AN ECOLOGICAL MOMENTARY ASSESSMENT STUDY OF THE EMOTION REGULATION FUNCTIONS OF NONSUICIDAL SELF-INJURY AMONG ADOLESCENTS AND YOUNG ADULTS

by

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ABSTRACT OF THE DISSERTATION

An Ecological Momentary Assessment Study of the Emotion Regulation Functions of Nonsuicidal Self-injury Among Adolescents and Young Adults

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Emotion regulation functions have been consistently implicated in the reinforcement and maintenance of non-suicidal self-injury (NSSI). However, few studies have used Ecological Momentary Assessment (EMA) to examine the way specific negative and positive emotions are experienced immediately before and after NSSI behaviors. The current study used a smartphone app called "*Track It*" to examine the emotional antecedents and consequences of NSSI in real time. Participants were 24 adolescents and young adults, ages 15-21, who used the *Track It* app to monitor their affective experiences and NSSI thoughts and behaviors for two weeks. Results indicated the presence of distinct emotional antecedents to NSSI thoughts and behaviors. In addition, immediately following NSSI behaviors there were significant reductions in high-arousal negative emotions and increases in low-arousal positive emotions, suggesting that the behavior may serve as an effective method of emotion regulation. Lastly, the magnitude of changes in positive emotion following NSSI behaviors predicted increased frequency of NSSI thoughts, suggesting that these behaviors may be positively reinforced. In contrast, greater changes in negative emotion following NSSI predicted fewer NSSI thoughts, suggesting that individuals who engage in NSSI for negative reinforcement may do so more impulsively. These findings extend current understandings of the emotional regulation functions of NSSI and have important implications for interventions targeting NSSI.

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I. Introduction

Nonsuicidal self-injury (NSSI) is defined as the deliberate destruction or alteration of body tissue without lethal intent (Chapman, Gratz, & Brown, 2006). Although NSSI is prevalent across all ages, adolescents and young adults are at particularly high risk of engaging in NSSI (Laye-Gindhu & Schonert-Reichl, 2005; Rodham & Hawton, 2009). The prevalence of NSSI is as high as 36% among adolescents (Zetterqvist, Lundh, Dahlström, & Svedin, 2013) and as high as 43.6% among young adults (Hasking, Momeni, Swannell, & Chia, 2008). These high rates of NSSI among adolescents and young adults are alarming given that NSSI is associated with numerous deleterious consequences including academic difficulties, rejection and stigmatization by peers, risk for contracting infectious diseases, and increased risk of suicide (Asarnow et al., 2011; DiClemente, Ponton, & Hartley, 1991; Favazza, 1998).

Yet, despite the prevalence and known deleterious effects of NSSI, the functions of these behaviors remain poorly understood, and as a result it remains difficult for clinicians to predict, prevent, and treat NSSI (Klonsky, 2007). Several different potential functions of NSSI have been hypothesized including self-punishment (Favazza 1996; Nock & Prinstein, 2004), halting dissociation (Gunderson, 1984; Herpertz, 1995), replacing suicidal urges (Suyemoto, 1998), interpersonal communication (Favazza 1996), enabling experiential avoidance (Chapman et al., 2006), and emotion regulation (Nock & Prinstein, 2004). Of these different functions, the evidence to date most consistently supports the emotion regulation function of NSSI (Bentley, Nock, & Barlow, 2014; Kamphuis, Ruyling, & Reijntjes, 2007; Klonsky, 2007). For example, in one study of 75 women with Borderline Personality Disorder (BPD), 96% of participants reported engaging in NSSI to obtain relief from negative emotions (Brown, Comtois, & Linehan, 2002). Similarly, emotion regulation was the most commonly endorsed function of NSSI among a heterogeneous group of adult psychiatric inpatients (Herpertz, 1995), a non-clinical sample of adults (Favazza & Conterio, 1989), adolescent inpatients (Nock & Prinstein, 2004), and a community sample of adolescent self-injurers (Laye-Gindhu & Schonert-Reichl, 2005). These results suggest that for both adults and adolescents, regardless of clinical presentation, the most commonly endorsed function of NSSI is consistently an effort at emotion-regulation.

According to the Four-Function Model of self-injury (Nock, 2009; 2010), the emotion regulation function can be further divided into two distinct functional reinforcement processes: automatic negative reinforcement (ANR) and automatic positive reinforcement (APR). In ANR, NSSI serves to reduce or eliminate aversive thoughts and/or emotional states, while in APR NSSI serves to generate desired emotions, feelings, or stimulation. This model, which has received extensive support from existing research using retrospective self-report methodology (e.g., Brown et al., 2002; Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007; Nock & Prinstein, 2004), distinguishes between ANR and APR, suggesting that they represent distinct antecedents and consequences that cause and maintain NSSI.

Automatic Negative Reinforcement (ANR)

To date, the majority of research has focused on the role of ANR in maintaining NSSI (Nock, 2010), perhaps because it has been consistently identified as the most common motivation for NSSI (Klonsky, 2011; Nock Prinstein & Sterba, 2009). Across multiple self-report studies, individuals consistently report the presence of elevated negative emotions prior to an act of NSSI (e.g., Kamphuis et al., 2007; Klonsky 2009). Furthermore, research suggests that such elevated negative emotion decreases following an act of NSSI. For example, Kamphuis et al. (2007) asked 106 women to report their experiences of negative emotion immediately before and after engaging in NSSI using self-report measures, and found that the vast majority of women reported a significant and reliable reduction in negative emotion (anger, depression, fatigue and tension) from pre- to post-NSSI. Similarly, laboratory studies using NSSI proxies, such as self-injury imagery (Haines, Williams, Brain, & Wilson, 1995) or the cold pressor test (Russ et al., 1992), which requires participants to intentionally cause themselves acute pain, have also suggested that elevated negative emotion precedes and is reduced following NSSI proxies. Perhaps most significantly, Klonsky (2009) found that greater reductions in negative emotion following NSSI, as reported in retrospective structured interviews, predicted increased lifetime frequency of skin cutting. This finding suggests that not only does NSSI result in reduced negative emotion, but that these reductions may provide reinforcement, increasing the likelihood that the behavior will be repeated. Together these studies support the ANR function of NSSI by demonstrating that negative emotion increases prior to acts of NSSI, is reduced following acts of NSSI, and that these reductions in negative emotion may reinforce and increase the likelihood that the behavior will be repeated.

There are several potential mechanisms through which engaging in NSSI may result in reduced negative emotions. Existing research suggests that a tendency to engage in rumination about negative events is associated with increased risk of NSSI (Selby, Connell, & Joiner, 2010), potentially because NSSI may function as a form of distraction from aversive cycles of rumination (Selby et al., 2013; Selby, Kranzler, Panza, & Fehling, 2015). The Emotional Cascade Model (Selby & Joiner, 2009) posits that NSSI may be serve as a distraction from emotional cascades in which rumination and negative emotion escalate in a self-amplifying positive feedback loop, creating an emotional state which is extremely aversive, painful, and difficult to tolerate. The intense physical sensations associated with NSSI (e.g., pain, the sight of blood), may serve to "short-circuit" these painful emotional cascades, providing potent distractions that result in reductions in negative emotion. Alternatively, it has been hypothesized that individuals may feel helpless, frustrated or overwhelmed in the face of negative emotions, and may inflict physical pain as it is a form of pain that they can competently cope with (e.g., by cleaning or bandaging the wound), thereby reducing feelings of helplessness or frustration (see Klonsky, 2007).

Automatic Positive Reinforcement (APR)

Although less commonly reported than ANR, APR also constitutes a frequently endorsed motivation for NSSI (Nock and Prinstein, 2004), with the rate of individuals reporting APR ranging from 36% (Klonsky, 2011) to 92% (Turner, Chapman, & Layden, 2012). APR functions all elicit a desired emotional state, but the specific desired emotional state can differ. For example, some individuals report engaging in NSSI to elicit feelings of excitement or exhilaration (Klonsky, 2009; Nixon, Cloutier, & Aggarwal, 2002; Osuch, Noll, & Putnam, 1999), or to achieve a kick/high (Kleindienst et al., 2008), while others report engaging in NSSI to elicit satisfaction, stimulation, "to feel relaxed," or "to feel something even if it was pain" (Nock & Prinstein, 2004; Selby, Nock, & Kranzler, 2014). Although pain is not typically considered a desired emotional state, there is evidence suggesting that pain might also serve an APR function for self-injurers (Bresin & Gordon, 2013). Importantly, many participants who engage in NSSI for APR reasons often report attempting to feel more than one APR sensation (Selby et al., 2014).

Thus, although it may seem counter-intuitive, research suggests that inflicting physical harm can in fact elicit positive or desired emotions and sensations in self-injurers. One potential explanation for this paradoxical effect is the opioid hypothesis (see Nock, 2010; Richardson & Zaleski, 1986), which posits that endogenous opiates (endorphins) may be released in response to tissue damage caused during NSSI, leading to immediate and short-lived sensations of euphoria. Such euphoria may be satisfying and/or exhilarating, reinforcing NSSI behaviors. However, a study of the opiate antagonist naloxone failed to support this theory, demonstrating that the presence of naloxone did not reduce improvements in emotion following a self-injury proxy, even when the effects of endorphins were blocked (Russ, Roth, Kakuma, Harrison, & Hull, 1994). Alternatively, the sensations caused by NSSI may serve to distract from painful cascades of rumination and negative emotion, providing subsequent emotions of relief (Selby & Joiner, 2009). Similarly, another potential mechanism of positive reinforcement may be pain offset relief, wherein the offset from the physical pain caused by NSSI simultaneously functions as ANR as well as APR by generating a feeling of relief from emotional pain (Franklin et al., 2013). Indeed results from laboratory studies using psychophysiological indices of positive emotion demonstrated that painful experiences (electric shocks) can simultaneously generate both negative and positive reinforcement (Franklin et al., 2013), though this study is limited by the use of electric shocks as a proxy in place of actual NSSI behaviors.

Yet, despite the frequency of APR motivations for NSSI, APR motivations have received far less attention than ANR motivations for NSSI (Nock, 2010). Existing studies suggest that positive emotions decrease prior to episodes of NSSI and increase following an act of NSSI (Kamphuis et al., 2007; Muehlenkamp et al., 2009). More specifically, Kamphuis et al. (2007) found that participants reported significantly higher levels of the positive emotion “vigor” immediately after engaging in NSSI as compared to self-reports of their emotional state immediately prior to engaging in NSSI. Similarly, in a study of participants with bulimia nervosa, Muehlenkamp et al. (2009) found that positive emotion significantly decreased over time prior to NSSI behaviors and increased significantly following NSSI behaviors. Using retrospective structure interviews, Klonsky (2009) found that low arousal affect-states of relief, calm, satisfaction, and relaxation demonstrated the most significant increases from before to after NSSI.

Furthermore, APR functions of NSSI may reinforce and increase the likelihood of subsequent NSSI thoughts and behaviors. Klonsky (2009) found that, as with reductions in negative emotions, participants’ retrospective reports of increases in positive emotions following NSSI also predicted increased lifetime frequency of skin cutting. Similarly, in an EMA study of self-injurers, Selby et al. (2014) found that participants who reported APR motivations for NSSI also reported more NSSI thoughts, longer duration of these NSSI thoughts, as well as more NSSI behaviors than those engaging in NSSI for other motivations. In particular, engaging in NSSI to experience pain sensations was associated with the highest NSSI frequency. Most recently, Yen et al. (2015) found that self-reported APR functions predicted continued engagement in NSSI at six months follow-up. Thus, while APR has received less attention in the literature than ANR, findings to date suggest that NSSI results in increased positive emotions or sensations, and that these increases may provide positive reinforcement, increasing the likelihood that the behavior will be repeated.

Limitations in Existing Research

However, existing studies have relied on retrospective self-report methods, which are limited by recall biases and are unable to assess the functions of NSSI in real time, immediately before and after NSSI behaviors occur. In addition, for ethical reasons laboratory studies have used NSSI proxies rather than stimulating actual NSSI behaviors. As a result, few studies have examined the momentary experiences of NSSI behaviors and the way in which these behaviors are negatively and positively reinforced. Studies that utilize Ecological Momentary Assessment (EMA) methodologies (e.g., personal digital assistants, smartphones) are needed in order to assess the emotional experiences associated with NSSI behaviors in real time, as these behaviors occur outside the laboratory (Shiffman, Stone, & Hufford, 2008). This EMA approach reduces the problem of recall biases and improves ecological validity by capturing experiences in real-time and in natural settings (Hufford, 2007), and allows for a more accurate assessment of the emotional antecedents and consequences of NSSI. This may be particularly important among individuals with BPD, a diagnosis highly associated with NSSI, for whom there may be a tendency to retrospectively underestimate positive emotions and overestimate negative emotions (Ebner-Priemer et al., 2006). Furthermore, this approach improves our ability to study “dynamic processes” such as affective instability (Ebner-Priemer & Trull, 2009), which is particularly relevant when examining the proximal emotional antecedents and consequences of NSSI. In addition, the computerized method of data collection makes them particularly suitable for the measurement of sensitive topics such as NSSI (Tourangeau & Yan, 2007).

To date, only a small handful of studies have used EMA methodology to examine the emotion regulation functions of NSSI (see Hamza & Willoughby, 2015 for a recent review). Existing EMA studies have focused primarily on the role of negative emotion (e.g. Bresin, Carter, & Gordon, 2013; Nock et al., 2009) or have examined a few emotions but have not assessed the role of a comprehensive list of emotions (e.g., Selby et al., 2014). For example, Selby et al. (2014) examined APR functions by assessing levels of broad emotional states of satisfaction, stimulation, and pain, but did not examine the way in which specific emotions may be elicited by NSSI and serve to negatively or positively reinforce NSSI. This is particularly important given that initial findings suggest that changes in some emotions (e.g. high-arousal negative emotions such as overwhelmed) may be more likely to occur and reinforce NSSI than other emotions (e.g. low-arousal negative emotions such as sad; Claes, Klonsky, Muehlenkamp, Kuppens, & Vandereycken, 2010; Kleindienst et al., 2008; Klonsky, 2009). Two EMA studies have modeled the way negative and positive emotion changes in the hours preceding and following NSSI behaviors (Armey, Crowther, & Miller, 2011; Muehlenkamp et al., 2009). Armey et al. (2011) found that negative affect increased prior to NSSI, peaked during NSSI, and then decreased after NSSI, but found no significant changes in positive affect. In contrast, Muehlenkamp et al. (2009) found that positive affect decreased and negative affect increased before NSSI, and following NSSI positive affect increased while there was no significant change in negative affect. One explanation for this discrepancy may be that both studies measured the trajectories of emotions several hours before and after NSSI incidents, without examining how participants were feeling immediately before and after they engaged in NSSI. Given that individuals who engage in impulsive behaviors such as NSSI may experience greater affective lability, or rapid fluctuations between positive and negative emotions (Anestis et al., 2009), the different findings across these studies may be a result of measurements occurring at different time points along the trajectory of emotional changes surrounding NSSI. To date, no study has examined the immediate emotional impact of NSSI specifically by asking participants to rate a comprehensive list of emotions as they occur in the moments *immediately* before and *immediately* after they engage in NSSI. Furthermore, no EMA studies have examined whether the magnitude of momentary changes in emotion following NSSI reinforce the behavior and predict greater frequency of subsequent NSSI behaviors.

Thus, despite advances in recent years, there continue to be significant gaps in our understanding of the emotional experiences associated with NSSI behaviors. As a result, it remains difficult to predict and prevent NSSI behaviors and there is a paucity of evidence-based treatments for NSSI (Bentley et al., 2014; Muehlenkamp, 2006). Furthermore, research suggests that NSSI may have addictive properties, with adolescents reporting increasing frequency or severity since starting the behavior and an inability to resist urges to engage in the behavior despite negative consequences (Nixon et al., 2002), suggesting that there may be particular clinical importance in understanding the factors that reinforce and increase the likelihood of subsequent NSSI behaviors. A better understanding of the role of the proximal emotional antecedents and consequences of NSSI behaviors may provide important insight into the reinforcing nature of this maladaptive and dangerous behavior. If ANR and APR occur and predict increased NSSI frequency, these may prove to be important targets for treatments addressing NSSI. For example, Bentley et al. (2014) note that if NSSI is maintained through ANR, with an individual engaging in NSSI to reduce negation emotions, treatment might focus on distress tolerance and radical acceptance. In contrast, if NSSI is maintained through APR, with an individual engaging in NSSI in order to elicit desired emotions, treatment might focus instead on helping individuals cultivate positive emotions through mindfulness or other adaptive methods. As such, an understanding of the emotional experiences that reinforce NSSI can inform the development of more precise and effective treatments.

The Current Study

The purpose of the current study was to further examine the role of ANR and APR in maintaining NSSI behaviors by using EMA methodology in the form of a smartphone app called "*Track It.*" The *Track It* smartphone app was designed specifically for this study and was used to examine the real-time emotional experiences and functions of NSSI among adolescents and young adults. The app signaled participants to answer questions about their emotions and NSSI behaviors at five random time points throughout the day and allowed them to initiate entries immediately after engaging in NSSI behaviors. The current study was designed specifically to provide an in-depth examination of the role of specific emotions as both antecedents and consequences of NSSI behaviors. This study addressed previous limitations by having participants rate a comprehensive list of emotions of varying valence and arousal as they were experienced immediately before and after NSSI behaviors.

Hypotheses

The first hypothesis of the current study was that, consistent with previous research, elevated negative emotion or decreased positive emotion at one assessment time would predict increased intensity of NSSI thoughts and increased frequency of NSSI behaviors at the subsequent assessment time. This would demonstrate that specific emotional experiences precede the onset of NSSI thoughts and behaviors.

Second, it was hypothesized that there would be a significant decrease in self-reported negative emotion, and a significant increase in self-reported positive emotion, from pre- to post-NSSI behaviors. While previous studies have examined changes in trajectories of overall positive and negative emotion surrounding NSSI behaviors, this study also included exploratory analyses examining the effects of NSSI on discrete positive and negative emotions to determine which emotions were most impacted.

Third, an ANR index was calculated for each participant, reflecting the average magnitude of decreases in negative emotion from pre- to post-NSSI behaviors reported across the monitoring period. Similarly, an APR index was also calculated for each participant, reflecting the average magnitude of increases in positive emotion from pre- to post-NSSI behaviors reported across the monitoring period. It was hypothesized that these indices of ANR and APR would each individually predict increased frequency of NSSI behaviors and NSSI thoughts reported during the two-week monitoring period, indicating that NSSI behaviors were both positively and negatively reinforced.

II. Method

Participants

Participants were 24 adolescents and young adults (age range: 15–21 years, M = 19.29, SD = 1.76). Of these, 66.7% (N = 16) were female, 29.2% were male (N = 7), and 1 participant (4.2%) identified as transgender. In terms of race/ethnicity, 45.8 % of the sample (N = 11) was White, 8.3 % was African-American (N = 2), 20.8% was Asian (N= 5), 12.5% was Hispanic/Latino (N = 3), and 12.5% was multiracial (N = 3). In terms of sexual orientation, 66.7% (N = 16) identified as heterosexual, 12.5% identified as bisexual (N = 3), 4.2% identified as gay/lesbian (N = 1), 8.3% (N = 2) identified as other (e.g. pansexual), and 8.3% (N = 2) did not wish to report their sexual orientation. Household income ranged from under $9,999 (16.7%) to $150,000 and over (8.3%).

Participants were recruited from local treatment centers and the surrounding community in New Jersey through flyers and online advertisements. In addition, participants were also recruited from an adolescent depression and suicide program at an urban hospital in New York through the referral of their clinicians. Inclusion criteria required that participants be aged 15-21 and have engaged in NSSI twice over the past two weeks. Participants were excluded if they: 1) were non-English speaking or unable to understand research consent forms, 2) were determined to be at severe or extreme risk for suicide (see suicide risk assessment below) due to ethical concerns of participant deterioration, or 3) had received a diagnosis of a schizophrenia spectrum disorder, psychotic disorder, life-threatening anorexia, or developmental delays. All participants were provided written informed consent in order to participate in the study. In addition, for participants younger than 18 years, both participant assent and parental consent were obtained. This study was approved by the university IRB board.

Procedure

Phone Screen

Flyers and online advertisements instructed interested participants to contact the research project personnel by email. Project personal then scheduled a time to speak by phone with interested participants to describe the study, conduct pre-screening procedures, and schedule a baseline visit. For participants under the age of 18, project personnel asked them to have a parent or guardian available for the pre-screen phone call. Upon calling participants, project personnel first asked the participant's age and, for all participants under 18 years old, asked to speak with a parent or legal guardian before asking any other questions or providing any additional information. Parents/guardians were informed of the nature of the study, the questions that would be asked of their child during the pre-screen, and asked for verbal consent to proceed with the pre-screening with their child. Pre-screening questions consisted of a brief set of questions regarding NSSI and exclusion criteria (excluding questions about suicidal ideation for ethical purposes, since I had no ability in this scenario to facilitate the safety of those with high suicide risk). NSSI was defined to potential participants as "behaviors intentionally meant to cause damage or pain to your own body that you engaged in without intent to die." Participants meeting eligibility criteria at this time were scheduled for an in-person baseline assessment.

Baseline Visit

Following the consent process, eligible participants completed a 2-hour baseline session. As part of this visit, participants completed a battery of self-report measures and semi-structured interviews, and received training in the use of a smartphone app called "*Track It,"* an android-based program that was designed specifically for this study in collaboration with the Rutgers Department of Computer Engineering. As part of this training, the definition of NSSI and all terms used in the *Track It* assessment were explained to participants. Participants were also provided with a user "cheat sheet," which included directions for the use of the app and definitions of key terms used in the assessment, as well as the contact information of study personnel in case they encountered any difficulties. Participants with android phones were given the option of downloading the *Track It* app directly onto their personal smart phone; all other participants were loaned a study android phone with the app installed on it.

Smartphone EMA App and Assessment Protocol

The *Track It* phone app was programmed to employ both signal-contingent and event-contingent assessments. Signal-contingent entries prompted participants to complete assessments five times throughout the day in response to alarms they received through the app. These alarms were designed to signal participants at random times within five pre-determined time intervals: 9:00 am-11:30 am; 11:30 am-2:00 pm; 2:00 pm-4:30 pm; 4:30 pm-7:00 pm; 7:00 pm-9:00pm. Participants had one hour to complete these assessments. For event-contingent assessments, participants were asked to complete an assessment after engaging in any NSSI behaviors. Entries took approximately 3-5 minutes to complete. As part of each of these entries, participants reported whether they have had thoughts of NSSI and whether had engaged in any form of NSSI since the previous entry. If they endorsed any NSSI behaviors, participants were asked to report the frequency, method, and duration of their self-injury and to rate the intensity of their positive and negative emotions immediately before and after the behavior. See Figure 1 for model screens of the *Track It* app.

To ensure confidentiality, participants were encouraged to password protect access to their smartphones. In addition, data from the "*Track It"* app was immediately sent to the investigators' secure server via a secure protocol as soon as the participant had Wi-Fi access. The uploaded data did not contain any personally identifiable information. Instead, data was linked via an assigned random number, and the link was stored on paper in a secure cabinet on Rutgers property.

Following their baseline visit, participants used the *Track It* app for two practice days, followed by a two-week monitoring period. Participants were encouraged to contact study personnel if they encountered technological difficulties.

Post-assessment Visit

Following the completion of the practice days and 2-week monitoring period, participants returned to the lab for a 1-hour post-monitoring session, which included the completion of self-report measures and a debriefing. Participants were compensated for their participation in the study at this time. Participants who completed at least 80% of prompted entries received $300 for their participation, while participants who completed less than 80% were compensated $150.

Measures

<u>*Baseline Assessments*</u>

Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). The BDI is a 21-item self-report measure of depressive symptomatology. The BDI is widely used and has demonstrated good internal consistency and validity (see Beck, Steer, & Carbin, 1988 for a review). Each item is rated from 0 to 3. A total score is calculated by summing all responses and can range from 0-63. In the current study, scores ranged from 2-50 and I obtained excellent reliability, with a coefficient alpha of .93.

Positive and Negative Affect Scale (*PANAS*; Watson, Clark, & Tellegen 1988). The PANAS is a self-report measure of positive and negative affect. Participants are asked to rate the extent to which they have experienced each emotion over the *past week* from 1 (very slightly or not at all) to 5 (extremely). Scores from the 10 positive emotions (interested, excited, strong, enthusiastic, proud, alert, inspired, determined, attentive, active) were summed to create a total positive affect score and scores from the 10 negative emotions (distressed, upset, guilty, scared, hostile, irritable, ashamed, nervous, jittery, afraid) were summed to create a total negative affect score. Scores on each subscale can range from 10 – 50, with higher scores representing higher levels of positive and negative affect respectively. In the current study, total positive affect scores ranged from 11-38, and total negative affect scores ranged from 11-39. This measure has been demonstrated to have high reliability and validity (Crawford & Henry, 2004; Watson et al., 1988). In the current study, I obtained good reliability for the positive affect subscale, with a coefficient alpha of .85, as well as good reliability for the negative affect subscale, with a coefficient alpha of .81.

Inventory of Statements about Self-Injury (ISAS; Klonsky & Glenn, 2009; Klonsky & Olino, 2008). The ISAS is a self-report measure of the frequency and functions of NSSI. The reliability and validity of the ISAS as a measure of NSSI frequency and functions has been demonstrated in a large sample of young adults (Klonsky & Glenn, 2009; Klonsky & Olino, 2008). The first section of the ISAS assesses the lifetime frequency of 12 different methods of NSSI (i.e., banging/hitting self, biting, burning, carving, cutting, interfering with wound healing, needle-sticking, pinching, hair pulling, rubbing skin against rough surfaces, severe scratching, and swallowing chemicals). Total NSSI frequency scores were calculated by summing lifetime frequency of engaging in each of these methods of NSSI. The last section of the ISAS assesses different functions of NSSI, asking participants to rate from 0-2 the extent to which they are engaging in NSSI for each function. A total ANR score was be calculated by summing the following items: "When I self-harm I am…releasing emotional pressure that has built up inside of me", "…calming myself down", and "…reducing anxiety, frustration, anger, or other overwhelming emotions". A total APR score was calculated by summing the following items: "…causing pain so I will stop feeling numb," "doing something to generate excitement or exhilaration," "trying to feel something (as opposed to nothing) even if it is physical pain," "making sure I am still alive when I don't feel real," and "…doing something to generate excitement or exhilaration." In the current study, I obtained good reliability for the ANR index score, with a coefficient alpha of 0.74, and acceptable reliability for the APR index score, with a coefficient alpha of 0.61.

Structured Clinical Interview for DSM–IV Axis II Disorders (SCID–II; First, Gibbon, Spitzer, Williams, & Benjamin, 1997). The SCID–II is a structured clinical interview that is used to assess Axis II disorders. Reliability and consistency of the SCID-II have been previously demonstrated (Maffei et al., 1997). Only the BPD module was administered in the current study. BPD scores were calculated by summing the nine SCID–II items, scored 1 (absent), 2 (sub-threshold) or 3 (present), with possible scores ranging from 9-27. In the current study scores ranged from 11-27 (M = 18.09, SD = 5.04). The presence of five threshold items was considered necessary for a BPD diagnosis. All assessments were completed by clinical psychology graduate students who were trained and supervised by a doctoral level psychologist.

Mini International Neuropsychiatric Interview (*MINI*; Sheehan et al., 1998). The MINI is a short, structured diagnostic interview that assesses constructs from the text revision of the Diagnostic and Statistical Manual of Mental Disorders, fourth edition, text revision. This measure was used to assess for Axis I disorders. Good interrater reliability, test-retest reliability, and convergent construct validity with longer structured clinical interviews of general psychopathology have been demonstrated (Sheehan et al., 1998). All assessments were completed by clinical psychology graduate students who were trained and supervised by a doctoral level psychologist.

Suicide Risk Assessment. All participants that reported the presence of current suicidal ideation or past suicidal ideation or attempts were assessed for suicide risk in line with guidelines established by Joiner, Walker, Rudd, and Jobes (1999). An individual's risk for suicide was designated as *nonexistent* if he or she had no current suicidal symptoms, no history of suicide, and no or few other risk factors. Risk for suicide was considered *mild* if the individual was a multiple attempter with no other risk factors or was a non-multiple attempter experiencing suicidal ideation of limited intensity and duration, no or mild resolved plans and preparation, and no or few other risk factors. An individual was designated at *moderate* risk if he or she was a multiple attempter with any other significant risk factor. A non-multiple attempter with moderate to severe resolved plans and preparations or moderate to severe suicidal desire and ideation accompanied by at least two other risk factors was considered to be at *moderate* risk for suicide. A multiple attempter with two or more risk factors or a non-multiple attempter with moderate to severe symptoms of resolved plans and preparations accompanied by one other risk factor was designated at *severe* risk for suicide. An individual was considered at *extreme* risk for suicide if he or she was a multiple attempter with severe resolved plans and preparation or was a non-multiple attempter with resolved plans and preparations and two or more other risk factors. All decisions regarding risk were made in consultation with Dr. Edward A. Selby. In the current study, no potential participants were determined to be at severe or extreme risk.

“Track It” Momentary Assessments

At each EMA assessment participants used the *Track It* app to report on their current emotions, NSSI thoughts, NSSI behaviors, and, if they endorsed a NSSI behavior, the emotions that immediately preceded and followed the behavior.

Emotion Assessment

Participants were first asked to rate the extent to which they were feeling each of 21 emotions "*right now*" using a ten-point scale ranging from 0 (not at all) to 10 (extremely). Emotions were chosen based on Klonsky's (2009) findings of the most commonly endorsed positive and negative emotions experienced immediately before and after NSSI. Negative emotions included: overwhelmed, sad, frustrated, angry, hurt emotionally/rejected, anxious/afraid, lonely, empty/numb inside, guilty, ashamed, physically numb, and embarrassed. Positive emotions included: content, relieved, proud, happy, experiencing a rush or a high, calm/relaxed, excited, and satisfied. Given that research has demonstrated that individuals engage in NSSI in order to elicit physical pain (e.g. Selby et al., 2014), and that physical pain can have positive consequences (e.g. providing an important contrast for pleasurable experiences, increasing cognitive control, reducing rumination; Bastian, Jetten, Hornsey, & Leknes, 2014), physical pain was also assessed and examined separately for its role in positively reinforcing NSSI. At each assessment in which NSSI behavior was endorsed, participants were also asked to rate the extent to which they experienced these same 21 emotions immediately before and immediately after engaging in NSSI.

NSSI Assessment

Participants were then asked whether they had any thoughts or urges to self-injure since the last assessment. If participants responded in the affirmative, they were asked to rate the intensity of their thoughts from 0 ("not intense at all") to 10 ("very intense"). They were also asked to rate the duration of the thoughts from 1 ("less than 5 seconds") to 5 (“More than 5 hours”). Last, they were asked to rate how hard they tried to resist these thoughts from 0 (“not hard at all”) to 10 (“very hard”).

In addition, participants were asked whether they engaged in any NSSI behaviors since the last entry. If participants responded in the affirmative, they were asked to report the frequency of this behavior (“How many times did you engage in self-injury?”). They were also asked to select from a list of methods of NSSI (including cutting, biting, punching self/wall/object, scratching, getting into a physical fight in order to get hurt, burning, pulling hair out, banging head, hitting myself with object, or other). Last, they were asked to rate the duration of their NSSI behaviors from 1 (“less than 5 seconds”) to 5 (“More than 5 hours”). If participants indicated that no self-injury occurred, then they completed the rest of the assessment following the self-injury section.

Data Analytic Strategy

Descriptives

First, demographic data and descriptive information about frequency, method, duration, and function of NSSI behaviors and thoughts were examined. In addition, average scores of negative and positive emotions before and after NSSI were examined, as well as baseline self-reports of the functions of NSSI. Bivariate correlations between key variables were examined. The significance level for all tests was $\alpha = 0.05$ (two sided). All variables were examined for outliers, which were handled by being “brought to the fence” of 2 standard deviations. All analyses were conducted using SPSS 19.0.

Hypothesis 1: To examine the first hypothesis, that the presence of elevated negative emotion or decreased positive emotion at any specific time point would predict increased intensity of NSSI thoughts and increased frequency of NSSI behaviors at the subsequent assessment time, time-lagged analyses were used. At each assessment point, participants rated the intensity of their thoughts of NSSI and reported how many times they engaged in NSSI. Lag-variables were created, which allowed for the examination of how negative emotion (NE) and positive emotion (PE) at one assessment predicted the intensity of NSSI thoughts and frequency of NSSI behaviors at the subsequent assessment point. A lag-NE variable was created by taking the NE score for each participant at one signal and shifting the data, thereby allowing the data to predict NSSI thoughts and behaviors at the subsequent assessment point. Similarly, a lag-PE variable was created by shifting the PE score for each participant at each signal. The lag variables were created within each participant within each day of monitoring, and the missing score at the start of each day for each participant was not included in analyses. It was expected that higher levels of lag-NE and lower levels of lag-PE at the first assessment would predict increased intensity of NSSI thoughts and increased frequency of NSSI behaviors at the next assessment.

In order to account for the nested structure of the data, with multiple daily assessments nested within each participant, generalized linear mixed modeling (GLMM) was used. This analysis allows for two levels of predictors: within-subjects observations each day (Level 1) and between-subjects at baseline (Level 2). Because the outcome variable for this analysis was a count of the number of NSSI behaviors, a Poisson log link function was used (Dobson and Barnett, 2008). Similarly, the intensity of NSSI thoughts was rated as zero at most assessments and a Poisson log link function was used for this outcome variable as well. Relative risk ratios were calculated for the lag-NE and lag-PE predictors to indicate the amount of fluctuation in risk of NSSI behaviors or intensity of NSSI thoughts for every unit of change in each predictor variable. In addition, following the examination of main-effects, analyses were conducted controlling for baseline reports of NSSI frequency, as well as baseline reports of NE and PE as measured by the PANAS. Baseline NE and PE were examined in order to determine the extent to which momentary changes in emotions predict NSSI behaviors above and beyond baseline emotional dispositions. The final model therefore included Level 1 predictors of lag-NE and lag-PE as well as Level 2 predictors of baseline NSSI frequency, and baseline NE and PE. In addition, covariates of age and gender were included in the model as Level 2 predictors. Predictor variables were entered as fixed effects, and the intercept was specified as random.

Hypothesis 2: To examine the second hypothesis, that engaging in NSSI would result in significant decreases in negative emotion and increases in positive emotion from pre- to post-NSSI behaviors, paired samples t-tests were used to examine whether negative and positive emotions changed significantly from before to after NSSI behaviors. Only data from entries in which NSSI was reported were used for these analyses. As described above, at each EMA assessment in which participants reported engaging in NSSI, they were asked to rate the extent to which they experienced a range of negative and positive emotions immediately before engaging in NSSI and then to rate the extent to which they experienced the same emotions immediately after engaging in NSSI. A total "negative emotion before" score was calculated for each entry by summing participants' ratings of the following negative emotions right before engaging in NSSI: overwhelmed, sad, frustrated, angry, hurt emotionally/rejected, anxious/afraid, lonely, empty/numb inside, guilty, ashamed, and embarrassed. The examination of these negative emotions together as one negative emotion score was justified by a good internal consistency score of alpha = .86. Similarly, a total “negative emotion after” score was calculated for each entry by summing participants’ ratings of the same negative emotions right after engaging in NSSI. Likewise, a total “positive emotion before” score was calculated for each entry by summing participants’ ratings of the following positive emotions right before engaging in NSSI: content, relieved, proud, happy, experiencing a rush or a high, calm/relaxed, excited, and satisfied. The examination of these positive emotions together as one positive emotion score was justified by a good internal consistency score of alpha = .83. A total “positive emotion after” score was similarly calculated for each entry by summing participants’ ratings of the same positive emotions right after engaging in NSSI.

It was expected that some participants would report multiple incidents of NSSI and therefore rate their emotions before and after NSSI at multiple different assessment points. As such all total “negative emotion before” scores were averaged within each participant, resulting in one “average negative emotion before” score for each participant. Likewise, one “average negative emotion after” score was calculated for each participant, as was one “average positive emotion before” and one “average positive emotion after” score. In this way, data collected from across the monitoring period were aggregated and reduced for this analysis, in order to examine overall emotional experiences associated with NSSI behaviors in the most straightforward and clear way. Participants who did not report any incidents of NSSI over the two-week monitoring period were excluded from these analyses.

Paired samples t-tests were then used to examine whether there was a significant difference between "average negative emotion before" and "average negative emotion after" scores, and between "average positive emotion before" and "average positive emotion after" scores. As these differences were significant, the means of each group were examined to determine whether the differences were in the anticipated direction (e.g. negative emotion was lower after NSSI, and positive emotion was higher). In addition, these t-tests of average negative and positive emotions were also followed by exploratory t-tests examining differences in each specific negative and positive emotion. Although multiple comparisons were conducted, given the exploratory nature of these analyses, a more conservative alpha was not used in this study. In addition, Cohen's d values were calculated to indicate the magnitude of change in negative and positive emotions from before to after self-injury.

Hypothesis 3: The third hypothesis was that the magnitude of decreases in negative emotion and increases in positive emotion from pre- to post-NSSI behaviors would each predict increased frequency of NSSI behaviors and NSSI thoughts reported during the two-week monitoring period. To examine this hypothesis, an ANR index and APR index were calculated for each participant. An ANR index was calculated by subtracting total negative emotions after NSSI from total negative emotions before each NSSI episode to obtain a negative emotion difference score for each incident of NSSI, and then averaging these difference scores to obtain one ANR index value for each participant (N = each individual's total number of NSSI incidents).

$$\text{ANR Index} = \sum (\mathrm{NE}pre - \mathrm{NE}post)/N$$

Similarly, an APR index was calculated by subtracting total positive emotions before NSSI from total positive emotions after NSSI to obtain a positive emotion difference score for each incident of NSSI, and then averaging these difference scores to obtain one APR index value for each participant.

$$\text{APR Index} = \sum(\mathrm{PE}post - \mathrm{PE}pre)/N$$

Thus, ANR and APR indices represent the average change in negative and positive emotions experienced by a participant following their NSSI behaviors. Participants who did not report any incidents of NSSI over the two-week monitoring period (four total) received ANR and APR index values of zero and were excluded from these analyses.

These indices were entered as predictors in Poisson regression analyses predicting total frequencies of NSSI behaviors and thoughts. Poisson regression analyses were used because the outcome variables were counts of the number of NSSI episodes or thoughts reported during monitoring, rather than continuous, and as such they were not normally distributed. In this way, the violations of traditional linear regression analyses were accounted for by including a Poisson distribution and log link function (Dobson and Barnett, 2008). Relative risk ratios were calculated from each of the predictor variables to indicate the amount of fluctuation in risk of NSSI behaviors or thoughts for every unit of change in the predictor variable. For each dependent variable (NSSI behaviors and NSSI thoughts), following examination of main effects, participant age, gender, number of previous NSSI episodes reported at baseline, and baseline depressive symptoms were entered as covariates to examine how robust the effects were.

III. Results

Results from semi-structured interviews indicated that at baseline 54.2% (N = 13) of participants met criteria for Major Depressive Disorder, 43.5% (N = 10) met criteria for BPD, 62.5% (N = 15) met criteria for at least one anxiety disorder (M = 1.13 anxiety disorders, SD = 1.15, range = 0-4), 16.7% (N = 4) met criteria for a substance use disorder and 58.3% (N = 14) met proposed criteria for DSM-5 NSSI Disorder. According to the ISAS self-report measure, participants reported an average lifetime NSSI frequency of 220.83 (SD = 220.83, range = 13- 1,107), and 96% of participants (N = 23) reported engaging in NSSI for at least one ANR motivation while 83% (N = 20) reported engaging in NSSI for at least one APR motivation**.** Eight participants (33.4%) reported a history of at least one suicide attempt (M = .38 attempts, SD = .58, range = 0-2).

All participants completed the EMA study protocol (e.g., there was no attrition) and 91.67% were compliant in completing at least 80% of entries. No adverse events were reported. There were a total of 1,863 entries; 40 entries consisted of the app crashing before data was recorded and were therefore deleted, leaving 1,823 valid entries. Among these, a total of 270 NSSI thoughts and 70 NSSI behaviors were reported. All participants reported at least one NSSI thought (M = 11.29, SD = 9.20, range = 1- 42) and 83.3% (N = 20) reported at least one NSSI behavior (M = 2.92, SD = 2.08, range = 0-7) over the monitoring period. In terms of NSSI thoughts, participants reported an average intensity of those thoughts of 5.90 out of 10 (SD = 2.32, range = 0-10). The average number of self-injurious actions within each reported episode of NSSI (i.e. number of cuts, burns, etc.) was 4.17 (SD = 5.67, range = 1 – 25). Average momentary negative emotion across all assessments *(“How are you feeling RIGHT NOW”)* was 22.24 (SD = 19.59, range = 0 – 98), while average momentary positive emotion across all assessments was 15.60 (SD = 13.79, range = 0 – 80). Means, standard deviations, and bivariate correlations are presented in Table 1. The absence of many significant correlations between variables is likely a result of limited between-subjects power due to the small sample size.

Table 2 presents information about the methods and duration of reported NSSI thoughts and behaviors. As displayed in Table 2, the most common method of NSSI was cutting, followed by scratching and then punching. While it remains unclear whether hair pulling should be considered a valid form of NSSI, in the current study 10 out of the 11 incidents of NSSI involving hair pulling also involved engagement in a more valid form of NSSI (e.g. hair pulling and burning were reported in the same incident of NSSI). Table 3 presents the frequency of each method by gender. At each entry in which an NSSI behavior was endorsed, participants were asked to report the function of the behavior. As displayed in Table 4, the most commonly endorsed function of NSSI was "to release the emotional pressure that built up inside you", followed by "to stop or get rid of bad or negative feelings". Overall, automatic negative reinforcement functions were the most commonly endorsed functions, followed by automatic positive reinforcement functions. Notably, only one episode of NSSI was reportedly engaged in for social positive reinforcement functions.

Hypothesis 1:

Generalized linear mixed modeling with a Poisson distribution and log Link function was used to examine the first hypothesis, that the presence of elevated negative emotion or decreased positive emotion at any specific time point would predict increased intensity of NSSI thoughts and increased frequency of NSSI behaviors at the subsequent assessment time. The observations-within-individuals nesting structure was justified by significant ICCs for both intensity of NSSI thoughts (ICC = .55) and frequency of NSSI behaviors (ICC = .73), indicating that 55% of the variance in NSSI thoughts intensity and 73% of the variance in NSSI behavior frequency was between persons, with the remainder being within-person variation.

Lag variables were created to represent levels of total negative emotion (lag NE) and total positive emotion (lag PE) at the prior assessment point. An examination of main effects revealed that higher lag NE significantly predicted greater intensity of NSSI thoughts at the subsequent assessment ($t(1,389) = 9.10$, $B = 0.02$, $SE = 0.002$, $p < .001$, $RR = 1.02$), while higher lag PE significantly predicted lower intensity of NSSI thoughts ($t(1,389) = -5.07$, $B = -.02$, $SE = 0.003$, $p < .001$, $RR = 0.98$). Similarly, lag NE predicted increased frequency of NSSI behaviors at the subsequent assessment ($t(1,389) = 3.40$, $B = 0.01$, $SE = 0.002$, $p < .001$, $RR = 1.01$), though there was no significant effect of lag PE ($t(1,389) = 0.14$, $B = 0.00$, $SE = 0.002$, $p = .89$, $RR = 1.002$) on NSSI behaviors.

Following this examination of main effects, models were run controlling for covariates of age, gender, baseline PANAS negative affect, baseline PANAS positive affect, and baseline NSSI frequency. As displayed in Table 5, lag negative emotion continued to predict greater intensity of NSSI thoughts at the subsequent assessment, above and beyond baseline levels of overall negative affect. Similarly, lag positive emotion predicted lower intensity of NSSI thoughts at the subsequent assessment, even after controlling for baseline levels of overall positive affect. In the model predicting NSSI behaviors, lag negative emotion similarly predicted greater frequency of NSSI behaviors at the subsequent assessment, though lag positive emotion was not a significant predictor of NSSI frequency. Though older individuals thought about NSSI less intensely, there was no significant difference in frequency of NSSI behavior by age. Female gender was associated with significantly more intense NSSI thoughts and more NSSI behaviors. Greater baseline negative affect predicted greater intensity of NSSI thoughts but less NSSI behaviors, and greater baseline positive affect predicted greater intensity of NSSI thoughts but did not predict NSSI behaviors.

Results from these analyses generally support my hypothesis, in suggesting that NSSI thoughts and behaviors were more likely to occur at times when individuals experienced greater need for emotion regulation strategies- following the presence of elevated negative emotion or decreased positive emotion.

Hypothesis 2:

To examine the second hypothesis, that engaging in NSSI would result in significant decreases in negative emotion and increases in positive emotion from pre- to post-NSSI behaviors, paired samples t-tests were conducted. As described above, a total "negative emotion before" score was calculated for each NSSI incident by summing participants' ratings of negative emotions right before engaging in NSSI. Similarly, a total "positive emotion before" score, as well as "negative emotion after" and "positive emotion after" scores were calculated by summing ratings of negative and positive emotions respectively. For participants who reported multiple incidents of NSSI, these scores were averaged to create one "average negative emotion before" score, as well as one "average negative emotion after" score, one "average positive emotion before" and one "average positive emotion after" score.

Results from paired-samples t-tests indicated a significant decrease in negative emotion from before NSSI occurred ($M = 47.50$, $SD = 19.60$) to after NSSI behaviors ($M = 38.62$, $SD = 22.47$); $t(19) = 2.87$, $p = .01$, Cohen's $d = 0.42$. In addition, there was a significant increase in total positive emotion from before ($M = 4.67$, $SD = 4.99$) to after NSSI behaviors ($M = 14.63$, $SD = 11.04$); $t(19) = -4.91$, $p < .001$, Cohen's $d = 1.16$. Changes in reports of physical pain were examined separately and, as expected, results demonstrated a significant increase in physical pain from before ($M = 1.22$, $SD = 1.76$) to after NSSI behaviors ($M = 3.25$, $SD = 2.30$); $t(19) = -4.91$, $p < .001$, Cohen's $d = 0.99$. These results are displayed in Figure 2.

Exploratory analyses were then conducted to examine differences in each specific negative and positive emotion. The following negative emotions demonstrated significant decreases from before to after NSSI behaviors: angry ($t(19) = 2.48$, $p = .02$, Cohen's $d = 0.48$), hurt/rejected ($t(19) = 2.43$, $p = .03$, Cohen's $d = 0.45$), frustrated ($t(19) = 3.14$, $p = .005$, Cohen's $d = 0.66$), anxious/afraid ($t(19) = 2.31$, $p = .03$, Cohen's $d = 0.37$), and overwhelmed ($t(19) = 3.10$, $p = .006$, Cohen's $d = 0.65$). In contrast, there was a significant *increase* in average levels of guilty from before to after NSSI ($t(19) = -2.21$, $p = .04$, Cohen's $d = -0.27$). These changes in negative emotion are displayed in Figure 3. There were no significant differences in the follow negative emotions: sad ($t(19) = 2.08$, $p = .051$), ashamed ($t(19) = -.80$, $p = .43$), embarrassed ($t(19) = -.15$, $p = .88$), lonely ($t(19) = 1.12$, $p = .28$), or empty/numb inside ($t(19) = 1.35$, $p = .19$).

The following positive emotions demonstrated significant increases from before to after NSSI behaviors: happy ($t(19) = -2.97$, $p = .008$, Cohen's $d = -0.78$), content ($t(19) = -4.002$, $p = .001$, Cohen's $d = -1.25$), proud ($t(19) = -2.53$), $p = .02$, Cohen's $d = -0.68$), relieved ($t(19) = -5.08$, $p < .001$, Cohen's $d = -1.47$), calm/relaxed ($t(19) = -3.95$, $p = .001$, Cohen's $d = -0.97$), and satisfied ($t(19) = -3.14$, $p = .005$, Cohen's $d = -0.97$). There was also a significant increase in average levels of physical pain ($t(19) = -4.91$, $p< .001$, Cohen's $d = -0.99$). These changes in positive emotion are displayed in Figure 4. There were no significant differences in the following positive emotions: experiencing a rush or high ($t(19) = .18$, $p =.86$) or excited ($t(19) = -1.63$, $p =.12$).

Hypothesis 3:

My third hypothesis was that the magnitude of decreases in negative emotion and increases in positive emotion from pre- to post-NSSI behaviors would each predict increased frequency of NSSI behaviors and NSSI thoughts reported during the two-week monitoring period. To examine this hypothesis an ANR index and an APR index were calculated for each participant and then used to predict frequency of thoughts and behaviors. As described above, the ANR index was calculated by subtracting total negative emotions after NSSI from total negative emotions before each NSSI episode to obtain a negative emotion difference score for each incident of NSSI, and then averaging these difference scores to obtain one ANR index value for each participant. Because guilt appeared to have a different trajectory than other negative emotions (see Figure 3), the ANR index was calculated excluding the negative emotions of guilt and shame. The mean ANR index across the 20 participants who engaged in NSSI was 10.27 units of change ($SD = 13.68$, range = -10.40 – 49.67). Similarly, an APR index was calculated by subtracting total positive emotions before NSSI from total positive emotions after NSSI to obtain a positive emotion difference score for each incident of NSSI, and then averaging difference scores to obtain one APR index value for each participant. The mean APR index score was 9.97 units of change (SD = 9.08, range = 0 – 29.60). The ANR and APR indices were significantly positively correlated ($r = .50$, $p = .03$), and the magnitude of this correlation was in line with previous research (Selby et al., 2014).

Separate regressions were examined for NSSI thoughts and behaviors. There was one outlier (NSSI thoughts = 42), which was handled by being "brought to the fence" of 2 standard deviations. In the first step, only ANR and APR index scores were entered to obtain simple main effects. As expected, results indicated a significant main effect of APR index on NSSI thoughts ($B = .05$, $SE = .008$, Wald = 35.10, $p < .001$), but no significant effect on NSSI behaviors ($B = .02$, $SE = .01$, Wald = 2.59, $p = .11$). In contrast, there was a significant, but inverse, main effect of ANR index on NSSI thoughts ($B = -.02$, $SE = .007$, Wald = 13.73, $p < .001$) and no significant effect on NSSI behaviors ($B = -.01$ $SE = .01$, Wald = 1.10, $p = .30$).

Next, covariates of participant age, gender, number of previous NSSI episodes reported at baseline, and baseline depressive symptoms were added to the analyses. As displayed in Table 6, APR index continued to predict significantly more NSSI thoughts, while ANR index continued to predict significantly fewer NSSI thoughts. There were no significant predictors of NSSI behaviors over the monitoring period.

Supplemental Analyses

Given the unexpected finding that ANR index was inversely associated with NSSI thoughts, and the finding that neither index predicted NSSI behaviors, several supplemental analyses were conducted in attempt to further explore these findings. First, to examine whether those who experienced ANR, or a reduction in negative emotion following NSSI behaviors, were more likely to think about or engage in NSSI than participants who did not, a binary ANR variable was created. Seventeen participants reported a significant reduction in negative emotion following NSSI behaviors, while 3 did not. When entered as a predictor in Poisson regressions, this binary ANR variable did not significantly predict NSSI thoughts ($B = 4.33$, $SE = 4.74$, $Wald = .84$, $p = .36$) or NSSI behaviors ($B = .98$, $SE = 1.05$, $Wald = .87$, $p = .35$). Next, I examined whether the continuous ANR index was a significant predictor among the 17 participants who did experience a significant reduction in negative emotion following NSSI. However, when those who did not experience significant reduction in negative emotion were excluded, ANR index was not a significant predictor of either NSSI thoughts ($B = -.21$, $SE = .13$, $Wald = 2.77$, $p = .10$) or NSSI behaviors ($B = -.02$, $SE = .032$, $Wald = .44$, $p = .51$). Another possibility is that creating the ANR index score by averaging the change in negative emotions across all incidents of NSSI may have resulted in the loss of data. To address this possibility, I also examined each individual's maximum change in negative emotion (as opposed to the average change across all NSSI episodes), but again found that it predicted neither the frequency of NSSI thoughts ($B = -.20$, $SE = .16$, $Wald = 1.49$, $p = .22$) nor NSSI behaviors ($B = -.002$, $SE = .03$, $Wald = .005$, $p = .95$).

Next I examined whether there was a significant interaction between ANR and APR indices, such that greater reductions in negative emotion in conjunction with greater increases in positive emotion following NSSI behaviors are exponentially more reinforcing and predictive of NSSI thoughts and behaviors. However, the interaction between ANR and APR indices was not a significant predictor of NSSI thoughts ($B = -.007$, $SE = .02$, $Wald = .20$, $p = .66$) or behaviors ($B = .005$, $SE = .004$, $Wald = 1.76$, $p = .19$).

Given that baseline reports of lifetime NSSI frequency did not significantly predict the frequency of NSSI thoughts or behaviors over the monitoring period, one reason for these surprising results may be that NSSI frequency over a two-week period of time may not be a reliable indicator of an individual's overall likelihood of engaging in NSSI. Instead, NSSI frequency may fluctuate over any given two week period and lifetime NSSI frequency may be a more accurate indicator of the reinforcing effects of the ANR and APR functions of NSSI. I therefore examined whether ANR and APR indices predicted ISAS self-reports of lifetime NSSI frequency. However, neither ANR index (B = -12.61, SE = 8.07, Wald = 2.44, p = .12) nor APR index (B = 14.10, SE = 12.17, Wald = 1.34, p = .25) significantly predicted lifetime NSSI frequency.

Given that the change in physical pain was not included in either the ANR or APR indices, but that research has shown experiences of physical pain to be associated with NSSI frequency (Selby et al., 2014), a physical pain index score was created by subtracting physical pain before NSSI from physical pain after NSSI, and then averaging these change scores across all NSSI episodes a participant reported, to generate a total change in physical pain score for each participant. Results indicated that, similar to the ANR index, there was a significant inverse main effect such that greater increases in physical pain following NSSI predicted fewer NSSI thoughts over the monitoring period (B = -.1.74, SE= .87, Wald = 4.00, p = .045). This effect was no longer significant after controlling for APR and ANR indices (B = -1.27, SE = .74, Wald = 2.96, p = .09). Changes in physical pain did not significantly predict NSSI behaviors (B = -.004, SE = .21, Wald = 0.00, p = .99).

Next, I examined whether individuals' baseline ISAS self-reports of the functions of their NSSI behaviors predicted NSSI thoughts and behaviors above and beyond the extent to which they actually experienced changes in emotions. The ISAS measure includes an Affect Regulation/ANR function score (comprised of the following three items: "When I self harm I am"… 1) reducing anxiety, frustration, anger, or other overwhelming emotions, 2) releasing emotional pressure that has built up inside of me or 3) calming myself down), which are each rated on a scale from 0-3. Of the 24 participants in the study, 23 endorsed an ANR function of their NSSI behaviors (subscale range from 0-6, M = 5.00, SD = 1.53). In addition, the ISAS measure includes an "Anti-Dissociation/Feeling-Generation" subscale score comprised of the following items ("When I self harm I am"…1) causing pain so I will stop feeling numb, 2) trying to feel something (as opposed to nothing) even if it is physical pain, 3) making sure I am still alive when I don't feel real. In addition, I added one item from the sensation-seeking subscale consistent with this study's definition of APR ("…doing something to generate excitement or exhilaration"). Twenty of the 24 participants endorsed at least one of these APR functions (subscale range 0-7, M = 3.21, SD = 1.93). Consistent with my initial findings, the ISAS APR subscale score significantly predicted increased NSSI thoughts ($B = 2.35$, $SE = .66$, Wald = 12.61, $p < .001$), while the ISAS ANR subscale did not ($B = -.19$, $SE = .84$, Wald = .05, $p = .82$). Neither significantly predicted NSSI behaviors.

The number of years which participants reported engaging in NSSI for (M = 5.33, SD = 2.39, range = 1-10) did not significantly predict NSSI thoughts or behaviors over the monitoring period. Treatment status (N = 12 engaged in therapy) did significantly predict NSSI thoughts ($B = .28$, $SE = .13$, Wald = 4.49, $p = .03$), such that those engaged in therapy reported significantly more NSSI thoughts, but did not predict NSSI behaviors (B = .03, SE - .24, Wald = .01, p = .90). The total number of Axis I disorders each participant met criteria for (M = 2.5, SD = 1.96, range = 0-7) also significantly predicted increased NSSI thoughts (B = .13, SE = .03, Wald = 16.19, $p < .001$), but did not significantly predict NSSI behaviors (B = .02, SE = .06, Wald = .10, p = .76). When Poisson regressions discussed above were conducted controlling for treatment status and total number of Axis I disorders, the results remained unchanged.

IV. Discussion

Emotion regulation functions have consistently been highlighted as primary motivations and maintaining factors for NSSI. However, existing research has relied primarily on retrospective self-report methods, limiting our ability to understand the extent and implications of emotional experiences associated with NSSI. The current study used Ecological Momentary Assessment (EMA) methodology in the form of a smartphone app called "*Track It",* which asked participants to record their NSSI urges and behaviors multiple times each day and to rate a comprehensive list of negative and positive emotions as they occurred in the moments leading up and to following NSSI behaviors.

Results from time-lagged generalized linear mixed modeling demonstrated that both elevated negative emotion and decreased positive emotion at one assessment time predicted increased intensity of NSSI thoughts at the subsequent assessment time and that elevated negative emotion, but not decreased positive emotion, predicted increased frequency of NSSI behaviors at the next assessment. Furthermore, participants reported significant increases in total positive emotion and decreases in total negative emotion immediately following NSSI behaviors. Lastly, the magnitude of changes in positive emotion following NSSI behaviors predicted increased frequency of NSSI thoughts. Contrary to expectations, greater changes in negative emotion predicted fewer NSSI thoughts and neither changes in positive or negative emotions predicted the frequency of NSSI behaviors reported over the monitoring period. Together these findings increase our understanding of the emotion regulation functions of NSSI by demonstrating that specific emotional experiences preceded and predicted the onset of NSSI thoughts and behaviors, and that engaging in NSSI constituted an effective method of regulating both negative and positive emotions, which may have reinforced these NSSI behaviors.

The finding that increased negative emotion predicted NSSI behaviors is consistent with previous EMA research demonstrating that in the hours leading up to reported incidents of NSSI there is a significant increase in negative emotion (Armey et al., 2011; Muehlenkamp et al., 2009). The current study extended these findings by demonstrating that increased negative emotion not only preceded, but also predicted greater frequency of NSSI behaviors at the next assessment time. This is important given research demonstrating that although NSSI may occur in the context of specific emotions (e.g. sad/worthless), these emotions may not always predict the presence of NSSI behaviors (Nock et al., 2009). Furthermore, this study extended previous research by demonstrating that increased negative emotion also predicted greater intensity of NSSI thoughts. Together these findings contribute to evidence suggesting that individuals think about and engage in NSSI as a method of regulating aversive emotions. Decreased positive emotion also predicted greater intensity of NSSI thoughts, though it did not significantly predict greater frequency of NSSI behaviors at the subsequent assessment time. This finding is consistent with results from Armey et al. (2011), which similarly failed to find a significant decrease in positive emotion before NSSI behaviors. One explanation for this may be that while individuals experiencing low positive emotion may think about and experience urges to engage in NSSI to elicit desired emotions, this may not be as compelling a motivation to actually engage in NSSI as the desire to avoid aversive negative emotions.

Consistent with expectations, higher levels of baseline negative affect predicted increased intensity of NSSI thoughts, but contrary to expectations, higher levels of positive affect did as well. One potential explanation for this finding may be that individuals with higher levels of both negative and positive affect may have greater affective lability, experiencing more fluctuations between positive and negative emotions, which has been associated with increased impulsive behaviors (Anestis et al., 2009). Further research should build on this study by calculating affective instability indices to determine the contribution of affective instability to NSSI thoughts and behaviors in the current sample. Similarly, baseline negative affect was inversely associated with NSSI behaviors, while lag negative emotion was positively associated with NSSI behaviors. This may suggest that, consistent with previous research (Selby, Franklin, Carson-Wong, & Rizvi, 2013), it is the fluctuations or momentary increases in negative emotion, rather than the stable presence of negative emotion, which predict NSSI behaviors.

Consistent with my second hypothesis, engaging in NSSI resulted in significant, immediate decreases in negative emotion and increases in positive emotion. While previous EMA studies have examined the emotional antecedents and consequences of NSSI behaviors (Armey et al., 2011; Muehlenkamp et al., 2009), to my knowledge this is the first EMA study to specifically ask participants to rate a comprehensive list of emotions as they occurred in the moments *immediately* leading up to and then following NSSI behaviors. In line with results from previous studies (Armey et al., 2011; Kamphuis et al., 2007; Klonsky, 2009) individuals reported significantly less negative emotion following NSSI behaviors. Also in line with previous research (Klonsky, 2009;

Muehlenkamp et al., 2009), individuals reported significantly more positive emotion following NSSI behaviors. Exploratory analyses examining specific negative emotions demonstrated that, consistent with previous findings (Claes et al., 2010; Klonsky, 2009), high-arousal negative emotions (frustrated, angry, hurt/rejected, anxious/afraid, overwhelmed) demonstrated significant reductions following NSSI, while low-arousal negative emotions (sad, embarrassed, lonely, empty/numb inside) did not. These findings have implications for the treatment and prevention of NSSI and suggest that interventions might benefit from focusing specifically on identifying and targeting high-arousal negative emotion. Exploratory analyses examining specific positive emotions were also consistent with previous research (Claes et al., 2010; Klonsky, 2009), with significant increases in low-arousal positive emotions (content, calm/relaxed, satisfied, relieved) but not high-arousal positive emotions (excited, experiencing a rush or high) following NSSI. In contrast, Kleindienst et al. (2008) found significant increases in high-arousal positive emotions (e.g., euphoric, excited) following NSSI. However, this study used retrospective self-report methodology, with a median length of 11.6 months since the NSSI incident participants were recalling. Thus, it may be that when retrospectively recalling NSSI, participants may overestimate the behavior's efficacy in eliciting high-arousal positive emotions. Together findings from the current study suggest that NSSI behaviors may function as an effective method of regulating high-arousal negative emotion and eliciting increased low-arousal positive emotions.

Changes in specific negative emotions tended to be of medium effect size, with frustrated and overwhelmed demonstrating the largest effect sizes, while changes in positive emotion tended to be of large effect size, with content and relieved demonstrating the largest effect sizes. Thus, while participants most commonly reported engaging in NSSI to reduce negative emotions, in reality they experienced larger changes in positive emotion. Of note, according to Watson and Tellegen's (1985) model of emotion, positive emotions of calm and relaxed reflect low negative affect more than high positive affect. It is therefore possible to interpret changes in some (though not all) of these positive emotions as indications of negative reinforcement, or the reduction of negative emotion, rather than positive reinforcement (Klonsky, 2009). In line with this possibility, there was a significant correlation between participants' average levels of relief following NSSI behaviors and their average reductions in total negative emotions following NSSI ($r = .50$, $p = .02$). In contrast, average levels of calm/relaxed after NSSI were not significantly associated with average reductions in total negative emotions following NSSI ($r = .35$, $p = .13$). This may suggest that the positive emotion of relief in particular may be better understood as an indication of negative reinforcement. However, psychophysiological evidence suggests that NSSI behaviors can elicit simultaneous, but independent, positive and negative reinforcement (Franklin et al., 2013). Similarly, research that examined the association between multiple motives for NSSI failed to find a significant correlation between the motive of obtaining relief and the motive of reducing unpleasant emotions (Kleindienst et al., 2008). Thus while there may be some conceptual overlap between these positive and negative emotions, the measurement of positive emotions such as calm and relieved may also capture an emotional experience that is more complex than a simple reduction of negative emotion. At the very least, these positive emotions may capture a person's subjective evaluation of the significance of the change in negative emotion her or she experienced. Future research should examine whether emotions such as relieved, relaxed, and calm constitute APR or whether they are more accurately characterized as a subjective assessment of ANR. Of note, in the current study positive emotions of happy, proud, content, and satisfied also demonstrated significant increases following NSSI, demonstrating the presence of distinct improvements in positive affect that cannot be interpreted as reductions in negative affect. Furthermore, even after the APR index was recalculated excluding the emotion of relief, the APR index continued to predict greater thoughts of NSSI, suggesting that relief alone did not account for the APR effects.

Interestingly, although overall negative affect decreased immediately after NSSI behaviors, in the current study participants reported a significant *increase* in guilt immediately following NSSI. In addition, shame tended to increase following NSSI, though the change was not significant. In contrast, previous research has found that guilt decreases significantly following NSSI behaviors (Armey et al., 2011). However, Armey et al. (2011) found that guilt "lingered" for a period of time immediately following NSSI before decaying in the subsequent hours. Together these findings suggest that although individuals may engage in NSSI to alleviate negative emotions of guilt and shame, these feelings might actually temporarily intensify following NSSI before ultimately decaying, potentially because of negative self-appraisals about engaging in the behavior. This finding highlights the importance of examining both proximal and distal emotional antecedents and consequences of NSSI behaviors, as it provides a more nuanced understanding of the rapidly changing emotional context of NSSI. Alternatively, another explanation for this discrepancy may be that guilt and shame may play mixed roles in NSSI (Kleindienst et al., 2008). Kleindienst et al. (2008) found that a slight majority of

BPD patients (53%) reported an increase in shame following NSSI, though 17% reported shame to be an antecedent for NSSI. Similarly, they found that guilt tended to decrease following NSSI (among 39% of patients), though a significant portion of patients (23%) reported that guilt actually increased following NSSI. Thus, it may be that guilt and shame function as both emotional antecedents and emotional consequences of NSSI. At times, individuals may engage in NSSI to reduce the momentary guilt or shame they are experiencing in their lives and at other times they may experience increased guilt and shame following NSSI as a result of subsequent social rejection or self-appraisals.

Results also partially supported my third hypothesis, that the magnitude of changes in emotion following NSSI would predict increased frequency of NSSI thoughts and behaviors over the two-week monitoring period. As expected, higher scores on the APR index, which indicates each participant's average increase in positive emotion following NSSI behaviors, predicted increased frequency of NSSI thoughts over the monitoring period. This finding suggests that participants who experienced the greatest increase in desired emotions were the most likely to think about NSSI, demonstrating the effects of automatic positive reinforcement in maintaining NSSI. This finding builds on existing research in suggesting a significant role of APR in reinforcing and maintaining NSSI (e.g., Muehlenkamp et al., 2009; Selby et al., 2014, Yen et al., 2015).

In contrast, higher scores on the ANR index, which indicates the magnitude of each participant's average decrease in negative emotion following NSSI behaviors, predicted lower frequency of NSSI thoughts over the monitoring period. This inverse relationship appears to suggest that, contrary to expectations, participants who experienced the greatest average reduction in negative emotion were the least likely to think about NSSI. Though these findings did not support my initial hypothesis, they are consistent with existing research (Claes et al., 2010, Selby et al., 2014, Yen at al., 2015). Claes and colleagues (2010) found an "almost significant" positive relationship between the level of planning for NSSI and change in low-arousal positive affect from before to after NSSI (with $p < .05$, but the correlation was not significant after a Bonferroni correction), but no relationship with change in negative affect. Similarly, Selby et al. (2014) found that individuals who engage in NSSI for APR functions reported greater frequency as well as duration of NSSI thoughts, tending to think about NSSI for 1-30 minutes prior to engaging in the behavior, whereas those engage in NSSI for other reasons tended to think about it for under a minute. Furthermore, Yen et al. (2015) recently found that self-reported APR functions predicted continued engagement in NSSI at six months follow-up, while ANR functions did not.

One potential explanation may be that individuals who engage in NSSI for APR functions may be more likely to experience the addictive-like qualities of NSSI (Nixon et al., 2002), leading them to think about and crave NSSI more regularly for the positive emotions or potential release of endogenous opioids that these behaviors elicit. In contrast, those who engage in NSSI for ANR functions may do so more impulsively, when they become overwhelmed with negative emotion that crosses a threshold they are no longer able to tolerate. Consistent with this possibility, research has demonstrated an association between negative urgency, the tendency to act rashly in the face of negative emotion (Whiteside & Lynam, 2001), and maladaptive behaviors (Anestis, Selby, & Joiner, 2007) and NSSI (Bresin, Carter, & Gordon, 2013; Glenn & Klonsky, 2010). Thus, when NSSI functions to alleviate negative emotion, it may often constitute an impulsive behavior with little forethought. The inverse relationship between ANR index scores and NSSI thought frequency may indicate that the more effective participants found NSSI to be in reducing negative emotions, the less negative emotion they continued to experience and the less they thought about or craved NSSI, until the next time they felt so overwhelmed with negative emotion that they impulsively engaged in NSSI behavior. Alternatively, another explanation may be that changes in positive emotion may be more potent than changes in negative emotion. As discussed above, the effect size for the change in positive emotion was larger than for the change in negative emotion following NSSI. Changes in positive emotion may therefore be more reinforcing because they are experienced as a larger shift in emotions. Thus, while ANR functions are most frequently reported in retrospective self-reports, these functions may be most salient for initial engagement in NSSI, while APR functions may be more salient for the maintenance of NSSI.

There are several limitations to the way ANR and APR indices were calculated in the current study, most notably that change-scores were averaged across all NSSI episodes each individual reported, potentially contributing to the loss of valuable data. As a result, supplemental analyses were also conducted examining ISAS self-reports of ANR and APR functioning. Results from these analyses were consistent with initial findings, demonstrating that higher scores on the APR subscale significantly predicted increased NSSI thoughts, while the ANR subscale did not. Thus, while future research should develop a more sophisticated way to calculate ANR and APR indices (see future directions), findings from ISAS self-reports of NSSI functions suggest these findings are robust.

Of note, neither APR index nor ANR index scores significantly predicted NSSI behaviors over the monitoring period. This may reflect the limited range in total reported episodes of NSSI behaviors (range = 0-7) and small sample size, restricting the variance in this outcome variable. Furthermore, anecdotally, when asked about the frequency of their NSSI behaviors during the study pre-screen many participants responded that the frequency of their NSSI behaviors varies by week depending on the context of life events and subsequent emotional experiences. Consistent with this anecdotal evidence, lifetime NSSI frequency did not significantly predict NSSI frequency over the monitoring period, despite research demonstrating that previous NSSI frequency is one of the strongest predictors of future NSSI (e.g., Tuisku et al., 2014; Wichstrom 2009). Thus, NSSI frequency over the two-week monitoring period may not have been an accurate reflection of participants' overall NSSI frequency. Results should be replicated using a longer monitoring period and more longitudinal study design to enable greater accuracy in the assessment of NSSI frequency and with a larger sample size to increase statistical power.

Importantly, the correlation between frequency of NSSI thoughts and frequency of NSSI behaviors was not significant (see Table 1), suggesting that individuals who thought about NSSI most frequently did not necessarily engage in NSSI behaviors most frequently. As such, although the ANR index was inversely associated with NSSI thoughts, in a replication with a larger sample size and a more longitudinal assessment of NSSI it is possible that the ANR index may predict greater frequency of NSSI behaviors. Similarly, supplemental analyses revealed that the magnitude of increase in physical pain following NSSI behaviors was inversely associated with NSSI thoughts and did not significantly predict NSSI behaviors. As with ANR index, this may suggest that individuals who experience significant pain following NSSI may engage in NSSI impulsively, without thinking about or craving the behavior. This is consistent with the Emotional Cascade Model (Selby & Joiner, 2009), which posits that the pain caused by NSSI may serve as a potent distraction from escalating negative emotion and thoughts. According to this model, when used for this function NSSI may constitute an impulsive behavior with limited forethought, with the pain serving to halt a quickly rising cascade of negative emotion. Alternatively, the inverse relationship between increases in pain and NSSI thoughts may suggest the presence of pain analgesia, with individuals who experience stronger analgesic effect and report less pain after NSSI potentially more likely to think about engaging in the behavior again.

Findings regarding gender differences were largely consistent with existing research (e.g., Armey et al., 2011; Zetterqvist et al., 2013). The most commonly reported method of NSSI over the monitoring period was cutting, with females engaging in cutting and scratching most frequently and males engaging in punching, head banging and cutting most frequently. Female gender also predicted increased intensity of NSSI thoughts and frequency of NSSI behaviors, in line with previous research (Zetterqvist et al., 2013).

Implications

Findings from this study have important implications for the treatment of NSSI. Few studies to date have examined emotional antecedents to NSSI thoughts and the current study builds on existing research by lending insight into the overlap and differences in emotional antecedents and predictors of NSSI thoughts and NSSI behaviors. Results from the current study suggest that momentary negative emotion predicts subsequent NSSI thoughts and behaviors. Like Armey et al. (2011), levels of negative emotion at one assessment time predicted NSSI thoughts and behaviors up to several hours later, suggesting that emotional antecedents to NSSI may precede NSSI by several hours. In contrast, momentary positive emotion predicted subsequent NSSI thoughts but not NSSI behaviors. As such, interventions aimed at reducing NSSI behaviors might benefit from a primary focus on the management of daily negative emotion. Interventions such as Dialectical Behavioral Therapy (DBT; Linehan, 1993) or Acceptance-Based Emotion Regulation Therapy (Gratz, 2007) that focus on helping patients identify and regulate difficult emotions may be particularly effective.

However, results also suggest that clinicians working with self-injurers should be aware that NSSI is effective in both decreasing high-arousal negative emotion and increasing low-arousal positive emotion. It is therefore not surprising that many adolescent and adult self-injurers deny finding their NSSI distressing (Andover, 2014; In-Albon, Ruf, & Schmid, 2013; Zetterqvist et al., 2013). In order to help patients change this behavior clinicians may first need to validate its effectiveness and help patients identify reasons why, *despite* its short-term effectiveness, they may want to change this behavior. It may also be important to provide patients with alternative effective emotion regulation strategies with a particular emphasis on strategies for decreasing high arousal negative emotions and eliciting low arousal positive emotions to use in place of NSSI. Increasing patients' self-efficacy in using adaptive emotion regulation strategies may increase their motivation and confidence in their ability to reduce NSSI behaviors.

Furthermore, there may be two different profiles of self-injurers with individuals who experience APR following NSSI reporting more frequent thoughts and urges to engage in NSSI and those who experience ANR following NSSI potentially engaging in NSSI more impulsively, with less forethought. This finding is consistent with research identifying the role of negative urgency in NSSI (e.g., Bresin et al., 2013; Glenn & Klonsky, 2010) and suggests that, although negative emotion may build for several hours leading up to NSSI, the urge to engage in NSSI may not begin until negative emotion crosses a certain intolerable threshold at which point individuals may rashly engage in NSSI to avoid their now intolerable levels of negative emotion. For this subset of individuals, treatment might focus on distress tolerance skills (a component of DBT treatment; Linehan, 1993), helping them notice and tolerate elevated negative emotion and NSSI urges without acting on them. In contrast, individuals who experience APR benefits from NSSI may spend more time thinking about and craving NSSI (though not necessarily acting on these urges). For these individuals, treatment focusing on alternative adaptive ways to elicit positive emotion, such as Behavioral Activation strategies (Jacobson, Martell, & Dimidjian, 2001), may be particularly beneficial. These findings support Klonsky's (2007) recommendation that clinicians should assess the function of their patients' self-injury in order to inform the most effective treatment approach.

Strengths, Limitations, and Future Directions

There were several notable strengths to the current study. Most importantly, existing studies of NSSI have focused primarily on the role of negative emotion (e.g. Bresin et al., 2013; Kamphuis et al., 2007), or have examined a few emotions but have not assessed the role of a comprehensive list of emotions (e.g., Kamphuis et al., 2007; Selby et al., 2013). Few studies have used EMA methodology to examine a comprehensive set of emotions surrounding NSSI and those that have (e.g., Armey et al., 2011; Muehlenkamp et al., 2009) examined the way these emotions changed in the hours before and after behaviors without examining the immediate emotional impact of NSSI. The current study built on existing research by using EMA methodology to examine a comprehensive list of negative and positive emotions as they occurred in the moments immediately leading up to and following NSSI. Furthermore, the participant sample included in this study was diverse in terms of race, socioeconomic status, and clinical presentation. Generalizability was also increased by recruiting from both clinical and community samples and examining NSSI in both adolescents and young adults.

Despites these strengths, results from this study should be considered in light of several limitations. Most significantly, this study was limited by a relatively small sample size. Although the sample in the current study included 24 participants, with 20 participants engaging in 70 NSSI behaviors, which is comparable to previous EMA studies of NSSI (e.g. Muehlenkamp et al., 2009; Nock et al., 2009), this small sample size may have limited statistical power and reduced my ability to detect between-persons outcomes of small effect size. Second, though EMA methodology improves ecological validity and reduces recall bias, this methodology still relies on self-report ratings. Particularly when assessing emotional experiences, this approach is limited by the fact that participants with low emotional awareness may not be able to accurately report on their emotional experiences. Third, the data analytic strategy used in the second and third hypotheses involved averaging data across all NSSI episodes reported by each participant, potentially resulting in the loss of valuable data. Of note, despite this approach, findings were replicated using data from baseline self-reports on the ISAS measure. In addition, though the real-time nature of the data collection may increase accuracy and ecological validity, findings from this study are still correlational in nature, and causal relationships between the emotional antecedents and consequences of NSSI and NSSI thoughts and behaviors cannot be made. An additional problem was that the monitoring period lasted for only two weeks and a more longitudinal assessment of NSSI frequency is needed to determine how emotional antecedents and consequences predict NSSI thoughts and behaviors over a longer period of time.

Future Directions

Results from this study indicate the importance of continued investigation of the role of both negative and positive affect in the maintenance and reinforcement of NSSI. Future research should replicate this study using a larger sample size to increase statistical power to predict the frequency of NSSI behaviors. Data analysis for the current study was conducted on a subsample of participants and results should be reanalyzed once full data collection is completed. Furthermore, results from the current study are limited by self-reports of emotional experiences and future EMA research should incorporate the use of psychophysiological measures such as “smart watches” (e.g. Neumitra Neuma physiological bio-watch), which indicate sympathetic responding as a correlate of emotional stress and would provide additional measures of the emotional context of NSSI. Furthermore, though EMA studies offer more accurate depictions of momentary changes in emotion, cognition, and behavior, this approach is limited in that participants are typically asked to monitor their experiences for 1-2 week periods, limiting our ability to examine how momentary experiences predict outcomes such as NSSI frequency over a more sustained period of time. Future EMA studies should extend the monitoring period and/or include both an EMA component as well as a follow-up visit 6-12 months later to better determine how momentary ANR and APR effects predict subsequent NSSI frequency. In addition, future studies should use alternative statistical approaches (e.g., mixed modeling) to examine the changes in emotions as well as the reinforcing effects of ANR and APR (hypotheses 2 and 3 in the current study) without averaging across all NSSI episodes reported by each participant.

Conclusion

Despite these limitations, the current study contributes to a growing body of EMA studies examining the emotional antecedents, consequences, and functions of NSSI. Participants rated a comprehensive list of negative and positive emotions as they occurred immediately before and after NSSI behaviors. Results indicated the presence of distinct emotional antecedents to NSSI thoughts and behaviors. In addition, NSSI behaviors resulted in significant reductions in high-arousal negative emotions and increases in low-arousal positive emotions, suggesting that the behavior may provide an effective method of emotion regulation. Lastly, the magnitude of changes in positive emotion following NSSI behaviors predicted increased frequency of NSSI thoughts, suggesting that APR functions may reinforce and maintain NSSI. In contrast, greater changes in negative emotion following NSSI predicted fewer NSSI thoughts, suggesting that individuals who engage in NSSI for ANR reasons may do so more impulsively. These findings extend current understandings of the emotional regulation functions of NSSI and have important implications for the treatment and prevention of these dangerous behaviors.

V. References

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Table 1. Means, standard deviations and bivariate correlations

	1	2	3	4	5	6	7	8	9	10
1. Age	-									
2. Gender	.08	-								
3. Number of Diagnoses	-.26	.17	-							
4. EMA NSSI Behaviors	.25	.29	.05	-						
5. EMA NSSI Thoughts	-.27	.40	.36	.35	-					
6. Lifetime NSSI Frequency	-.33	.25	.20	.30	.53**	-				
7. Avg EMA Neg. Emotion	-.20	.14	.38	.07	.58**	.48*	-			
8. Avg EMA Pos. Emotion	.09	-.29	.23	.16	-.02	.002	.26	-		
9. ISAS ANR Subscale	-.21	.06	.03	-.32	.03	-.004	-.21	-.35	-	
10. ISAS APR Subscale	-.39	.31	.27	.13	.59**	.28	.25	-.20	.13	-
Mean	19.29	-	2.50	2.92	10.79	220.83	22.61	15.86	5.46	7.21
(SD)	(1.76)		(1.96)	(2.08)	(7.65)	(276.49)	(12.78)	(8.19)	(.98)	(1.93)

Note: p<0.05, **p< 0.01. EMA NSSI Behaviors = Total number of NSSI episodes reported over monitoring period. EMA NSSI Thoughts = Total number of NSSI thoughts reported over monitoring period. Lifetime NSSI Frequency= Self-report of lifetime frequency of NSSI on the ISAS measure. Avg. EMA Neg. Emotion= Average total negative emotion across monitoring when asked to rate emotions "Now". Avg EMA Pos. Emotion= Average total positive emotion across monitoring when asked to rate emotions "Now". ISAS ANR Subscale= ISAS Self-reports of ANR functions of NSSI. ISAS APR Subscale= ISAS Self-reports of APR functions of NSSI.

Table 2. Method and duration of NSSI Thoughts and Behaviors

	NSSI Thoughts	**NSSI Behaviors**
Duration of thought or behavior		
Less than 5 seconds	24 (8.9%)	10 (14.3%)
5-60 seconds	78 (28.9%)	20 (28.6%)
1-30 minutes	104 (38.5%)	33 (47.1%)
30-60 minutes	51 (18.9%)	3 (4.3%)
1-5 hours	10 (3.7%)	4 (5.7%)
More than 5 hours	3 (1.1%)	0
Method		
Cutting	-	30 (42.9%)
Biting	-	10 (14.3%)
Punching	-	19 (27.1%)
Scratching	-	21 (30%)
Intentional Fighting	-	0
Burning	-	8 (11.4%)
Hair pulling	-	11 (15.7%)
Head Banging	-	2 (2.9%)
Hitting self with object	-	1 (2.9%)
Other	-	8 (11.4%)

*Note: Methods add up to more than 100% as multiple methods were endorsed within one episode of NSSI.

Table 3. Frequency of NSSI Method by Gender

NSSI Method	Women: N=16 (%)	Men: N=7 (%)
Cutting	10 (71.43 %)	2 (40.00%)
Biting	5 (35.71%)	0
Punching	5 (35.71%)	3 (60.00 %)
Scratching	6 (42.86%)	0
Intentional Fighting	0	0
Burning	5 (35.71%)	0
Hair pulling	5 (35.71%)	0
Head Banging	0	2 (40.00%)
Hitting self with object	1 (7.14%)	1 (20.00 %)
Other	5 (35.71%)	0

Table 4. NSSI Functions

Automatic Negative Reinforcement (ANR)	
To stop or get rid of bad or negative feelings	39 (55.7%)
To get rid of a feeling of numbness or emptiness	29 (41.4%)
To release the emotional pressure that built up inside you	46 (65.7%)
To get away or escape from your thoughts or memories	20 (28.6%)
Automatic Positive Reinforcement (APR)	
To feel a sense of control	27 (38.6%)
To feel something, even if it was pain	19 (27.1%)
To feel a rush or high	5 (7.1%)
To feel calm or relaxed	14 (20%)
To punish myself	22 (31.4%)
Social Negative Reinforcement (SNR)	
To avoid doing something unpleasant	4 (5.7%)
To avoid punishment or paying the consequences	0
To make others realize they're putting too much pressure on you	2 (2.9%)
Social Positive Reinforcement (SPR)	
To try to fit in with other people who are also doing it	0
To get attention from others	0
To get other people to act differently towards you	0
To let others know you're in emotional pain	1 (1.4%)

*Note: Functions add up to more than 100% as multiple functions were often endorsed for the same episode of NSSI

Table 5. Generalized linear mixed models predicting NSSI thoughts and behaviors

	NSSI Thoughts				NSSI Behaviors			
	B	SE	*t*	RR	B	SE	*t*	RR
Within level								
Lag NE	0.02	0.002	9.63***	1.02	0.04	0.004	12.36***	1.04
Lag PE	-0.01	0.003	-4.83***	.99	0.01	0.01	0.97	1.01
Between level								
Age	-0.12	0.02	-4.74***	.89	-0.04	0.09	-0.46	0.96
Gender	0.66	0.16	4.21***	1.88	.90	0.26	3.53***	1.42
Baseline PANAS Negative Affect	0.04	0.01	5.67***	1.04	-0.05	0.02	-2.49*	0.95
Baseline PANAS Positive Affect	0.02	0.008	3.06**	1.02	0.02	0.02	1.18	1.02
ISAS- Lifetime NSSI frequency	0.00	0.00	-1.29	1.00	0.00	0.00	-0.41	1.00

Note: Lag NE = lag negative emotion, Lag PE = lag positive emotion, PANAS = Positive and Negative Affect Scale, ISAS = Inventory of Statements about Self-Injury, **p* < .05, ***p* < .01, ****p* < .001

Table 6. Poisson Regression analyses predicting NSSI thoughts and behaviors

	NSSI Thoughts				**NSSI Behaviors**			
	B	*SE*	*Wald*	*p*	*B*	*SE*	*Wald*	*p*
ANR Index	-.02	.006	8.98	**.003**	-.01	.01	.71	.40
APR Index	.04	.009	20.08	**<.001**	.02	.02	1.17	.28
Age	-.12	.04	7.29	.01	.11	.26	1.37	.24
Gender	.68	.45	2.35	.13	.14	.26	.30	.59
ISAS Baseline NSSI	.00	.003	1.06	.30	.000	.001	.06	.81
BDI	.01	.006	.40	.10	.01	.01	1.01	.32

Figure 1. Sample "*Track It*" Screens

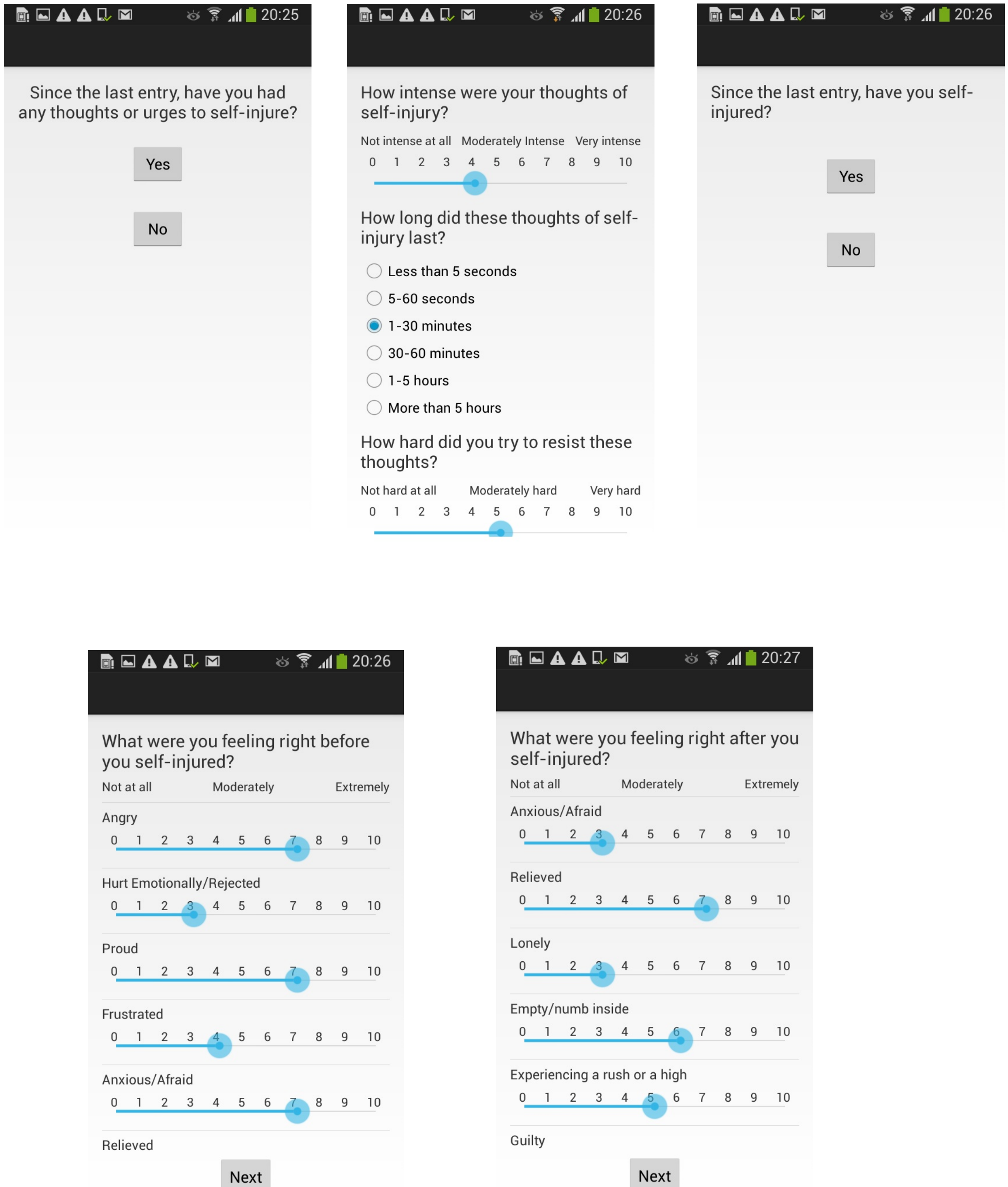

Figure 2. Total Negative and Positive Emotion Before and After NSSI

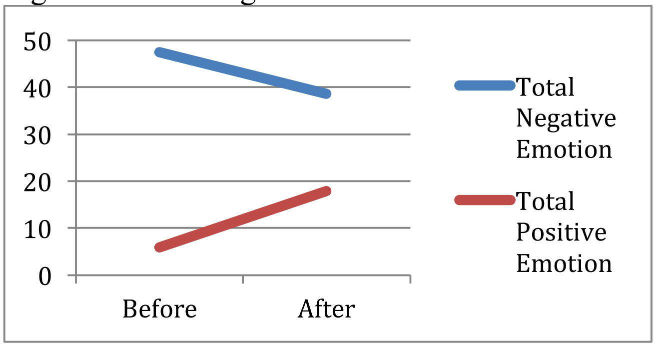

Figure 3. Specific Negative Emotions Before and After NSSI

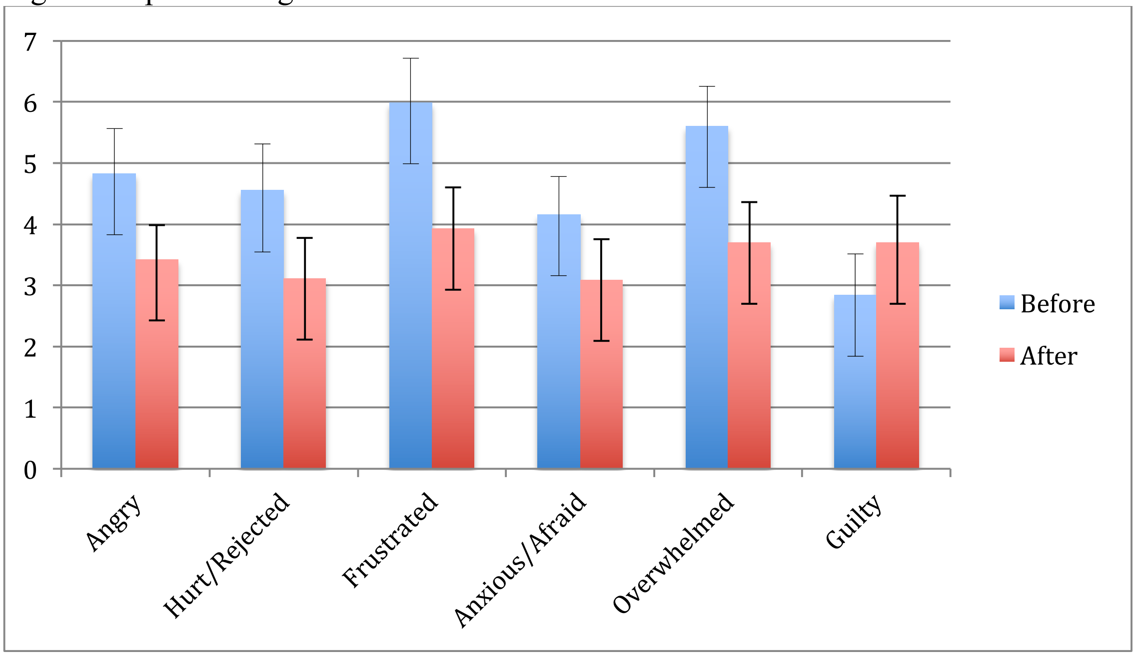

Figure 4. Specific Positive Emotions Before and After NSSI