly important if a participant had seemed upset or had chosen to withdraw from the experiment. For researchers who may wish to conduct similar research, it is important to recognise the value these interpersonal skills bring to the research process, and to be aware that building these relationships may require additional time—I would typically schedule 1.5 hours per participant (one hour for data collection, and 30 minutes to continue the discussion if desired and to check in with the confederate).

The social and cultural milieu in which this thesis took place also raised ethical considerations. We paused data collection during times in which it would be reasonable to assume higher than usual stress (for participants, confederates, and/or myself) to mitigate additional demands during already challenging times. From the outset of Study 2, we had planned to pause data collection in the last weeks of trimesters and over exam periods, when

[44] That is, not relying on participants to read and understand the way informed consent is communicated on written (and Ethics Committee approved) information sheets—something that research shows is difficult for participants (Nishimura et al., 2013).

assessment demands for university students tend to be higher. We also paused Study 2 data collection for several weeks following the terrorist attack at two Christchurch mosques in March 2019, and after a person in my broader community died by suicide in 2018. Such considerations are crucial to the ethical practice of doing research, particularly research that creates emotional challenge. In my experience, these decisions are often made informally within the research team (often without explicit consideration of underlying values) and are not typically reported in experimental method sections or discussed in guidelines for conducting stress and/or NSSI research. Greater transparency around when and how such decisions are made may be worth considering.

Unexpected challenges

When I began this thesis in 2018, I brought with me four years of experience conducting NSSI research as part of the Youth Wellbeing Study, and eight years conducting cognitive experiments as part of the Cognitive and Affective Neuroscience Lab and other cognition-focused labs. I knew that undertaking doctoral research would, at times, be demanding and difficult. However, I was not expecting the level of emotional labour that was required to make Study 2 safe and comfortable for participants, confederates, and myself (as described above). Although my confederates and I were blind to participants' NSSI status during data collection, several participants arrived at laboratory sessions with visible self-injury scars. It is likely that I was warmer toward these participants, and that my confederates were less likely to press them to go faster. Of the few participants (n = 5) who withdrew their consent, three got teary or cried during or immediately after the stress induction.[45] I found such responses distressing and they made me feel guilty and ashamed. Thus, Study 2 required me to work in and move between different roles as the expert researcher, the fellow student, the conduit to support and, following the session, the person in need of support.

The tension between the need to create 'real' negative emotion/stress in the lab and the desire to protect people from unpleasant experiences is inherent in all research that experimentally induces emotional challenge. This tension will likely be balanced differently depending on the unique context of the participants and the researcher. I chose to balance this tension by using an extensive informed consent process, including explicit opportunities to withdraw throughout the study, establishing a wide-ranging distress protocol in case of participant distress, and building connection with each participant. Indeed, precisely *because*

[45] I administered the distress protocol for one participant. Following a guided grounding practice, they did not require additional support contained in the distress protocol. For all other participants who became distressed, their distress was mitigated following the immediate debriefing.

I took explicit steps to build rapport and connect with participants, I was likely more vulnerable to feeling ashamed and guilty when my research caused them distress. I managed these feelings by reflecting on the values that motivate me to conduct NSSI research in general, and research on emotional responding in NSSI in particular, both in supervision and in my own therapy.

Adolescence is a developmental period critical for both NSSI onset (e.g., Plener et al., 2015) and emotional development (e.g., McRae et al., 2012; Steinberg, 2005). Thus, when I began this thesis in 2018, I intended to spend 2020 (the last year of my PhD) working in secondary schools to replicate and extend Study 2 by assessing how adolescents with and without NSSI responded to real-time emotional challenge. As part of the broader Youth Wellbeing Study research group, at the end of 2019 I partnered with schools to conduct the psychophysiology study on site as part of a broader wellbeing study. However, in an effort to contain community transmission of COVID-19, Aotearoa New Zealand went into nationwide lockdown on March 25th, 2020 (approximately one month into the school year). Lockdown restrictions were lifted on May 13th, 2020, when secondary schools returned to face-to-face teaching. COVID-19 and lockdown caused severe disruption for school communities, and mental health professionals reported escalating mental health need among young people. I decided it was not feasible to conduct the planned study in this context. Instead, I developed Study 3, which could safely create emotional challenge online.

Final thoughts

In drawing my reflection on the process of this thesis to a close, I am mindful of what is 'missing' from its pages. Throughout my PhD, I conducted my research while engaging in community partnership and NSSI advocacy work (for examples of this work, https://youthwellbeingstudy.wordpress.com/resources/ and http://icsesgroup.org/resources). I chose to split my time between thesis research and community work partly because doing so aligned with my values, and because I was mindful that if I wasn't listening to the voices of people struggling with NSSI and those who work to support them, my research would run the risk of becoming 'out of touch' with the very phenomena it purports to focus on. I am profoundly grateful to the mental health professionals, youth workers, school communities, and research participants who helped me to develop as a researcher and person. I hope that this programme of research works towards creating a community that is better able to understand and respond to NSSI.

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Appendix A

Study 1a preregistration

Title:

Measurement of Non-Suicidal Self-Injury

Contributors:

Kealagh Robinson and Marc S Wilson

Registration type:

Preregistration Template from AsPredicted.org

Date registered:

August 9, 2018

Registered from:

osf.io/8gwju

Citation:

osf.io/jnbf8

Have any data been collected for this study already?

Yes, at least some data have been collected for this study already

What's the main question being asked or hypothesis being tested in this study?

Q1. Do people report their NSSI history differently when responding to a single item of NSSI engagement compared to a behavioural checklist? Prediction 1: Participants less likely to report a history of NSSI when assessed using a single item measure of NSSI engagement compared to a behavioural checklist. Q2. Are people who do not fit the stereotype of someone who self-injures (i.e., a young woman), more likely to show this discrepancy between assessment types? Prediction 2: Men are more likely to under report their NSSI history on a single item question (relative to a behavioural checklist) than women. Prediction 3: Older participants are more likely to under report their NSSI history on a single item question (relative to a behavioural checklist) than younger participants. Q3: Are people who report no NSSI history on a single item measure but a history on a behavioural checklist more

likely to be recalling NSSI act(s) from longer ago? Prediction 4: Participants who under report their NSSI history on a single item question (relative to a behavioural checklist), are less likely to report an act of NSSI within the last year.
Describe the key dependent variable(s) specifying how they will be measured.

Prediction 1: The DV is prevalence of lifetime NSSI status, measured as a percentage of the sample, split into 'NSSI history', 'no history of NSSI', and 'NSSI thoughts'. For the single item, NSSI prevalence will be based on participants response (response options: 'Yes', 'No', and 'Thought About It'. For the behavioural checklist, participants who report engaging in one or more behaviours once or more will be classified as 'NSSI history'. Participants who report thinking about in engaging in one or more behaviours (but not engaging in any behaviours once or more) will be classified as 'NSSI thoughts'. Participants who report never engaging in or thinking about engaging in any NSSI behaviours will be classified as 'no history of NSSI'. Prediction 2, 3, 4: We will create an index of change, based on how participants respond to both assessment types. Participants assigned to different groups ('NSSI history', 'no history of NSSI', and 'NSSI thoughts) on the two assessment types will be coded as 'Change'. Participants who are assigned to the same group on both assessments will be coded as 'Stable'.

How many and which conditions will participants be assigned to?
All participants will complete the single item assessment: "Please indicate whether you have had thoughts about hurting yourself on purpose, or whether you have hurt yourself on purpose (e.g. punched yourself or objects like walls, prevented wounds from healing, or cut, burnt, scratched or carved your skin, etc.)" and respond either 'Yes', 'No', and 'Thought about it'. All participants will complete the behavioural checklist (DSHI-s, Lundh et al., 2007) which describes 13 common NSSI behaviours (e.g., cutting skin, punching or banging the body) and to each behavioural description indicate the frequency they have engaged in the behaviour on a five point scale ranging from 0 ("never") to 4 ("many times"). Note this scale has been modified to include the response 1 ("thought about"). We will randomise the order in which participants complete these two assessment types. Half of participants will complete the single item assessment and then the behavioural checklist. The remaining half of participants will complete the behavioural checklist followed by the single item.

Specify exactly which analyses you will conduct to examine the main question/hypothesis.

P values less than .05 will be accepted as statistically significant and relevant follow-up analyses will be conducted on these effects. Trends (less than .10) will be followed up if they are predicted. Prediction 1: Participants under report their NSSI history when assessed using a single item measure compared to a behavioural checklist. We will conduct a Pearson Chi-Square statistical test to see if there is a significant relationship between Assessment Order (Single item first vs behavioural checklist first) and NSSI prevalence (NSSI history', 'no history of NSSI', and 'NSSI thoughts'). Prediction 2: Men are more likely to under report their NSSI history on a single item question (relative to a behavioural checklist) than women. Prediction 3: Older participants will be more likely to under report their NSSI history on a single item question (relative to a behavioural checklist) than younger participants. Prediction 4: Participants who under report their NSSI history on a single item question (relative to a behavioural checklist), are less likely to report an act of NSSI within the last year. For these analyses, we will exclude participants who completed the behavioural checklist first (i.e., only use the half of sample that completed the single item followed by these behavioural checklist). We will then conduct a logistic regression to test whether age, gender, and past year NSSI predict change (vs stability) in NSSI reporting.

Any secondary analyses?

We will also assess for interactions between age, gender, and past-year NSSI to predict change (vs stability) in NSSI reporting. Given the scarcity of data addressing these questions, we will conduct exploratory analyses with ethnicity.

How many observations will be collected or what will determine sample size? No need to justify decision, but be precise about exactly how the number will be determined.

All students enrolled in an introductory psychology class (approx. n = 835) will be invited to take part in the experiment as part of a broader online set of questionnaires. Participants will take part in exchange for course credit.

Anything else you would like to pre-register? (e.g., data exclusions, variables collected for exploratory purposes, unusual analyses planned?)

Data exclusions: Data from participants who complete the survey several times (identified by student ID) will be visually inspected. The most complete survey response for each will be retained, excepting when the questionnaires assessing NSSI have been answered in which case the earliest of the responses will be taken. Participants who indicate a history of NSSI also complete a measure of the functions their NSSI serves (ISAS; Klonsky & Glenn, 2009)

and will be asked to indicate in how many times they have engaged in NSSI in the last year, and the number of days they have engaged NSSI in the last year. These variables were assessed in order to better describe the makeup of the NSSI sample, and may be used in exploratory analyses. At the end of the experiment, all participants also complete six items assessing their experience during the experiment. Participants are asked to indicate the extent to which taking part in the experiment was interesting, distressing, confusing, boring, important, and unethical on a five-point scale ranging from 1- Strongly Disagree to 5 – Strongly Agree. These variables may be used in exploratory analyses.

Appendix B

Study 1b preregistration

Title:

Measurement of Non-Suicidal Self-Injury

Contributors:

Kealagh Robinson and Marc S Wilson

Registration type:

Preregistration Template from AsPredicted.org

Date registered:

March 11, 2019

Registered from:

osf.io/8gwju

Have any data been collected for this study already?

No, no data have been collected for this study yet

What's the main question being asked or hypothesis being tested in this study?

Primary Question: Do fewer people report a history of NSSI on the single-item measure, compared to the behavioural checklist, because the memory demands of this measure are higher? Prediction 1: Fewer participants will report a history of NSSI on a single-item measure of NSSI engagement compared to a behavioural checklist. Prediction 2: If behavioural checklists better facilitate memory recall than a single-item assessment, then the memory benefits afforded by the behavioural checklist should extend to a single-item presented immediately afterwards. That is, the discrepancy across assessments should be attenuated the in behavioural-checklist first condition relative to the single-item first condition. Q2: Are people who show discrepancy across NSSI assessments not paying attention during the survey? Prediction 3: Inattention will be strongly related to reporting discrepancy, such that participants who fail the attention check are more likely to report different responses across the two assessments than those who pass the check. Q3. Are people who do not fit the prototype of someone who self-injures (i.e., a young woman), more likely to show this discrepancy between assessment types? Prediction 4: Men are more likely to report a discrepant NSSI history across the single-item and behavioural checklist than

women. Prediction 5: Older participants are more likely to report a discrepant NSSI history across the single-item and behavioural checklist than younger participants. Q4: Are people who report a discrepant NSSI history across the single-item and behavioural checklist more likely to be recalling NSSI act(s) from longer ago? Prediction 6: NSSI recency will negatively predict discrepant responding across the single-item and behavioural checklist. Q5. Are people who report greater anxiety, depression, and stress less likely to report discrepant NSSI histories? Prediction 7. Anxiety, depression, and stress symptoms will negatively predict discrepant responding across the single-item and behavioural checklist.

Describe the key dependent variable(s) specifying how they will be measured.

Prediction 1: The DV is prevalence of lifetime NSSI status, measured as a percentage of the sample, split into 'NSSI history', 'no history of NSSI', and 'NSSI thoughts'. For the single-item, NSSI prevalence will be based on participants response to the options: 'Yes', 'No', and 'Thought About It'. For the behavioural checklist, participants who report engaging in one or more behaviours once or more will be classified as 'NSSI history'. Participants who report thinking about in engaging in one or more behaviours (but not engaging in any behaviours once or more) will be classified as 'NSSI thoughts'. Participants who report never engaging in or thinking about engaging in any NSSI behaviours will be classified as 'no history of NSSI'. Prediction 2-7: We will create an index of discrepancy, based on how participants respond to both assessment types. Participants assigned to different groups ('NSSI history', 'no history of NSSI', and 'NSSI thoughts') on the two assessment types will be coded as 'Change'. Participants who are assigned to the same group on both assessments will be coded as 'Stable'. Prediction 3: Participants who fail the attention check ("Please select 'Applied to me very much, or most of the time' for this question to show that you are paying attention", presented as part of the DASS21) will be assigned an inattentive score of 1, while those who responded as instructed were assigned an inattentive score of 0.

How many and which conditions will participants be assigned to?

All participants will complete the single-item assessment: "Please indicate whether you have had thoughts about hurting yourself on purpose, or whether you have hurt yourself on purpose (e.g. punched yourself or objects like walls, prevented wounds from healing, or cut, burnt, scratched or carved your skin, etc.)" and respond either 'Yes', 'No', or 'Thought about it'. All participants will complete the behavioural checklist (DSHI-s, Lundh et al., 2007) which describes 13 common NSSI behaviours (e.g., cutting skin, punching or banging the body) and to each behavioural description indicate the frequency they have engaged in the

behaviour on a five-point scale ranging from ‘0-never ‘to ‘4-many times’. Note that this scale has been modified to include the response 1- thought about it. We will randomise the order in which participants complete these two assessment types. Half of participants will complete the single-item assessment and then the behavioural checklist. The remaining half of participants will complete the behavioural checklist followed by the single-item.

Specify exactly which analyses you will conduct to examine the main question/hypothesis.

P values less than .05 will be accepted as statistically significant and relevant follow-up analyses will be conducted on these effects. Trends (less than .10) will be followed up if they are predicted. Prediction 1 & 2: We will conduct two Pearson Chi-Square statistical tests comparing Assessment Order (Single-item first vs behavioural checklist first) with NSSI status (‘NSSI history’, ‘no history of NSSI’, and ‘NSSI thoughts) for the single-item assessment and the behavioural-checklist assessment. If behavioural checklist prompt better memory recall than do single-items, then we should see a relationship between assessment order and prevalence on the single-item (where prevalence is higher when the single-item is presented second), but no such relationship for prevalence when measured with a behavioural checklist. If we find a memory effect (as described above), then for the analyses reported below we will exclude participants who completed the behavioural checklist first (i.e., only use the half of the sample that completed the single-item followed by these behavioural checklist). If we do not find a memory effect, we will use the entire sample. Prediction 3: We will conduct a Pearson Chi-Square statistical test comparing Attention (Inattentive vs Attentive) with Assessment discrepancy (Change vs Stable). If assessment discrepancy is in part due to poor attention, then we should see a relationship between attention and discrepancy whereby participants who fail the attention check are more likely to report different responses across the two assessments. Prediction 4: Men are more likely to report a discrepant NSSI history across the single-item and behavioural checklist than women. Prediction 5: Older participants are more likely to report a discrepant NSSI history across the single-item and behavioural checklist than younger participants. Prediction 6: NSSI recency will negatively predict discrepant responding across the single-item and behavioural checklist. We will test these predictions by conducting binomial logistic regression with age, gender, and NSSI recency of engagement in NSSI within the past year as the predictor variables and assessment change (verses stability) as the dependent variable. If the overall model is significant, then the significant predictor variables will be statistically controlled for

in the remaining analyses. Prediction 7. Anxiety, depression, and stress symptoms will negatively predict discrepant responding across the single-item and behavioural checklist. We will test this prediction by conducting binomial logistic regression with anxiety, depression, and stress symptoms as the predictor variables and assessment change (verses stability) as the dependent variable.

Any secondary analyses?

We will conduct an exploratory binomial logistic regression to examine whether engagement in specific methods of NSSI reported on the behavioural checklist are associated with change (versus stability) across assessment methods. We will also conduct exploratory analyses of the subset of the sample who report engaging in one or more NSSI behaviours on the behavioural checklist but no history of NSSI on the single-item, to test whether age, gender, NSSI recency, NSSI identity, anxiety, depression, and stress predict this specific type of discrepancy across NSSI assessments. We will conduct an exploratory analysis to assess whether strength of agreement with the statement "I feel I have a lot in common with people who self-injure" predicts discrepancy in responding. If more than 100 participants also took part in Study One (conducted a year earlier) then we will also conduct exploratory analyses testing how reliably people report discrepant NSSI histories.

How many observations will be collected or what will determine sample size? No need to justify decision, but be precise about exactly how the number will be determined.

All students enrolled in an introductory psychology class (approx. n = 950) will be invited to take part in the experiment as part of a broader online set of questionnaires. Participants will take part in exchange for course credit.

Anything else you would like to pre-register? (e.g., data exclusions, variables collected for exploratory purposes, unusual analyses planned?)

Data exclusions: Data from participants who complete the survey several times (identified by student ID) will be visually inspected. The most complete survey response for each will be retained, excepting when the questionnaires assessing NSSI have been answered in which case the earliest of the responses will be taken. Participants who had taken part in Study One (conducted a year earlier) will be identified by student ID number and excluded from analysis (although see the exploratory analysis discussed above). Participants who indicate a history of NSSI also complete a measure of the functions their NSSI serves (ISAS; Klonsky & Glenn, 2009) and will be asked to indicate how many times they have engaged in NSSI in the

last year, and the number of days they have engaged NSSI in the last year. These variables were assessed in order to better describe the makeup of the NSSI sample and may be used in exploratory analyses. At the end of the experiment, all participants also complete six items assessing their experience during the experiment. Participants are asked to indicate the extent to which taking part in the experiment was interesting, distressing, confusing, boring, important, and unethical on a five-point scale ranging from '1- Strongly Disagree' to '5 – Strongly Agree'. These variables may be used in exploratory analyses.

Appendix C

Deliberate Self-Harm Inventory

(DSHI-s; Lundh et al., 2007)

Have you EVER deliberately (but without wanting to kill yourself) …

Response options:

0 = I've never thought about doing this

1 = I've thought about doing this, but have never done it

2 = I've done this once

3 = I've done this a few times

4 = I've done this many times

1. … cut your wrist, arms, or other areas of your body?
2. … burned yourself with a cigarette, lighter or match?
3. … carved words, pictures, designs or other marks into your skin (not including tattoos or tā moko)?
4. … severely scratched yourself, to the extent that scarring, or bleeding occurred?
5. … bitten yourself, to the extent that you broke the skin?
6. … rubbed sandpaper on your body?
7. … dripped acid onto your skin?
8. … used bleach, or oven cleaner to scrub your skin?
9. … stuck sharp objects such as needles, pins, staples, etc. into your skin (not including tattoos or tā moko, ear or body piercing, or needles for drug use)?
10. … rubbed glass into your skin?
11. … broken your own bones?
12. … punched yourself, or banged your head against something, to the extent that caused a bruise to appear?
13. … prevented wounds from healing?

Note. Items 3 and 9 were modified to explicitly exclude tā moko, the body and face marking that is part of Māori culture.

Appendix D

Study 1b NSSI identity analysis

In Study 1b, all participants also completed the item *"I feel I have a lot in common with other people who hurt themselves"*, responding on a 7-point Likert scale ranging from *'1 – Strongly disagree'* to *'7 – Strongly Agree'.* This item created by modifying the item *"I feel I have a lot in common with other members of my ethnic group"* from the York Ethnic Identification Scale (Cameron et al., 1997) which indexes ingroup ties. This item was included for exploratory analysis in order to assess whether greater identification with a 'self-injury group' was associated with greater consistency across both assessments.

Responses to this item were non-normally distributed (*Skew* = 0.77, *Kurtosis* = -0.37), an on average participants responding with disagreement (*Mean* = 2.57, *Median* = 2). A Mann-Whitney test indicated that participants who did not report engaging in NSSI on either the behavioural checklist or the single-item reported less NSSI identity (*Mean Rank* = 286.87) than did participants who reported a history of NSSI on one or both assessments (*Mean Rank* = 395.95), $U = 38932.50$, $p < .001$, $\eta^2 = .06$. In order to test whether identification with 'a self-injury group' was uniquely associated with change (versus stability) across NSSI assessment methods, we conducted a hierarchical logistic regression with gender and NSSI past-year frequency entered into the first step of the model, followed by responses to the self-injury identification item. The second step of the model was not statistically significant ($\chi^2(1) < 0.01$, $p = .967$; Nagelkerke $R^2 = .12$), and inspection of the identification variable found no evidence that it was associated with assessment discrepancy ($b < -.01$, $p = .967$, $SE = .06$, OR = 1.00, 95% CI [0.88,1.13]).

Appendix E

Study 2 preregistration

Title:

Physiological and subjective response to acute emotional challenge in young people who self-injure.

Contributors:

Kealagh Robinson and Marc S Wilson

Registration type:

Prereg Challenge

Date registered:

September 11, 2018

Registered from:

osf.io/px534

Citation:

osf.io/5vbu4

Research Questions

Non-suicidal self-injury (NSSI) refers to the intentional and self-inflicted destruction of body tissue without suicidal intent (commonly, cutting or scratching the skin; Whitlock et al., 2011). Compared to people with no history of NSSI (Controls), people who engage in NSSI consistently report greater global emotion reactivity and emotion dysregulation (e.g., Eichen et al., 2015; Nock et al., 2008), and difficulty using cognitive reappraisal strategies (e.g., Martin et al., 2011). Together with longitudinal evidence (Fox et al., 2015, Robinson et al., 2018), this suggests that people who self-injure have abnormalities in the emotional response and regulation of that response. However, these conclusions are based on retrospective evaluations of emotional experience (i.e., self-report survey designs) which contain likely bias in appraisal and reporting of the phenomena. Preliminary evidence for a group difference during experimental manipulations of emotional challenge are mixed (see for example, Nock & Mendes, 2008; Tatnell et al., 2018). This experiment compares the emotional response and

recovery, assessed with both subjective and physiological measures, of people with and without a history of NSSI to an acute laboratory stressor.

Q1. Do people who self-injure have a greater emotional response to an emotional challenge than people without a history of NSSI?

Q2. Are people who self-injure less effective at recovering from an emotional challenge than people without a history of NSSI?

Q3. Do people who self-injure later remember their emotional response to be more intense than people without a history of NSSI?

Hypotheses

Manipulation Check: The stress induction task is effective in inducing negative mood.

Prediction: A main effect of test phase on heart rate, electrodermal activity, and subjective negative mood, with responses greater in the Stress Induction phase than both Baseline and Recovery phases, and greater during the Recovery phase than the Baseline phase.

Q1. Do people who self-injure show a greater emotional response to an acute laboratory stressor than people without a history of NSSI?

Generation Hypothesis: During an emotional challenge, people who self-injure physiologically generate (as indexed by heart rate and electrodermal response) and experience (as indexed by subjective negative mood) a more intense emotional response than compared to controls.

Generation Prediction: An interaction between Group and Test Phase whereby the NSSI group will show a greater increase in heart rate, electrodermal activity, and subjective mood from Baseline to Stress Induction than do controls.

Interpretation Hypothesis: During an emotional challenge, people who self-injure interpret a similar physiological response as more intense than do than people who do not self-injure).

Interpretation Prediction: An interaction between Group and Test Phase whereby the NSSI group will show a greater increase in subjective negative mood from Baseline to Stress Induction than do controls, but no such interaction in heart rate or electrodermal activity.

Q2: Are people who self-injure less effective at recovering from an emotional challenge than people without a history of NSSI?

Hypothesis: People who self-injure have a more sustained emotional response following emotional challenge than do controls.

Prediction: A Group by Test Phase interaction whereby the NSSI group shows less of a reduction in subjective negative mood, heart rate, and electrodermal response from the Stress

Induction to Resting phase than do the Control group. Hypothesis: During and following an emotional challenge, people who self-injure spontaneously engage in less effective emotion regulation strategies.

Prediction: A main effect of Test Phase whereby participants report engaging in more spontaneous emotion regulation during the Recovery than the Stress Induction phase. An interaction of Group by Emotion Regulation, whereby the NSSI group report using less Reappraisal and more Suppression than the Control group.

Q3. Do people who self-injure later remember their emotional response to be more intense than people without a history of NSSI?

Manipulation Check: Participants should remember how they felt during the Stress Induction and Recovery phases when asked two weeks later.

Prediction: Subjective negative mood reported during stress induction phase (Lab Stress Report) shows a positive correlation with later memory of this mood (Remembered Stress Report).

Prediction: Subjective negative mood reported during recovery phase (Lab Recovery Mood) shows a positive correlation with later memory of this mood (Remembered Recovery Mood).

Hypothesis: People who self-injure remember emotional challenges as more intense than controls.

Prediction: A main effect of Time such that participants rating of negative mood reported immediately after emotional challenge (During Session) as higher compared to their negative mood they report remembering Post Session two weeks later (i.e., fading affect bias). A Group by Time by Test Phase interaction, whereby the NSSI group show less of a reduction in negative mood from During Session to Post-Session (i.e., reduced fading affect bias) than do controls for the Stress Induction and Recovery test phases, but no difference for the Baseline phase.

Sampling Plan

Existing Data: Registration prior to analysis of the data

Explanation of existing data

Data from 37 participants have been run to allow sufficient time for data collection while participants are available. None of this data has been examined or analysed except for the first 13 participants, to ensure that all data was logging correctly, and that physiological recordings had sufficient signal to noise ratio to allow for analysis.

Data collection procedures

Participants will be recruited from a participant pool of university students enrolled in a first-year psychology course. All potential participants will complete a screening survey at the beginning of the university trimester assessing their eligibility to take part in the experimental session. Participants who meet the criteria for inclusion in the study will then be invited to take part in an hour-long laboratory study and will take part in exchange for course credit. Participants will be invited to take part in a follow-up online survey two weeks after their lab participation. Participants who complete the post-session survey will go in the draw to win one of five double movie vouchers. Participants will be topic blind prior to the lab session, in that they will not know that the study was assessing self-injury or emotional challenge. All participants will be aged 18-25 years old, identify as a woman, are fluent in English, are able to use a computer mouse and keyboard, with normal (or corrected to normal) eyesight and who consent to take part in self-injury related research. Participants recruited to the Control group will indicate during screening that they have never engaged (or thought about engaging) in 13 common NSSI behaviours (assessed via the DSHI-s; Lundh et al., 2007). Participants recruited to the NSSI group will indicate engaging in one or more common NSSI behaviours (as per the DSHI-s), report that their self-injury serves an affect regulation function (assessed via the ISAS; Klonsky & Glenn, 2009), and have engaged in an episode of NSSI within the last year. Both the experimenter and confederate will be blind to participant's group status during data collection. Data collection is expected to take several months. The study is approved by the School of Psychology Human Ethics Committee, by delegated authority of the Victoria University of Wellington Human Ethics Committee.
No files selected

Sample size

n = 50 per group (100 total). Participants who are excluded (see Data Exclusion) will be replaced.

Sample size rationale

Within the Trimester Two 2018 participant pool, 84 students are eligible to be recruited to the Control group and 108 eligible to be recruited to the NSSI group. Therefore 50 per group is achievable within the constraints of the semester. This yields the ability to detect an effect size of .10 with 80% power (using G*Power 3: Faul et al., 2007).

Stopping rule

If a participant is removed (see Exclusion Criteria) then they will be replaced. Data will be collected until there are 50 participants in each group. If less than 50 participants are recruited during the data collection window (Trimester Two 2018), students who during screening indicated that they were willing to be invited to take part in self-injury research will be approached to participate (excluding those who have already participated). Alternatively, additional participants will be recruited during Trimester One of 2019.

Variables

Manipulated variables

Group: 2 levels (NSSI and Control); between-subjects Test

Phase: 3 levels (Baseline, Stress Induction, and Recovery); within-subjects.

Time: 2 levels (Lab-Session and Follow-Up); within-subjects Participants with and without a history of NSSI will be recruited to the study as per the inclusion criteria above.

All participants with complete a five-minute baseline 'vanilla' counting task. They will then complete the math test component of the Trier Social Stress Test (Kirschbaum et al., 1993). Finally, they will complete a recovery period where they will rest quietly. Participants who consent to the follow-up survey will report their experience of the lab session two weeks after taking part.

No files selected

Measured variables

NSSI status will be assessed during screening by the simplified Deliberate Self-Harm Inventory (DSHI-s; Lundh et al., 2007). Potential participants who indicated a lifetime history of NSSI will also complete the Inventory of Statements about Self-Injury (ISAS; Klonsky & Glenn, 2009) in order to assess the functions of their self-injury, and asked to report how many times in the last year they have engaged in NSSI, and on how many days in the last year have they engaged in NSSI.

Heart rate will be measured using electrocardiogram (ECG), which tracks depolarisation of the heart muscle. ECG will be recorded using three disposable adhesive Ag-AgCl foam ECG electrodes (Kendall Meditrace, Tyco Healthcare). A Lead II system will be used with electrodes positioned on the right side of the chest (negative) and left ribcage (positive), referenced to a ground electrode on the left side of the chest. The two chest electrodes will be positioned below the clavicle and medially adjacent to the coracoid process. The rib electrode will be positioned directly below the left chest electrode, below the left ribcage.

Electrodermal activity will be recorded using ADInstruments MLT116F GSR electrodes attached to the medial phalanges of the index and ring fingers of the right hand. Electrodermal activity will be sampled at 1000 Hz and amplified using a GSR Amp (ML116; AD Instruments, Australia) and ECG will be sampled at 1000 Hz amplified using an ADInstruments ML408 Dual Bio Amp/Stimulator. Analogue signals will be converted to digital via a PowerLab 16/30 Amplifier (ML880; ADInstruments, Australia). Digitized signals will be recorded by LabChart Pro 8.1 software (ADInstruments, Australia) on a Dell Optiplex 9020 computer, running Windows 7 Enterprise operating system. The experimenter will enter triggers in to the LabChart recording to mark the beginning and end of the experimental phases.

Subjective negative mood will be measured using a visual analogue scale ranging from 0 to 100, with the anchor points set at 'Not at All' and 'Extremely'. Participants will be given a list of 9 different feeling labels (happy, sad, angry, anxious, stressed, jittery, frustrated, embarrassed, and ashamed) and instructed to rate the degree to which they feel each in the present moment. During the laboratory session, participants will complete the visual analogue scale five times: after providing informed consent, after the baseline task, after the stress induction, after the recovery task, and after the mood elevation task. As part of the post-session survey, participants will complete the visual analogue scale four times. The first-time participants will report how they feel in the present moment. The second, third and fourth time the instruction will be modified to "During the first task (counting blue rectangles of the IPRP study), I felt…", "During the math test of the IPRP study, I felt…" and "During the resting task of the IPRP study, I felt…" Participants will also be asked to rate the extent to which the following statements applied to them (both after the Stress Induction phase, and as part of the post-session survey): 'The counting task was stressful for me', 'The counting task was challenging'. These statements will be presented on a 17.8 cm visual analogue scale presented on the computer screen and ranging from 0 to 100, with the anchor points set at 'Not at all' and 'Extremely'.

Spontaneous use of cognitive reappraisal and expressive suppression emotion regulation strategies during the stress induction and resting phases will be assessed using a modified version of the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003). This scale will be presented twice (during the survey following the experimental tasks) and the instructions modified to 'During the math test…' and 'During the resting task…' (for other research that uses a modification of the situational framing of the ERQ see Ford, Feinberg, et al., 2018).

Participants respond to items such as ‘I controlled my emotions by not expressing them’ on a scale from 1- ‘Strongly Disagree’ to 7- ‘Strongly Agree’.

Participants will also complete questionnaire measures of trait emotional experience; the Emotion Reactivity Scale, the Difficulties in Emotion Regulation Scale, and the Implicit Theories of Emotion Scale. These will be administered (i) to replicate the large differences in trait emotional experience between NSSI and Control groups previously demonstrated, (ii) to conduct exploratory analyses assessing how these trait emotional experiences predict physiological and subjective responding to an emotional challenge. Participants will also complete the Depression, Anxiety and Stress Scale.

During the post-session survey participants will be asked to report the extent to which taking part in the laboratory-session was interesting, distressing, boring, important, unethical, and enjoyable on a five-point scale ranging from ‘1-Strongly Disagree’ to ‘5- Strongly Agree’. Participants will be asked ‘Is there anything else you think we should know about your experience in the IPRP study or should think about?’ and provided with an open text box to write their response.

No files selected

Indices

Subjective negative mood: happiness ratings will be reverse-coded, and then the mean response to each of the nine moods created.

Psychophysiology data: Heart rate and electrodermal activity will be averaged across the 4.5 minute Baseline, Stress Induction, and Recovery Phases for each participant. If the electrodermal data shows no skew or kurtosis then raw averages will be used analyses. If the data shows skew or kurtosis, then we will use log-transformed data for analysis (see Braithwaite et al., 2015). Hypothesis tests will be conducted with heart rate, eletrodermal activity, and subjective negative mood averages.

Exploratory analyses will create an index of Situational Reactivity (Stress Induction average – Baseline average) and Situational Recovery (Recovery average – Stress Induction average) for heart rate, electrodermal activity and subjective negative mood.

Spontaneous Emotion Regulation: Six items assessing cognitive reappraisal will be averaged to create a reappraisal score, and the four items assessing expressive suppression averaged to create a suppression score.

Trait emotional experience: The Emotion Reactivity Scale (ERS): items totalled to create an index of trait emotion reactivity. Difficulties in Emotion Regulation Scale (DERS-16): item

scores are totalled to give six subscale scores (Non-Acceptance of Emotional Responses, Difficulties Engaging in Goal Directed Behaviour, Impulse Control Difficulties, Lack of Emotional Awareness, Limited Access to Emotion Regulation Strategies, and Emotional Clarity) and an overall score of emotion dysregulation. Implicit Theories of Emotion Scale (ITES): Two contrait items will be reverse-coded (for example, 'Everyone can learn to control their feelings') before item scores averaged.
The Depression, Anxiety and Stress Scale (DASS-21): All seven items in each subscale (Depression, Anxiety, and Stress) totalled and then doubled, with higher scores indicating greater depression, anxiety, and stress.
No files selected

Design Plan

Study type: Experiment - A researcher randomly assigns treatments to study subjects, this includes field or lab experiments. This is also known as an intervention experiment and includes randomized controlled trials.

Blinding: Research personnel who interact directly with the study subjects (either human or non-human subjects) will not be aware of the assigned treatments.

Study design

This experiment is mixed design with self-injury status (NSSI, Control) as the between-subjects variable, test phase (Baseline, Stress Induction, Recovery) and time (Lab-Session, Post-Session) as within-subjects variables. No counterbalancing is required.
No files selected

Randomization

N/A

Analysis Plan

Statistical models

H1: Generation vs Interpretation Generation Hypothesis: During an emotional challenge, people who self-injure physiologically generate (as indexed by heart rate and electrodermal response) and experience (as indexed by subjective negative mood) a more intense emotional response when compared to controls.

Interpretation Hypothesis: During an emotional challenge, people who self-injure interpret a similar physiological response as more intense than do than people who do not self-injure).

We will conduct 3 separate mixed-model ANOVAs with Group (NSSI, Control) as the within-subjects factor and Test Phase (Baseline, Stress Induction) on heart rate, electrodermal response, and subjective negative mood. Generation Prediction: An interaction between Group and Test Phase whereby the NSSI group will show a greater increase in heart rate, electrodermal activity, and subjective mood from Baseline to Stress Induction than do controls. Interpretation Prediction: An interaction between Group and Test Phase whereby the NSSI group will show a greater increase in subjective negative mood from Baseline to Stress Induction than do controls, but no such interaction for heart rate or electrodermal activity. Note, we will not directly compare the physiological and subjective measures (i.e., include measure as a within-subject variable and assess its interaction with other variables) as these measures are so different as to make a within-subject variable inappropriate.

H2. People who self-injure have a more sustained emotional response following emotional challenge than do controls.

a. We will conduct 3 separate mixed-model ANCOVAs with Group (NSSI, Control) as the between-subjects factor, Test Phase (Stress Induction, Recovery) as the within-subjects factors, controlling for Baseline response on heart rate, electrodermal response, and subjective negative mood. Prediction: A Group by Test Phase interaction whereby the NSSI group shows less of a reduction in subjective negative mood, heart rate, and electrodermal response from the Stress Induction to Resting phase than do the Control group.
b. To test for group differences in spontaneous emotion regulation use, we will conduct two mixed-model ANOVAs with Group (NSSI, Controls) as the between-subjects variable, and Test Phase (Stress Induction, Recovery) and Emotion Regulation (Cognitive Reappraisal and Expressive Suppression) as the within-subjects variables on emotion regulation scores.

Prediction: A main effect of Test Phase whereby participants report engaging in more spontaneous emotion regulation during the Recovery than the Stress Induction phase. An interaction of Group by Emotion Regulation, whereby the NSSI group report using less Cognitive Reappraisal and more Expressive Suppression than the Control group.

H3. People who self-injure remember emotional challenges to be more intense than controls.

We will conduct a mixed-model ANOVA with Group (NSSI, Control) as the between-subjects variable, and Test Phase (Recovery, Stress Induction, Recovery) and Time (During Session, Post-Session) as the within-subjects variable.

Prediction: A main effect of Test Phase on reported negative mood (see H1 and H2 predictions detailed above). A main effect of Time such that participants rating of negative mood reported immediately after emotional challenge (During Session) as higher compared to the negative mood they report remembering Post Session two weeks later (i.e., fading affect bias). A Group by Time by Test Phase interaction, whereby the NSSI group show less of a reduction in negative mood from During Session to Post-Session (i.e., reduced fading affect bias) than do controls for the Stress Induction and Recovery test phases, but no difference for the Baseline phase.

No files selected

Transformations

Questionnaires: Internal consistency (Chronbach's alpha) will be calculated for each scale (except for the spontaneous use of appraisal and suppression, depression, anxiety, stress, interpersonal function, and intrapersonal functions, where alphas will be calculated for each subscale). Chronbach's alpha of .70 or higher will be deemed acceptable. Scale item(s) will be excluded if the alpha is below acceptability and the exclusion of the item(s) improves the internal consistency by more than .05.

Psychophysiology: ECG data will be filtered offline using LabChart version 8 (ADInstruments, 2014), with a band-pass filter of 8-40 Hz to remove, slow movement related artifacts. R-wave spikes will be identified as peaks more than two standard deviations above mean activity. Heart rate will be calculated using the inter-beat interval (the time between R-wave spikes) and then converted to number of beats per minute.Electrodermal activity will be converted from volts to micro-Siemens (μS) offline (1 V = 20 μS) and smoothed at 999 samples per second using a median filter. If the electrodermal data shows no skew or kurtosis then raw averages will be used for analyses. If the data shows skew or kurtosis, then we will use log-transformed data for analysis (see Braithwaite et al., 2015). Data recorded during the first 30 seconds of each of the three phases will be excluded in order to allow the participant to habituate to the experience of the task and to allow the experimenter to exit the recording room. Artifacts will be identified by two experimenters visually inspecting the ECG and electrodermal activity channels independently and any disagreements resolved.

Follow-up analyses

See Statistical Models section above.

Inference criteria

P values less than .05 will be accepted as statistically significant and relevant follow-up analyses will be conducted on these effects. Trends (less than .10) will be followed up if they are predicted. One or two tailed tests are specified in the predictions (Statistical Models, above). Planned comparisons will not be corrected for multiple comparisons (see Armstrong, 2014). Exploratory analyses (e.g. correlations between psychophysiology measures and questionnaire measures) for hypothesis generating will not be corrected for multiple comparisons, but will be interpreted with caution. If they are reported in the manuscript, the number of tests conducted will also be reported.

Data exclusion

Participants will be excluded from analyses using psychophysiology variables if: (i) they do not complete the baseline, stress induction, or recovery phases of the experiment; (ii) due to failures or experimenter error in the recording equipment, or (iii) if they report something, or are observed by the experimenter to being doing something which may compromise the integrity of the data (e.g., that they were using their cell phone during the baseline phase). These exclusions will occur prior to analysis of data. Participants who respond to the post-session survey more than 7 days following invitation (i.e., 3 weeks following the lab session) will be excluded from analysis which use post-session variables. Participants who do not complete a questionnaire will be excluded from analyses using that variable.

Missing data

Missing heart rate and electrodermal response will not be imputed.

Questionnaire data and subjective mood resport: We will test the missingness of questionnaire data using Little's missing completely at random (MCAR) test. If the questionnaire data is MCAR, or if the proportion of missing data is likely to be inconsequential (Schafer 1999), we will impute missing data using estimation maximization (EM) algorithm with 50 iterations. However, given that the DSHI-s operates more as a check-list of behaviours, missing data on the DSHI-s will be replaced with zeros (i.e., the absence of that behaviour) rather than using estimation maximization.

Post-Session survey: In our previous experience, approximately 75% of participants consent to be added to our community participant database. Therefore, if less than 50% of participants

consent to be invited to the post-session survey, or if less than 50% of these participants go on to complete the post-session survey within a week we will consider the analyses based on these variables to be underpowered and exploratory. Participants who do not complete the follow-up survey, or take longer than one week to do so, will be excluded from longitudinal analyses.

Exploratory analysis

Functional data analysis will be conducted with both the phasic heart rate and electrodermal activity over time across Baseline, Stress Induction, and Recovery phases. This is a data driven approach that allows us to identify precisely if and when there is a significant group difference during each phase of the experiment. Groups will be compared with a functional t-test at each time point and will be corrected using a false discovery rate (FDR). Our hypotheses for these analyses are as above—the analysis simply provides a higher resolution measurement of electrodermal and cardiac activity over time than our primary method, which averages electrodermal and cardiac activity across each 4.5-minute phase of the experiment.

We will conduct a logistic regression predicting group membership (NSSI, Control) by trait emotion questionnaires (DERS, ERS, DASS, ITES), situational reactivity and recovery in heart rate, electrodermal activity and subjective negative mood.

Shame is theorised to be a central emotion in NSSI (Lynch & Cozza, 2009) and previous experimental work has found greater shame reactivity in Borderline Personality Disorder outpatients compared to controls (Gratz et al., 2010). Thus, we may expect the NSSI group to show greater shame reactivity than controls, relative to other moods. We will conduct a 3 (Test Phase: Baseline vs Stress Induction vs Recovery) x 2 (Group: NSSI vs Control) x 9 (Mood: Unhappiness vs Sadness vs Anger vs Anxiety vs Stress vs Jitteriness vs Frustration vs Embarrassment vs Shame) ANOVA. If a significant Group by Test Phase by Mood interaction is found, then follow-up post hoc analyses will be conducted. Nine 2 (Group: NSSI vs Control) X 2 (Test Phase: Baseline vs Stress Induction) ANOVAs will be conducted with the negative mood ratings (Unhappiness, Sadness, Anger, Anxiety, Stress, Jitteriness, Frustration, Embarrassment, and Shame) to assess reactivity. Nine 2 (Group: NSSI vs Control) X 2 (Test Phase: Stress Induction vs Recovery) ANCOVAs will be conducted controlling for Baseline mood with the negative mood ratings (Unhappiness, Sadness, Anger, Anxiety, Stress, Jitteriness, Frustration, Embarrassment, and Shame) in order to assess recovery. Follow-up comparisons will be subjected to a Bonferroni correction.

Trait emotion questionnaires (Emotion Reactivity Scale, Difficulties in Emotion Dysregulation) will be correlated with physiological reactivity changes and physiological recovery indices for subjective negative mood, heart rate, and electrodermal activity. If retrospective evaluations and situational indices of reactivity and regulation assess the same underlying psychological construct, then they should be positively correlated with one another.

Participants' Experience of the Study: We are interested in the absolute level of endorsement in the extent to which participants experience the laboratory-session as interesting, distressing, boring, important, unethical, and enjoyable. We are interested in the potential Group (NSSI vs Controls) differences in experience. We will test this using independent t-tests comparing Group on each rating with Bonferroni corrections. Drawing from previous qualitative research (Hasking et al., 2015), we expect participants to report enjoying taking part on the laboratory-session and finding it to be interesting, and important. We predict group differences such that the NSSI group will find the laboratory-session more distressing and more important than controls. Open text responses to the question 'Is there anything else you think we should know about your experience in the IPRP study or should think about?' will be analysed using thematic analysis. We make no pre-registered predictions about the results of thematic analysis of the open text responses.

Appendix F

Inventory of Statements About Self-Injury

(ISAS; Klonsky & Glenn, 2009)

This inventory was written to help us better understand the experience of non-suicidal self-harm. Below is a list of statements that may or may not be relevant to your experience of self-harm. Please identify the statements that are most relevant for you:

Response Options:

1 = Not relevant
2 = Somewhat relevant
3 = Very relevant

When I self-harm, I am …

1. … calming myself down.
2. … creating a boundary between myself and others.
3. … punishing myself.
4. … giving myself a way to care for myself (by attending to the wound).
5. … causing pain so I will stop feeling numb.
6. … avoiding the impulse to attempt suicide.
7. … doing something to generate excitement or exhilaration.
8. … bonding with peers.
9. … letting others know the extent of my emotional pain.
10. … seeing if I can stand the pain.
11. … creating a physical sign that I feel awful.
12. … getting back at someone.
13. … ensuring that I am self-sufficient.
14. … releasing emotional pressure that has built up inside of me.
15. … demonstrating that I am separate from other people.
16. … expressing anger towards myself for being worthless or stupid.
17. …creating a physical injury that is easier to care for than my emotional distress.
18. … trying to feel something (as opposed to nothing) even if it is physical pain.
19. … responding to suicidal thoughts without actually attempting suicide.

20. … entertaining myself or others by doing something extreme.
21. … fitting in with others.
22. … seeking care or help from others.
23. … demonstrating I am tough or strong.
24. … proving to myself that my emotional pain is real.
25. … getting revenge against others.
26. … demonstrating that I do not need to rely on others for help.
27. … reducing anxiety, frustration, anger, or other overwhelming emotions.
28. … establishing a barrier between myself and others.
29. … reacting to feeling unhappy with myself or disgusted with myself.
30. … allowing myself to focus on treating the injury, which can be gratifying or satisfying.
31. … making sure I am still alive when I don't feel real.
32. … putting a stop to suicidal thoughts.
33. … pushing my limits in a manner akin to skydiving or other extreme activities.
34. … creating a sign of friendship or kinship with friends or loved ones.
35. … keeping a loved one from leaving or abandoning me.
36. … proving I can take the physical pain.
37. … signifying the emotional distress I'm experiencing.
38. … trying to hurt someone close to me.
39. … establishing that I am autonomous/independent.

Affect Regulation: 1, 14, 27

Interpersonal Boundaries: 2, 15, 28

Self-Punishment: 3, 16, 29

Self-Care: 4, 17, 30

Anti-Dissociation/Feeling-Generation: 5, 18, 31

Anti-Suicide: 6, 19, 32

Sensation-Seeking: 7, 20, 33

Peer-Bonding: 8, 21, 34

Interpersonal Influence: 9, 22, 35

Toughness: 10, 23, 36

Marking Distress: 11, 24, 37

Revenge: 12, 25, 38

Autonomy: 13, 26, 39

Intrapersonal Functions subscale comprised of Affect Regulation, Self-Punishment, Anti-Dissociation/Feeling-Generation, Anti-Suicide, and Marking Distress.

Interpersonal Functions subscale comprised of Interpersonal Boundaries, Self-Care, Sensation-Seeking, Peer-Bonding, Interpersonal Influence, Toughness, Revenge, and Autonomy.

Appendix G

Study 2 stress induction protocol

Experimenter (Robinson):

1. Ask the participant how they found the first task, and if they are happy to continue on to the second task. If NO, end recordings, validate their decision, and skip to the Debriefing Section of the procedure. If YES, continue.
2. Tell the participant that the second task is to complete a mental arithmetic task to gauge their working memory ability.
3. Tell them that an evaluator will now come in to run them through the task***. "This evaluator is a psychologist who is specially trained in analysing verbal and nonverbal behaviour".*** Remind the participant to sit as still as possible. Exit the room.

Confederate (Research Assistant):

4. Enter the room wearing a white lab coat, with your clipboard, notepaper with correct answers, pen and stopwatch. Sit down on a chair opposite the participant.
5. Maintain a neutral, professional demeanour (i.e., no small talk). You should be more serious/cold than causal or friendly. Say: ***"You will now complete a test of working memory and verbal intelligence. You are required to count backwards from 2023 in set of 17. You must count aloud. It is important that you count as quickly as possible without making any errors. Your performance will be timed and if you make a mistake, you will have to restart. Start counting now."*** Press [F3] to send the 'Start Task' comment.
6. Start your stopwatch and look intently at the participant, tick off each number as they say it. If they make a mistake, say ***"Stop. That was an error. Start again from 2023."*** Make a point of stopping and restarting the stopwatch, noting the timing and that a restart was made on your clipboard. (In reality, you are just stopping the stopwatch and not restarting, so that you can keep track of how much time has passed).
7. While they are counting, appear to be making notes about performance, particularly when they appear to struggle. Roughly once per minute, tell the participant **"*You need to count faster".***
8. After 5 minutes is up, tell the participant ***"Stop counting now".*** Press [F4] to send the 'End Task' comment. Exit the room.

Experimenter (Robinson):

1. Experimenter enters. Ask the participant how they if they are happy to continue on to the mood ratings. If NO, end recordings, validate their decision, and skip to the Debriefing Section of the procedure. If YES, continue.

Direct the participant to a computer where they can the next mood report (leave the door slightly ajar so that you can see when they've finished).

Appendix H

The Emotion Reactivity Scale

(ERS; Nock et al., 2008)

This questionnaire asks different questions about how you experience emotions on a regular basis (for example, each day). When you are asked about being "emotional," this may refer to being angry, sad, excited, or some other emotion. Please rate the following statements.

Response options:

0 = Not at all like me

1 = A little like me

2 = Somewhat like me

3 = A lot like me

4 = Completely like me

1. When something happens that upsets me, it's all I can think about it for a long time.
2. My feelings get hurt easily.
3. When I experience emotions, I feel them very strongly/intensely.
4. When I'm emotionally upset, my whole body gets physically upset as well.
5. I tend to get very emotional very easily.
6. I experience emotions very strongly.
7. I often feel extremely anxious.
8. When I feel emotional, it's hard for me to imagine feeling any other way.
9. Even the littlest things make me emotional.
10. If I have a disagreement with someone, it takes a long time for me to get over it.
11. When I am angry/upset, it takes me much longer than most people to calm down.
12. I get angry at people very easily.
13. I am often bothered by things that other people don't react to.
14. I am easily agitated.
15. My emotions go from neutral to extreme in an instant.
16. When something bad happens, my mood changes very quickly. People tell me I have a very short fuse.
17. People tell me that my emotions are often too intense for the situation.
18. I am a very sensitive person.

19. My moods are very strong and powerful.
20. I often get so upset it’s hard for me to think straight.
21. Other people tell me I'm overreacting.

Items are totalled to create an overall score of global emotion reactivity.

Appendix I

Difficulties in Emotion Regulation Scale

(DERS-16; Gratz & Roemer, 2004; Bjureberg et al., 2015)

The statements below relate to emotions. Please read each one and select an option that best represents how much each one applies to you.

Response options:

1 = Almost never (0-10%)

2 = Sometime (11-35%)

3 = About half the time (36-65%)

4 = Most of the time (66-90%)

5 = Almost always (91-100%)

1. I have difficulty making sense out of my feelings.
2. I am confused about how I feel.
3. When I'm upset, I have difficulty getting work done.
4. When I'm upset, I become out of control.
5. When I'm upset, I believe that I will remain that way for a long time.
6. When I'm upset, I believe that I'll end up feeling very depressed.
7. When I'm upset, I have difficulty focusing on other things.
8. When I'm upset, I feel out of control.
9. When I'm upset, I feel ashamed with myself for feeling that way.
10. When I'm upset, I feel like I am weak.
11. When I'm upset, I have difficulty controlling my behaviours.
12. When I'm upset, I believe that there is nothing I can do to make myself feel better.
13. When I'm upset, I become irritated with myself for feeling that way.
14. When I'm upset, I start to feel very bad about myself.
15. When I'm upset, I have difficulty thinking about anything else.
16. When I'm upset, my emotions feel overwhelming.

Nonacceptance of Emotional Responses subscale consists of items 9, 10, and 13.

Difficulties Engaging in Goal-Directed Behaviour subscale consists of items 3, 7, and 15.

Impulse Control Difficulties subscale consists of items 4, 8, and 11.

Limited Access to Effective Emotion Regulation Strategies subscale consists of items 5, 6, 12, 14, and 16.

Lack of Emotional Clarity subscale consists of items 1 and 2.

Appendix J

Emotion Regulation Questionnaire modified for Study 2

The next two sets of questions ask about questions about your emotional experience during the math test (the second task) and resting task (the third task) earlier in this study. In particular, we're interested in how you controlled (that is, regulate and manage) your emotions. The questions below involve two distinct aspects of your emotional life. One is your emotional experience, or what you feel like inside. The other is your emotional expression, or how you show your emotions in the way you talk, gesture, or behave. Although some of the following questions may seem similar to one another; they differ in important ways.

For each item, please answer using the following scale:
1 = Strongly disagree
2
3
4 = Neutral
5
6
7 = Strongly Agree

During the resting task…

1. … when I wanted to feel more positive emotion (such as joy or amusement), I changed what I was thinking about.
2. … I kept my emotions to myself.
3. … when I wanted to feel less negative emotion (such as sadness or anger), I changed what I was thinking about.
4. … when I was feeling positive emotions, I was careful not to express them.
5. … when I was faced with a stressful situation, I made myself think about it in a way that helped me stay calm.
6. … I controlled my emotions by not expressing them.
7. … when I wanted to feel more positive emotion, I changed the way I was thinking about the situation.

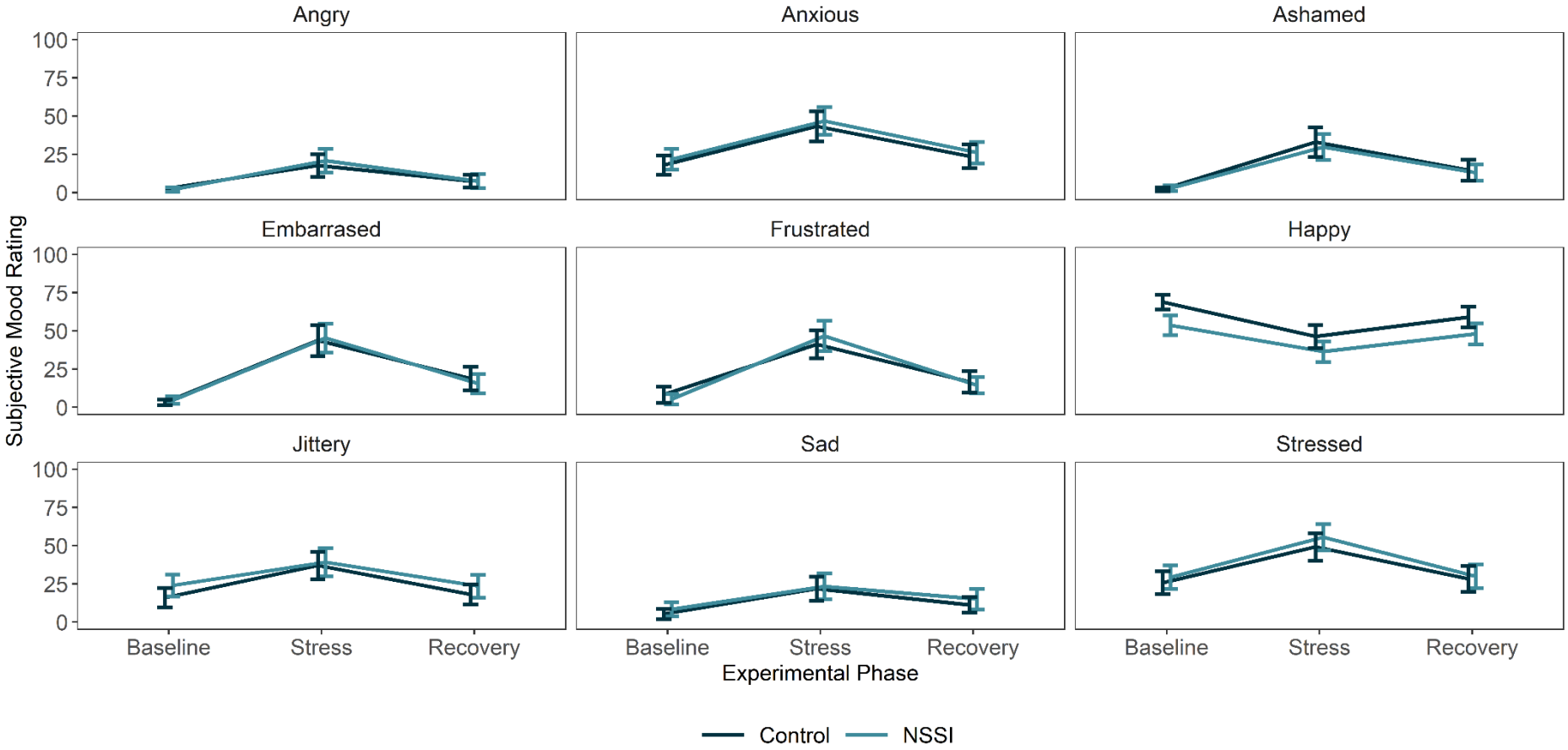
8. … I controlled my emotions by changing the way I thought about the situation I was in.
9. … when I was feeling negative emotions, I made sure not to express them.
10. … when I wanted to feel less negative emotion, I changed the way I was thinking about the situation.

The Cognitive Reappraisal subscale consists of items 1, 3, 5, 7, 8, and 10.

The Expressive Suppression subscale consists of items 2, 4, 6, and 9.

Appendix K

Change in discrete moods across laboratory session phases separated by non-suicidal self-injury status in Study 2.



Note. The NSSI × Time interactions across the nine discrete moods were all non-significant (*p*s range from .152 to .817).

Appendix L

Mixed-effects models predicting heart rate and electrodermal responding across the course of the laboratory session phases in Study 2

	Heart Rate (BPM)			Electrodermal Response (μS)		
	B	*t*	*p*	*B*	*t*	*p*
Linear effect of Time	70.56	30.33	< .001	0.87	35.21	< .001
Quadratic effect of Time	5295.00	-32.45	< .001	-0.01	-29.64	< .001
NSSI status	0.85	0.340	.734	-1.71	1.46	.148
Linear Time x NSSI status	0.06	0.94	.347	0.08	2.18	.023
Quadratic Time x NSSI status	< -0.01	-0.93	.356	< -0.01	-2.04	.041

Note. NSSI n = 51, Control n = 50. BPM = Beats Per Minute.

Appendix M

Study 3 preregistration

Title:

Subjective emotional response to social rejection in young women who self-injure

Contributors:

Kealagh Robinson

Registration type:

Preregistration Template from AsPredicted.org

Date registered:

July 28, 2020

Registered from:

osf.io/qxruh

Citation:

osf.io/cm2xy

Data collection

Have any data been collected for this study already? Note: 'Yes' is a discouraged answer for this preregistration form.

It's complicated. We have already collected some data but explain in Question 8 why readers may consider this a valid pre-registration nevertheless.

Hypothesis

Manipulation Check: The two social rejection tasks induce negative mood and reduced feelings of belonging.

Prediction: We predict a main effect of phase on subjective negative mood and feelings of belonging, such that participants report greater negative mood and less belonging following the rejection phase compared to the inclusion phase.

Q1. Do people who self-injure have a greater emotional response to social rejection than people without a history of NSSI?

Prediction A: An interaction between Group and Phase, such that, compared to people in the Control group, people in the NSSI group report a greater increase in subjective negative mood from Baseline to the Rejection phase (across Ambiguous and Unambiguous conditions).
Prediction B: An interaction between Group and Phase, such that, compared to people in the Control group, people in the NSSI group report a greater decrease in feelings of belonging from baseline to the rejection phase.
Q2: Do people who self-injure have a greater emotional response only to subtle social rejection than people without a history of NSSI?
Prediction A: An interaction between Group by Rejection by Ambiguity whereby the NSSI group show a greater increase in subjective negative mood from Baseline to Rejection than people in the Control group, in the Ambiguous Rejection Condition only.
Prediction B: An interaction between Group by Rejection by Ambiguity whereby the NSSI group show a greater decrease in feelings of belonging from Baseline to Rejection than people in the Control group, in the Ambiguous Rejection Condition only.

Dependent variable

Subjective negative mood: Measured using a visual analogue scale ranging from 0 to 100, with the anchor points set at 'Not at All' and 'Extremely'. Participants will be given a list of 11 different feeling labels: (angry, sad, ashamed, irritable, frustrated, anxious, alert, relaxed, interested, happy, and confident) and instructed to rate the degree to which they feel each in the present moment. During the study, participants will complete the visual analogue scale twice, once after the baseline inclusion game and once after the social rejection game. Alert, relaxed, interested, happy, and confident ratings will be reverse-coded, and then the mean response to each of the 11 moods will be created. Hypothesis tests will be conducted using subjective negative mood averages.
Feelings of belonging: Participants will be asked to respond to the three items: 'During the first ball-passing game, I felt poorly accepted by the other participants'; 'During the first ball-passing game, I felt as though I had made a "connection" or bonded with one or more of the participants'; and 'During the first ball-passing game, I felt like an outsider' using a visual analogue scale ranging from 0 to 100, with the anchor points set at 'Not at All' and 'Extremely'. These items have previously been used to assess how Cyberball games impact feelings of belonging (Zardo et al., 2004). During the study, participants will complete the belonging items twice; once after the baseline inclusion game and once after the social

rejection game. The items ‘During the first ball-passing game, I felt poorly accepted by the other participants’ and ‘During the first ball-passing game, I felt like an outsider’ will be reverse coded, and the mean response to the three items will be created.

Trait emotional experience: Participants will be invited to complete the Emotion Reactivity Scale (Nock et al., 2008), and the Difficulties in Emotion Regulation Scale (Gratz & Roemer, 2004). These measures will be administered to: (i) replicate the large differences in trait emotional experience between NSSI and Controls group previously demonstrated, and (ii) conduct exploratory analyses assessing how these trait emotional experiences predict subjective responding to an emotional challenge.

Attention checks: Participants will be asked to indicate the extent to which they gave the online study their full attention using the following four items: ‘During the questionnaires and picture viewing tasks, how often did you switch your attention to browse the internet?’; ‘During the questionnaires and picture viewing tasks, how often did you check your phone?’; ‘During the two ball passing games, how often did you switch your attention to browse the internet?’; ‘During the two ball passing games, how often did you check your phone?’ with the response options: ‘Never’, ‘1–2 times’, ‘3–5 times’, ‘6–9 times’, ‘10 times or more’. Participants will also be asked to respond to the two items: ‘In the first ball-passing game, what percentage of the time did the other players pass the ball to you?’ and ‘In the second ball-passing game, what percentage of the time did the other players pass the ball to you?’ with the response options: ‘1–10%’, ‘11–20%’, ‘21–30%’, ‘31–40%’, ‘41–50%’, ‘51–60%’, ‘61–70%’, ‘71–80%’, ‘81–90%’, ‘91–100%’. Deception checks: Participants will be asked to respond to the item “How confident are you that the other players in the two ball-passing games are other students in [psychology course]?” on a visual analogue scale ranging from 0 to 100, with the anchor points set at ‘Not at all confident’ and ‘Extremely confident’. Participants will be divided into those who believed that they were playing other students (reporting a confidence score of 50 or more) and those that did not (reporting a confidence score of 49 or less). Participants will also be asked to respond to the two open text items “In a few words, what do you think we are testing in this study? What is the hypothesis?” and “Is there any aspect of the study you think was a “trick” or that we mislead you about?”.

Conditions

How many and which conditions will participants be assigned to?

Social Rejection: 2 levels (Baseline, Exclusion), within-subjects.

Rejection Ambiguity: 2 levels (Unambiguous, Ambiguous), between-subjects

Recruited based on Self-Injury Status: 2 levels (NSSI and Control), between-subjects

Social Rejection: All participants will take part in two virtual ball-passing games (Cyberball: Williams & Jarvis, 2006) with three players (in reality, the participant and two programmed players). First, all participants will complete a baseline inclusion game, in which they receive the ball 13–14 times during 40 throw-long game (i.e., 22–35% of throws). For the second game, participants will be assigned to either the Unambiguous Social Rejection condition or an Ambiguous Social Rejection Condition.

Rejection Ambiguity: In the Unambiguous Social Rejection condition, participants receive the ball only once at the beginning of the 40 throw-long game (i.e., 2.5% of throws). In the Ambiguous Social Rejection condition, participants receive the ball 6 times over the course of the 40 throw-long game (i.e., 15% of throws). We pilot-tested three possible versions of the ambiguous social rejection condition (10%, 15%, and 23% of throws), and determined that the 6 throw condition was the most ambiguous level of exclusion (i.e., the condition with the most variability in change in subjective negative mood and belonging relative to the inclusion baseline).

Self-Injury Status: Participants with and without a history of NSSI will be recruited to the study. NSSI status will be assessed during screening by the simplified Deliberate Self-Harm Inventory (DSHI-s; Lundh et al., 2007). Potential participants who indicated a lifetime history of NSSI will also be invited to report how many times in the last year they have engaged in NSSI, and on how many days in the last year have they engaged in NSSI. Participants recruited to the Control group will indicate during screening that they have never engaged (or thought about engaging) in 13 common NSSI behaviours (assessed via the DSHI-s; Lundh et al., 2007). Participants recruited to the NSSI group will indicate engaging in one or more common NSSI behaviours (as per the DSHI-s), and report having engaged in NSSI at least once in the past year.

Analyses

H1: People who self-injure have a greater emotional response to social rejection than people without a history of NSSI. We will conduct a mixed ANOVA to investigate the effect of Group (NSSI, Control) and Rejection (Baseline, Stress Rejection) on subjective negative mood. Prediction: An interaction between Group and Social Rejection whereby the NSSI group will show a greater increase in subjective negative mood from Baseline to Social

Rejection than do controls. This analysis will then be repeated using feelings of belonging as the dependent variable. Prediction: An interaction between Group and Social Rejection whereby the NSSI group will show a greater decrease in feelings of belonging from Baseline to Social Rejection than do controls.

H2: People who self-injure have a similar emotional response to overt emotional challenges, but a greater emotional response to subtle emotional challenges than people without a history of NSSI. We will conduct a mixed-method ANOVAs with Group (NSSI, Control) and Ambiguity (Unambiguous, Ambiguous) as between-subjects factors, and Rejection (Baseline, Exclusion) as a within-subject factor on subjective negative mood. If people who self-injure are more attuned to subtle emotional threats, then we should see an interaction between Group by Rejection by Ambiguity whereby the NSSI group show a greater increase in subjective negative mood from Baseline to Rejection than people in the Control group, in the Ambiguous Rejection Condition only. This analysis will then be repeated using feelings of belonging as the dependent variable. Prediction: If people who self-injure are more attuned to subtle emotional threats, then we should see an interaction between Group by Rejection by Ambiguity whereby the NSSI group show a greater decrease in feelings of belonging from Baseline to Rejection than people in the Control group, in the Ambiguous Rejection Condition only.

If one version of the Rejection Ambiguous condition (Unambiguous or Ambiguous) does not produce a change in negative subjective negative mood (relative to Baseline), then we will conduct analyses on mood using only the version that created change in mood. Likewise, if one version of the Rejection Ambiguous condition (i.e., Unambiguous, Ambiguous) does not produce a change in feelings of belonging (relative to Baseline), then we will conduct analyses on feelings of belonging only in the version that created change feelings of belonging.

Significant interactions will be followed-up by with t-tests. For three-way interactions, we will collapse across the Social Rejection condition by creating change scores for subjective negative mood from Baseline to Rejection (Exclusion score minus Baseline score).

Follow-up analyses: Significant interactions will be followed-up by with t-tests. For three-way interactions, we will collapse across the Social Rejection condition by creating change scores for subjective negative mood from Baseline to Rejection (Exclusion score minus Baseline score).

Inference criteria: *p* values less than .05 will be accepted as statistically significant and relevant follow-up analyses will be conducted on these effects. Trends (less than .10) will be

followed up if they are predicted. One or two-tailed tests are specified in the predictions (Statistical Models, above). Planned comparisons will not be corrected for multiple comparisons (see Armstrong, 2014). Exploratory analyses (e.g. correlations between subjective mood change and trait questionnaire measures) for hypothesis-generating will not be corrected for multiple comparisons but will be interpreted with caution. If they are reported in the manuscript, the number of tests conducted will also be reported.

Exploratory analysis:

1. If a small number of participants (less than 20%) did not believe they were playing other students during the ball passing games, we will run exploratory analyses (as detailed above) with and without them. If a large number of participants (more than 20%) did not believe they were playing other students during the ball passing games, then we will include belief as a between-subjects variable in exploratory analyses.
2. Exploratory analyses will be conducted with the attention check items to investigate if poor attention to the study can explain the effects found.
3. We may also conduct exploratory analyses to assess change in discrete emotions, as well as the extent to which trait measures of emotional experience predict responding to social rejection.

Outliers and Exclusions

Participants will be excluded from analyses if: (i) they do not complete the baseline or phases of the experiment; or (ii) due to failures or researcher error in the data collection. These exclusions will occur prior to analysis of data. Participants who do not complete a questionnaire will be excluded from analyses using that variable.

Missing data: We will test the missingness of questionnaire data using Little's missing completely at random (MCAR) test. If the questionnaire data is MCAR, or if the proportion of missing data is likely to be inconsequential (Schafer 1999), we will impute missing data using estimation maximization (EM) algorithm with 50 iterations. However, given that the DSHI-s operates more as a checklist of behaviours, missing data on the DSHI-s will be replaced with zeros (i.e., the absence of that behaviour) rather than using estimation maximization.

Sample Size

n = 50 per group (200 total). Participants who are excluded (see Data Exclusion) will be replaced. Sample size rationale: Within the Trimester One 2020 (March- June 2020) participant pool, 76 students were eligible to be recruited to the Control group and 136 eligible to be recruited to the NSSI group. Therefore, a sample size of 50 per group over the course of two trimesters (Trimester Two 2020, & Trimester One 2021) is achievable within the time constraints of Robinson's PhD.

Other

Data collection procedures: Participants will be recruited from a participant pool of university students enrolled in a first-year psychology course. All potential participants will complete a screening survey at the beginning of the university trimester assessing their eligibility to take part in the online experimental session. Participants who meet the criteria for inclusion in the study will then be invited to take part in exchange for course credit. Participants will be topic blind prior to the study, in that they will not know that the study assesses self-injury or response to emotional challenge. All participants will be aged 18–25 years old, identify as a woman, fluent in English, able to use a computer mouse and keyboard, with normal (or corrected to normal) eyesight, and have provided consent to take part in self-injury related research. Data collection will take place online using Qualtrics and is expected to take several months. Due to the time constraints of Robinson's PhD, data collection will end by July 2021. The study is approved by the School of Psychology Human Ethics Committee, by delegated authority of the Victoria University of Wellington Human Ethics Committee.

Data from 18 participants (9% of expected sample) have been run to allow enough time for data collection while participants are available. None of this data was been examined for analysed except for the first 7 to ensure that all data was logging correctly.

Appendix N

Study 3 Cyberball instructions

WELCOME TO CYBERBALL

Welcome to Cyberball, the Interactive Ball-Tossing Game Used for Mental Visualization!

In the upcoming study, we test the effects of practising mental visualisation on task performance. Thus, we need you to practise your mental visualisation skills. We have found that the best way to do this is to have you play an online ball tossing game with other participants who are logged on at the same time. You will play this game twice.

In a few moments, you will be playing the first ball tossing game with other students over our network. The game is very simple. When the ball is tossed to you, simply click on the player you want to throw it to. When the game is over, you will be able to click through to the next page of the survey.

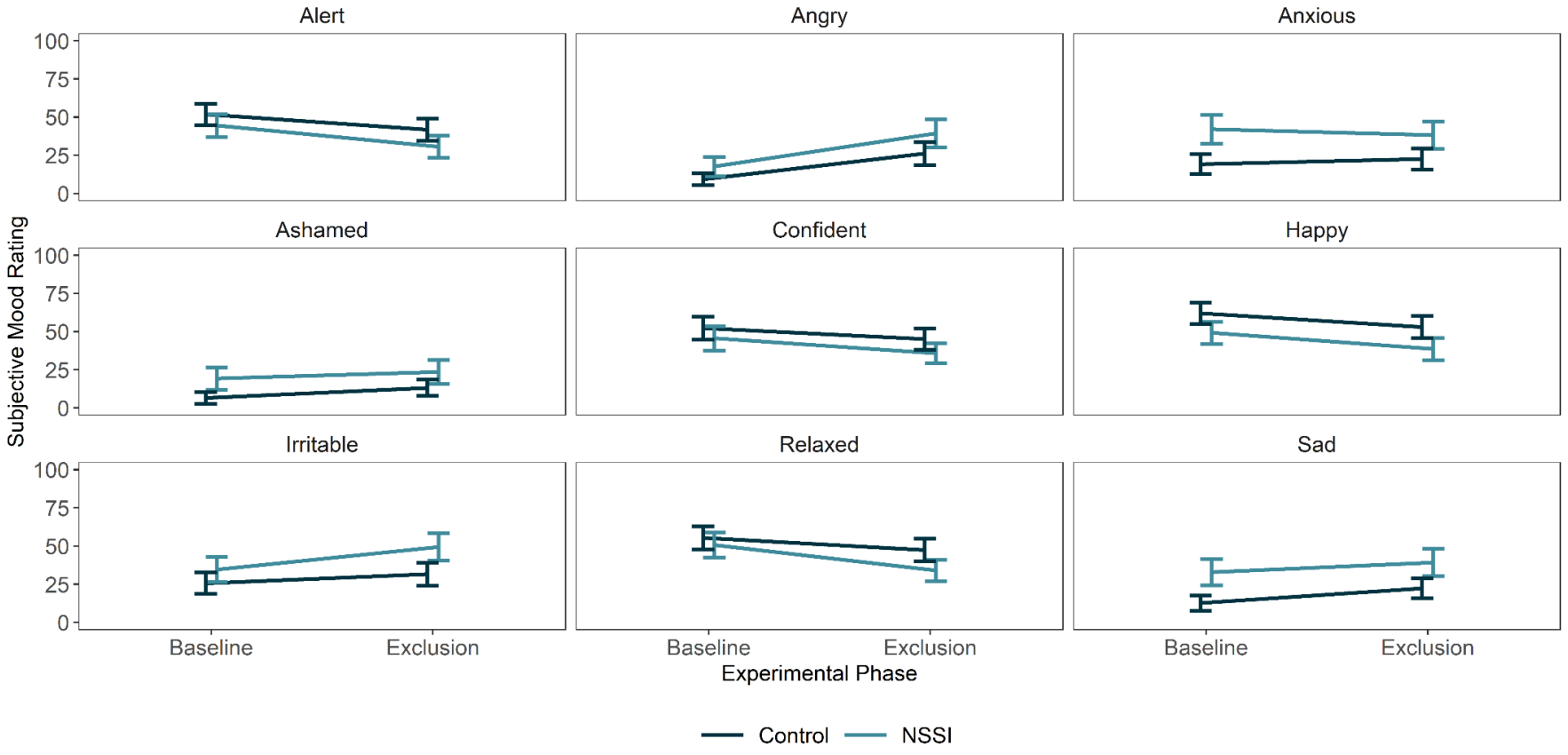
What is important is not your ball tossing performance, but that you MENTALLY VISUALISE the entire experience. Imagine what the others look like. What sort of people are they? Where are you playing? Is it warm and sunny or cold and rainy? Create in your mind a complete mental picture of what might be going on if you were playing this game in real life.

PLAY

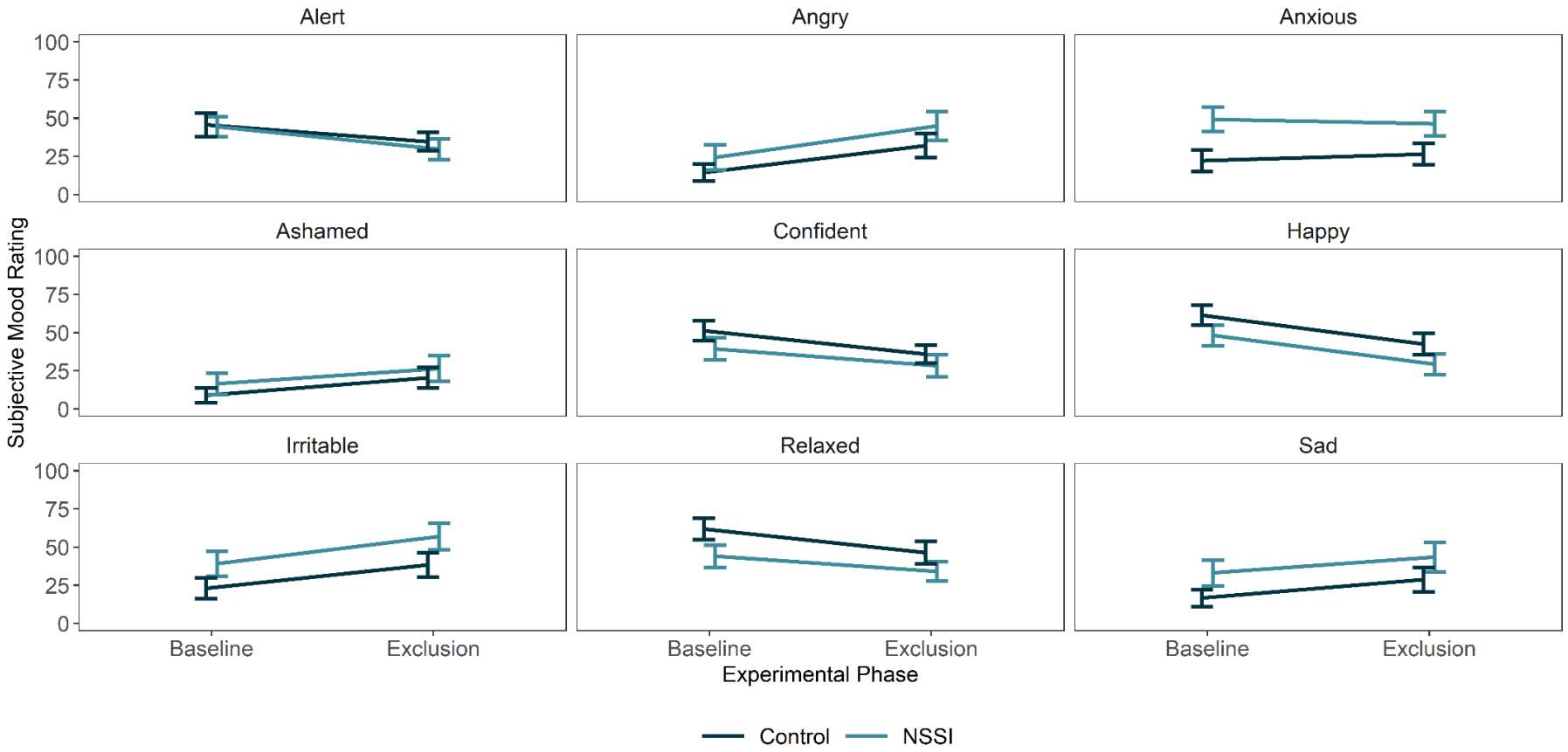
Appendix O

Ratings of discrete moods across emotional challenge in the Partial Exclusion (Panel A) and Total Exclusion (Panel B) separated by non-suicidal self-injury status in Study 3

A



B



Note. Partial Exclusion n = 100 (NSSI n = 50, Control n = 50), Total Exclusion n = 100 (NSSI n = 50, Control n = 50). Within each of the nine moods in both social exclusion conditions, the NSSI Status × Phase interactions were all non-significant (ps range from .074 to .989), providing no evidence for altered subjective reactivity to social exclusion by NSSI status.

Appendix P

Zero-order correlations between global self-reports and real-time reactivity and recovery, separated by non-suicidal self-injury status in Study 2

Control Group

	Global Self-Report		Reactivity to Acute Stress			Recovery from Acute Stress		
	1. DERS	2. ERS	3. Mood	4. HR	5. EDR	6. Mood	7. HR	8. EDR
1. DERS	-	**.64****	**.43***	-.16	.24	**.38***	-.10	.08
2. ERS	-	-	.19	-.06	.21	.15	< -.01	.09
3. Reactivity mood	-	-	-	.15	.15	**.74****	.07	.08
4. Reactivity HR	-	-	-	-	-.14	.16	**.90****	-.04
5. Reactivity EDR	-	-	-	-	-	.03	-.08	**.65****
6. Recovery mood	-	-	-	-	-	-	.15	.18
7. Recovery HR	-	-	-	-	-	-	-	.07

NSSI Group

	Global Self-Report		Reactivity to Acute Stress			Recovery from Acute Stress		
	1. DERS	2. ERS	3. Mood	4. HR	5. EDR	6. Mood	7. HR	8. EDR
1. DERS	-	**.56****	.02	-.11	.09	.09	-.10	.13
2. ERS	-	-	.13	-.14	-.14	.12	-.18	-.24
3. Reactivity mood	-	-	-	.21	-.27	**.74****	.16	**-.36***
4. Reactivity HR	-	-	-	-	-.14	.23	**.93****	-.17
5. Reactivity EDR	-	-	-	-	-	-.27	-.14	**.52****
6. Recovery mood	-	-	-	-	-	-	.23	-.21
7. Recovery HR	-	-	-	-	-	-	-	-.14

[a] DERS = Difficulties in Emotion Regulation Scale, ERS = Emotion Reactivity Scale, HR = Heart Rate, EDR = Electrodermal Responding. Duplicate correlations are not shown, and significant correlations are bolded for clarity. ** $p < .001$, * $p < .050$. Control $n = 50$, NSSI $n = 51$.

Appendix Q

Zero-order correlations between global self-reports and real-time subjective reactivity separated by non-suicidal self-injury status and exclusion condition in Study 3

Partial Exclusion

	NSSI Group		Control Group	
	2. DERS	3. ERS	1. DERS	2. ERS
1. Reactivity mood	-.05	.01	-.03	.07
2. DERS	-	**.73****	-	**.77****

Total Exclusion

	NSSI Group		Control Group	
	2. DERS	3. ERS	2. DERS	3. ERS
1. Reactivity mood	.25	.25	-.06	.01
2. DERS	-	**.48****	-	**.60****

Note. DERS = Difficulties in Emotion Regulation Scale, ERS = Emotion Reactivity Scale. Duplicate correlations are not shown, and significant correlations are bolded for clarity. ** $p < .001$, * $p < .050$. Partial Exclusion $n = 100$ (NSSI $n = 50$, Control $n = 50$), Total Exclusion $n = 100$ (NSSI $n = 50$, Control $n = 50$).