Nonsuicidal Self-Injury: An Emotion Regulation Perspective

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Abstract
Background: Nonsuicidal self-injury (NSSI) is widely thought to serve an emotion-regulatory function. ***Method:*** The focus of the present paper is to provide a conceptual framework for understanding how NSSI might modify a person's emotions. ***Results:*** Drawing upon the process model of emotion regulation, we argue that 5 families of emotion regulation strategies may be engaged by NSSI. Individuals may engage in NSSI as an alternative to more distressing situations. They also may use NSSI to modify their social environment. Individuals may shift their attention away from unpleasant emotions or thoughts via NSSI. NSSI may change cognitions about the self via self-punishment or transformation of the self from higher-order to lower-order awareness. NSSI may also bring about various physiological effects, such as changes in endogenous opioids or parasympathetic nervous system activation, as a way of modulating emotional responses. ***Conclusion:*** Simply labeling NSSI as 'emotion regulatory' does not tell us precisely what is going on. This is because at any given moment, NSSI can serve to regulate emotions in many different ways. One key challenge is to clarify the precise functions NSSI may be serving for a given individual in a particular context.

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One of the organizing principles of human behavior is the drive to maximize pleasure and minimize pain. What, then, do we make of behaviors such as cutting, burning and hitting oneself? In a way, these behaviors are even more baffling than suicide, because suicide can be understood as a means of terminating pain if living is equated with unbearable suffering. What might motivate people to cause themselves physical injury in the absence of suicidal intent?

Self-injury without suicidal intent has been reported throughout history, including biblical references to self-mutilation [1, 2]. Evidence of nonsuicidal self-injury (NSSI) appears in the modern era as well. In the 1960s, wrist-cutting without suicidal intent became regarded 'as a widespread phenomenon among hospitalized inpatients' [3].

In more recent years, NSSI has entered the mainstream, with celebrities such as Angelina Jolie and Demi Lovato reporting histories of 'cutting' [4, 5]. MTV has featured NSSI in an episode of its *True Life* series, entitled 'I Self-Injure' [6]. Both the national news media and academic researchers have focused attention on the proliferation of videos featuring NSSI on the Internet [7, 8]. In the popular imagination, NSSI is seen as a way to deal with uncomfortable emotions. For example, the promotional material for 'I Self-Injure' states that 'millions of young people' 'find relief from extreme anxiety by deliberately cutting, burning or otherwise hurting themselves' [9].

In the past few decades, psychological science has focused empirical attention on NSSI. However, the nature

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and extent of the emotion-regulatory functions of NSSI remain unclear. To provide a framework for understanding how NSSI might modify a person's emotions, we draw upon the emerging field of emotion regulation [10, 11]. In the first section, we review the definition and prevalence of NSSI, and set NSSI in the larger context of self-harm. In the second section, we consider the hypothesized functions of NSSI. In the third section, we examine empirical findings regarding the link between NSSI and negative and positive emotion. In the fourth section, we integrate theory and empirical findings on NSSI with the process model of emotion regulation. We conclude with suggestions for directions for future research.

NSSI: Definition and Prevalence

Humans engage in a variety of behaviors that can be considered self-harming. These range from the mild and passive (failing to eat healthfully) to the severe and active (committing suicide via firearm). The term 'self-harm' tends to be applied to harm to the physical body [12] rather than to simply making choices that are contrary to one's long-term self-interests.

Under the heading of self-harm, a variety of subgroups can be delineated, such as suicide, suicide attempts, severe self-mutilation such as amputations, indirect modes of damaging oneself via eating, drinking and smoking, and damage to the surface of the body such as cutting and burning skin [12]. Behaviors that cause harm to oneself can be both deliberate and accidental, although most research does not include self-harm that results from being clumsy or accident-prone. The first subgroup to be differentiated from the nonaccidental varieties of self-harm is that of completed suicide. The next subgroup of nonaccidental self-harm, after suicide, contains those behaviors that are intended to result in death but which the individual survives. In the UK, these first two subgroups are often termed 'deliberate self-harm'. Attempted but not completed suicide is also called 'parasuicide' by some researchers. The final subgroup of nonaccidental self-harm includes acts in which the person deliberately injures his or her own body, but does not intend for the injury to result in death.

Defining NSSI

NSSI, the subject of this review, includes a wide range of behaviors such as cutting, burning or scratching the skin. NSSI may also include self-hitting, head banging, bone breaking, interfering with wound healing, hair pulling and nail biting that results in bleeding. A wide range of names have been applied to these behaviors over the years, including 'self-mutilation', 'deliberate self-harm' and parasuicide. By definition, the self-harming behavior in NSSI is not intended to result in death. NSSI appears to be the most precise and agreed-upon term among current clinical researchers, although subtle variations persist.

A new diagnosis named 'nonsuicidal self-injury' has been included in the DSM-5 (Diagnostic and Statistical Manual of Psychiatric Disorders, 5th edition) section of conditions for further study [13]. The DSM-5 describes the behavior as 'intentional self-inflicted damage to the surface of his or her body of a sort likely to induce bleeding or bruising or pain (e.g., cutting, burning, stabbing, hitting, excessive rubbing), with the expectation that the injury will lead to only minor or moderate physical harm (i.e., there is no suicidal intent)' [13]. The diagnostic criteria also specify that the behavior 'is not socially sanctioned (e.g., body piercing, tattooing, part of a religious or cultural ritual) and is not restricted to picking a scab or nail biting' and 'does not occur exclusively during psychotic episodes, delirium, substance intoxication, or substance withdrawal. In individuals with a neurodevelopmental disorder, the behavior is not part of a pattern of repetitive stereotypies. The behavior is not better explained by another mental disorder or medical condition (i.e., psychotic disorder, autism spectrum disorder, intellectual disability, Lesch-Nyhan Syndrome, stereotypic movement disorder with self-injury, trichotillomania [hair-pulling disorder], excoriation [skin-picking] disorder)' [13]. This review will hew to the behavioral definition of NSSI as set forth by the American Psychiatric Association.

Prevalence of NSSI

Estimates of NSSI prevalence among nonclinical samples vary widely. The most commonly cited figure for nonclinical adults is that 4% report having engaged in NSSI [14]. A more recent random-digit dialing procedure of adults (age: 19–92 years) across 48 US states found a lifetime NSSI prevalence of 5.9%; 1.3% had engaged in NSSI on 10 or more occasions; 0.9% within the past 12 months [15].

Study participants consistently report that they first engaged in NSSI aged 12 through 14 years [16]. The median age at onset in Klonsky's [15] national survey was 14 years; the median age at offset was 20 years; NSSI continued beyond the age of 25 years in 30% of cases. In contrast to the

rate reported among adults, the lifetime prevalence among community samples of North American adolescents has been found to range from 13.0 to 23.2%, while the 12-month prevalence has been found to range from 2.5 to 12.5% [16]. Investigations of NSSI among German adolescents have found similar prevalence rates, with a 25.6% lifetime prevalence in one sample [17], and a 12-month prevalence ranging from 14.9 [18] to 19.8% [17]. A cross-national survey of adolescents in Austria, Germany and Switzerland found a 6-month prevalence of 18.8% [19]. Surveys of American and Turkish college students both found lifetime prevalence rates of slightly over 15% [20, 21].

While initially regarded as a behavior mostly restricted to women, more recent surveys have found that males and females are equally likely to engage in NSSI [14, 15, 22–24]. It is also clear that NSSI is an international phenomenon, having been studied in Turkey [21], Hong Kong [25, 26], Singapore [27], Austria [19], Belgium [28], Germany [17–19], Italy [29, 30], the Netherlands [30], Switzerland [19], Hungary [31], Norway [32], Sweden [33], Iceland [34] and Australia [23, 35], in addition to the USA and Canada.

Functions of NSSI

Theories about the functions of NSSI tend to fall into two camps: intrapersonal and interpersonal. Intrapersonal theories focus on how NSSI functions within the individual, acting to modulate internal states. Interpersonal theories grapple with the influence that NSSI has on other people. For instance, Nock and Prinstein [36] distinguished potential functions of NSSI into four behavioral reinforcers: (1) automatic-negative reinforcement, (2) automatic-positive reinforcement, (3) social-negative reinforcement and (4) social-positive reinforcement. They conceptualized automatic reinforcement as occurring within an individual, and social reinforcement as occurring in the interpersonal environment, with NSSI bringing about either the removal of an aversive stimulus or the addition of a positive one [36]. Automatic-positive reinforcement would consist of increases in particular sought-after thoughts or emotions such as empowerment, strength or peace. Automatic-negative reinforcement would include termination of negative rumination, intrusive memories or physical tension. Examples of social-positive reinforcement could include increased attention from parents or other family members. Social-negative reinforcement may include being left alone by a bully, or no longer being required to complete household chores or school assignments.

The experiential avoidance model (EAM) focuses on potential intrapersonal functions of NSSI [37]. It conceptualizes NSSI as 'a behavior that leads to the reduction or elimination of unwanted emotional responses, particularly the physiological aspects of the emotional response' [37]. In this model, NSSI is conditioned through negative reinforcement (fitting within Nock and Prinstein's concept of automatic-negative reinforcement), as the act of self-injury provides an escape from emotional arousal. The EAM does not specify the method of escape, hypothesizing that NSSI acts through the release of endogenous opioids, distraction or a self-punishment function which reduces arousal [37]. EAM theorists see NSSI in a similar class with substance use, bingeing and thought suppression [37].

Another intrapersonal view of functions of NSSI comes from dialectical behavior therapy for borderline personality disorder (BPD). NSSI is grouped with suicidal behaviors as 'maladaptive solution behaviors to the problem of overwhelming, uncontrollable, intensely painful negative affect' [38]. Linehan's central theory is that a subgroup of individuals (often those diagnosed with BPD) are more sensitive to, more reactive to and take longer to recover from emotional stimuli [39]. Linehan states that 'cutting and burning the body … seem to have important affect-regulating properties' though '[t]he exact mechanism here is unclear' [38].

While intrapersonal functional conceptualizations dominate the NSSI literature, Nock [40] incorporates 'idioms of distress' from anthropology and 'signals' from animal signaling into his interpersonal conceptualization of NSSI. He posits that NSSI may communicate 'signals of distress and signals of strength and fitness' [40]. A signal of distress is designed to elicit caregiving from others; Nock suggests that this distress signal may escalate to NSSI 'after one habituates to the level of caregiving provided in response to a weaker signal, when the level of caregiving decreases over time, or in the context of an "extinction burst" when caregiving is no longer provided in response to earlier signals' [40]. As a signal of strength and fitness, NSSI may indicate that 'a person has sufficient strength or fitness to withstand the injury resulting from the behavior' [40].

Emotions and NSSI

Emotions are a common thread running through both lay and clinical conceptualizations of NSSI, whether the emotions are feelings of comfort, relief or affiliation. Re-

search comparing support for a variety of models has found consistent evidence for the central role of affect and emotion [37, 41]. However, simply noting that affect and emotion play a central role in NSSI does little to illuminate exactly what that role is. This review seeks to bring an explicit affective-science perspective to bear on the role of emotions in NSSI. Before exploring this topic, however, we must clarify our use of the terms 'emotion' and 'affect'.

Defining Emotion

The terms 'emotion', 'mood' and 'affect' are often used interchangeably. However, affect scientists find it useful to distinguish among these terms. An emotion and a mood can be differentiated by the length of time over which they take place: emotions are short, while moods can last hours to days, or even weeks. Moods are more of a 'pervasive and sustained emotional "climate"' [13], and they are not always tied to specific events [42]. In contrast, emotions have a quick onset and often last only minutes or even seconds [43]. Affect is the broadest and most inclusive term for a valenced (i.e. positive or negative) state, covering moods and emotions as well as preferences and attitudes [44]. Emotions may be conceived of in terms of two relatively independent underlying dimensions: positive activation and negative activation [45]. Positive activation represents 'the extent to which a person avows a zest for life' [46]. Negative activation represents 'the extent to which a person reports feeling upset or unpleasantly aroused' [46]. For each of these dimensions, the high end represents a state of emotional arousal, whereas the low end represents a lack of affective involvement [46]. Arousal, or activation, refers to the mobilization or energy felt as part of the emotional experience [47].

Like other affective processes, emotions are embodied (i.e. physical) phenomena that consist of loosely coupled changes in peripheral physiology, subjective experience and behavior [48]. During an emotion episode, these changes show some degree of coherence [49]. Changes in peripheral physiology include heart rate, respiration, sweating and skin temperature [43]. Subjective experience is the internal feeling of the emotion [44]. The behavior can include changes in facial expression and vocal tone [43], as well as broader changes in behavioral tendencies [50]. In mobilizing physiological, experiential and behavioral systems, emotions prepare us to engage or withdraw as needed [50, 51].

Negative Activation and NSSI

In studies relying upon retrospective recall, individuals report a variety of high-activation negative emotions prior to NSSI including tension [52], anxiety [53], nervousness [53], anger [14, 53–56], sadness [14, 55, 57], frustration [56, 57] and self-hatred [55]. For the most part, individuals recall that high-activation negative emotions are significantly decreased after NSSI [53, 55, 56, 58, 59]. One exception to this is the frequent endorsement of an increase in shame [56] and guilt [60].

A number of studies have sought to explicitly measure changes in negative activation in NSSI. Haines et al. [61] were the first to measure affect while using personalized imagery scripts as a proxy for NSSI. Participants were interviewed in order to collect the details of an incident in which they had cut themselves, and these stories were turned into a guided imagery script which included four stages: (1) setting the scene, (2) approach, (3) incident and (4) consequence. Among prisoners who engage in NSSI, psychophysiological arousal remained high while they listened to the scene-setting and approach stages, then significantly decreased in the incident stage, remaining low in the consequence stage [61]. In comparison, matched controls, when listening to a script of an act of NSSI, showed tension through the incident stage [61].

In a study that used both NSSI and non-NSSI scripts, Brain et al. [62] asked participants (individuals with a recent history of NSSI, those with a distant history of NSSI, and matched controls) to create personalized imagery scripts for a neutral event, an angry incident, an accidental injury and an actual incident of NSSI (with the exception for the non-NSSI group of the NSSI incident). No differences in psychophysiological responses (finger pulse amplitude, heart rate, respiration and skin conductance level) were found between the NSSI and non-NSSI groups for the neutral script [62]. For the NSSI group's self-injury script, the physiological responses were different from those of their accidental injury and anger scripts, with arousal decreasing significantly during the incident stage (whereas in the other two scripts, arousal peaked during the incident) [62].

Another laboratory proxy assessed the effect of a forearm incision on subjective aversive tension [63]. Study participants were subjected to a stress induction, then received either a small forearm incision by scalpel or sham condition of being touched by the back of the scalpel [63]. Among study participants with a diagnosis of BPD (who had been assessed as engaging in NSSI at least once per

week), aversive tension dropped following both the incision and sham procedures, whereas healthy controls experienced a significant increase in aversive tension following the incision procedure [63].

Researchers have sought to improve upon retrospective recall and laboratory proxies by asking individuals who engage in NSSI to record their moment-to-moment emotions over the course of days or weeks using ecological momentary assessment (EMA). EMA requires participants to carry handheld computing devices that prompt the participant to record data at given intervals. Nock et al. [64] asked adolescents who had engaged in NSSI at some time over the past 2 weeks to complete EMA measures after any sort of self-injurious thought or behavior, as well as at midday and evening. Results indicated that 'feeling rejected, anger toward oneself, self-hatred, numb/nothing, and anger toward another' were predictive of engaging in NSSI, but the odds of NSSI decreased in the presence of feeling sad or worthless [64]. College students using EMA recorded statistically significant increases in guilt and anger prior to NSSI [65]. While participants reported less than 1 h of preparation time before engaging in NSSI, changes in affect were detectable via EMA many hours beforehand [65]. Negative affect reduced gradually following the NSSI episode, with change approximating a quadratic curve [65].

Positive Activation and NSSI

Researchers have also sought to investigate changes in positive activation surrounding NSSI. For example, 69.2% of one sample said that they feel better immediately after engaging in NSSI. However, 1 h after NSSI, about one third recalled feeling better and one third recalled feeling worse [66]. Studies relying upon retrospective recall have gathered reports of significant increases in feelings of relief during [56] and after NSSI [14, 52, 54, 56, 57, 67, 68], as well as feeling calm [57, 68], peaceful [58] and attentive [68] following NSSI. If we examine these emotions from a dimensional perspective, however, they may be better conceptualized as low in negative activation rather than high in positive activation. Two retrospective recall studies did find increases in emotions that appear to be high in positive activation: vigor [59] and happiness [58].

Muehlenkamp et al. [69] found that EMA measures among young women diagnosed with bulimia nervosa showed significant increases in negative affect and significant decreases in positive affect prior to acts of NSSI. This study used the Positive and Negative Affect Schedule, or PANAS, to measure changes in affect. Analyzed PANAS results did not separate out emotional states that can be categorized as high in positive activation, such as enthusiastic, from emotions such as calm, attentive and relaxed, which can be categorized as low in negative activation. In contrast to findings by Armey et al. [65] of decreased negative affect following NSSI among college students, Muehlenkamp et al. [69] concluded that positive affect significantly increased following NSSI but negative affect did not change. The difference between the two studies' findings could be due, in part, to the inclusion of a subscale measuring guilt in the study by Armey et al. [65]; guilt was not measured by Muehlenkamp et al. [69].

Individuals with BPD who reported an absence of pain during NSSI experienced an improvement in mood [70, 71] and a reduction in tension [71] following a cold pressor test (CPT) – immersion of one hand in cold water, used as a proxy for NSSI – whereas individuals with BPD who reported pain during NSSI did not [70, 71]. Franklin et al. [72] combined the CPT with acoustic startle. Startle has been extensively used to measure affective valence, with increases in startle response corresponding to increases in negative affect [72]. Prepulse inhibition (PPI) of acoustic startle (when a stimulus, or prepulse, is presented briefly before the startle-eliciting stimulus) has been used as a measure of the quality of neural information processing, with higher PPI indicating greater cognitive processing [72]. Additionally, increased arousal is associated with lower baseline PPI [72]. After undergoing a CPT, the NSSI group did not feel subjectively less distressed [72], but all who completed the CPT showed less startle reactivity, which led the authors to suggest that 'pain regulates affective valence' [72]. During the CPT, PPI increased for the NSSI group, but decreased for control and matched affect dysregulation groups [72]. This may mean that for the NSSI group, pain increased the quality of their information processing, but for non-NSSI individuals it had the opposite effect.

In general, it appears that most of the emotional change accompanying NSSI occurs through movement along the negative activation continuum, from high negative to low negative activation. While differences in terminology can make discussions of changes in affective state difficult, the bulk of the evidence suggests that the positive affect that emerges through NSSI may be principally via increases in low negative activation such as calm, rather than via changes in positive activation.

Emotion Regulation and NSSI

As we have seen, individuals appear to experience states of high negative activation before NSSI, which decrease afterward, giving rise to relief and other low negative activation states. A common term used to describe these changes in the literature on NSSI is 'emotion regulation', but this term is used in many different ways, and it is rarely, if ever, carefully defined. In order to clarify the nature and extent of effects of NSSI on emotions and other affective states, it is useful to draw upon the emerging literature on emotion regulation [10, 11].

Defining Emotion Regulation

Emotion regulation may be defined as the attempts individuals make to 'influence which emotions they have, when they have them, and how they experience and express them' [51]. This means that we can not only modulate our emotional behavior (i.e. the response tendency), we can also assert control over the intensity of our emotions and even which emotions we have. The need to regulate emotions arises because emotions are not always helpful – they can be of the wrong strength, come at the wrong time or be of the wrong type [43]. The target of emotion regulation can be both the expression and the experience of emotion [51], and while negative emotions are often the focus of studies of emotion regulation, positive emotions may be regulated as well [51].

The process model of emotion regulation posits that emotions can be regulated at five points in the emotion-generative process: (1) selection of the situation, (2) modification of the situation, (3) deployment of attention, (4) change of cognitions and (5) modulation of responses [51]. Situation selection involves the choice of whether or not to enter an environment that will bring about an emotional response. Situation modification regulates emotion by changing an otherwise unavoidable situation so that the emotions brought about in that situation will be modified or attenuated. Attention has been likened to 'an all-purpose "gatekeeper" that allows passage of goal-relevant information for further processing' [73]. As an emotion regulation strategy, attentional deployment involves the shifting of attention toward or away from stimuli likely to prompt an emotional response. Cognitive change involves the way an individual thinks about an emotion-provoking situation or stimulus. The appraisal of a situation influences the individual's emotion and the emotional intensity resulting from that situation [74]. Individuals

can ruminate, having 'repetitive thoughts around a common theme' [74], and they can also reappraise, or reinterpret the meaning of something [74]. Response modulation happens when individuals directly change the way they respond in an emotional situation. It occurs after the emotional response tendency has been generated, and involves 'influencing physiological, experiential, or behavioral responding as directly as possible' [75]; anxiolytic drugs, beta blockers and exercise are all examples of response modulation [75].

Situation Selection and NSSI

Thus far, empirical research has not focused on the ways in which individuals who engage in NSSI use situation selection to regulate emotional state. It stands to reason that individuals may choose to engage in NSSI in lieu of entering into an environment that they predict will be more distressing. Engaging in NSSI may lead to new situations, such as being taken for medical attention, or provide excuses for avoiding otherwise stressful situations, such as going to a swimming pool. Desire to conduct the behavior in private may also lead to isolation. Hilt et al. [76] found that young adolescent girls who were subject to peer victimization endorsed engaging in NSSI for social-negative reinforcement ('to avoid being with people') [76], which could indicate that NSSI is a way of avoiding situations in which they are subjected to bullying.

Situation Modification and NSSI

NSSI may allow individuals to modify their situation in a number of ways. Nock and Prinstein's [36] concepts of social reinforcement may be ways of modifying the environment in order to decrease negative and increase positive emotions. As mentioned above, NSSI as a signal of distress may elicit caregiving [40]. Spurring the people around them to act in a more caring way can be a way of modifying the situation. This theory is supported by the finding that among young adolescent girls, peer victimization was related to the social-positive reinforcement functions of NSSI ('to get attention') [76].

Another of Nock's [40] hypotheses, NSSI as a signal of strength and fitness, may also modify the environment by warding off potentially emotion-inducing unpleasant interactions. If NSSI signals strength to potential bullies who then cease or reduce victimization, the situation has been modified to reduce negative emotions. In a related

vein, Chapman et al. [37] note that in self-punishing, individuals who engage in NSSI may alter the demands that others might place on them. This can be another way of modifying the environment so that fewer negative emotions occur.

Attentional Deployment and NSSI

Numerous theories such as the EAM reviewed above [37] suggest that NSSI may be a way of diverting attention away from distressing thoughts. In the EAM, Chapman et al. [37] suggest that NSSI may act to distract or shift attention from emotional pain to physical pain, but they note that this may not be compatible with reports of absence of physical pain sensation during NSSI. They also suggest that an orienting response may be at work, jarring the individual out of dissociation, but unfortunately they are not able to offer empirical support for this hypothesis [37].

Najmi et al. [77] suggest that individuals may use NSSI as a 'focused distracter from thoughts that create aversive emotions' after use of an unfocused distraction strategy (using many different repetitive distracters) is unsuccessful. They note that unfocused distraction strategies can actually cause a rebound of the suppressed thought [77]. Supporting this theory of NSSI as focused distracter, the second most common reason given in one survey was 'to distract yourself from painful feelings' [14].

Engagement in NSSI has been found to correlate with at least one type of attentional emotion regulation strategy: suppression of thoughts and emotions. The most common retrospective reason given for NSSI was 'to avoid or suppress negative feelings' [53]. Participants who were categorized as showing moderate-to-severe NSSI (monthly or more, requiring first aid, and within the past year) reported more emotion suppression and avoidant coping than those who did not engage in NSSI [35]. Avoidant personality traits were found to be significant predictors of NSSI frequency among women diagnosed with BPD [78]. Najmi et al. [77] also found that the relationship between self-reported emotional reactivity and frequency of NSSI was partially mediated by 'the propensity to suppress unwanted thoughts' [77] and that a tendency to suppress unwanted thoughts was associated with endorsing 'to get rid of bad feelings' [77] as the individual's reported reason for engaging in NSSI.

Niedtfeld et al. [79] found bilateral insula activations in participants with BPD only when painful stimuli followed neutral pictures; after negative pictures, both painful and warm sensory stimuli had a dampening effect. The authors interpreted this finding as reflecting an attentional shift in the service of emotion regulation [79].

Weierich and Nock [80] examined reexperiencing symptoms (intrusive recollections, physiological reactivity secondary to recollections) and avoidance/numbing symptoms (efforts to avoid trauma reminders, difficulty feeling positive emotions) among adolescents. The relationship between retrospectively reported childhood sexual abuse and NSSI was independently mediated by both reexperiencing symptoms and avoidance/numbing symptoms [80]. This could suggest that NSSI may be a way to direct attention away from intrusive recollections or to avoid trauma reminders.

Dissociation is another trait frequently studied in conjunction with NSSI [22, 58, 81–86]. Dissociative states are characterized by a subjective reduction in sensory perception [87], and a significant percentage of individuals who engage in NSSI report the absence of pain during self-injury [88]. Lack of pain during NSSI may be a mark of dissociation, and as dissociation can be conceptualized as a type of cognitive control along the continuum of attentional awareness [89], dissociation during NSSI may be considered a type of attentional shift.

Another type of attentional deployment is rumination, in which an individual concentrates on feelings and their consequences [75]. Hilt et al. [76] found a significant correlation between rumination and engaging in NSSI for automatic negative reinforcement, though rumination did not mediate the relationship between NSSI and an automatic negative reinforcement function. They also found that depressive symptoms interacted with a more ruminative style, predicting engaging in NSSI for automatic-positive reinforcement functions such as 'to feel something, even if it is pain' and 'to relax' [76].

Cognitive Change and NSSI

One common reason given for engaging in NSSI is to 'punish oneself' [53]. Self-punishment has been conceptualized as a thought control strategy [90]. Chapman et al. [37] theorized: 'Self-punishment may be conceptualized as an attempt to avoid shame or unwanted negative beliefs about the self, as punishing the self may alleviate feelings of guilt or shame.' Others have also suggested that some of the relief reported by individuals following NSSI may be from 'relief of anxiety and guilt through self-punishment' [91]. Roseman et al. [92] identified the desire to self-punish as a characteristic action tendency for guilt.

They noted: 'Guilt seems to be an emotion in which people think about their transgressions and may attack themselves to rectify the situation' [92]. Self-punishment has been seen as a means of allowing individuals to 'restore their self-image after violating personal standards' [93]. If NSSI relieves guilt by allowing individuals to reappraise their view of themselves, it may be considered to act via cognitive change.

Experimental manipulations have found that individuals will engage in self-punishment if there is no way to compensate for the transgression that led to the feelings of guilt [93]. Self-criticism has been found to mediate the relationship between childhood emotional abuse and NSSI; self-criticism continued to predict NSSI when depression was controlled for [94]. Self-criticism scores were significantly associated with endorsement of self-punishment as a reason for engaging in NSSI, but not with other functional options such as automatic-negative reinforcement, or social-negative or -positive reinforcement [94].

NSSI could also spur cognitive change by shifting an individual's self-view from a higher-order to a lower-order self. That is, as suggested by Baumeister [95], physical pain may allow an individual to be 'aware of oneself at a low level, as a mere body experiencing sensations and movements' [95], rather than having the ordinary high-level awareness of the self 'as involved in various projects and relationships, with multiple ambitions, goals, responsibilities, and so forth' [95]. For individuals feeling overwhelmed by their responsibilities and the demands of their higher-order self, this cognitive transformation may provide relief by muting or silencing patterns of higher-level construal about the self that are producing negative emotions.

Response Modulation and NSSI

Theorists have suggested that the positive emotions induced by NSSI may come from release of endorphins [91, 96, 97]. Stanley et al. [98] examined individuals who were depressed, were diagnosed with cluster B personality disorders and had histories of suicidal behavior; they then divided them into two groups based on whether they had a history of repeated NSSI or no NSSI history. Cerebrospinal fluid in the NSSI group had significantly lower levels of two kinds of endogenous opioids: β-endorphin and Met-enkephalin [98]. Theorists suggest that if NSSI releases β-endorphin and enkephalins, increasing binding at μ- and δ-opioid receptors, lower resting levels of β-endorphin and enkephalins could increase the reward value of NSSI due to increased sensitivity to the resulting analgesia and euphoria [97]. Acupuncture therapy has been shown to increase short- and long-term μ-opioid receptor binding potential [99], and a pilot study of ear acupuncture successfully reduced acts of NSSI among a group of depressed adolescents [100]. Additionally, case studies [96, 101–103] and a pilot study with 5 participants [104] describe the successful use of naltrexone (an opioid receptor antagonist) in the treatment of NSSI. Buprenorphine, a μ-opioid partial agonist and κ-opioid antagonist, has also shown promise in case studies in reducing severe NSSI [105].

Glenn and Klonsky's [106] research focusing on the role of seeing blood in NSSI suggests a number of ways in which NSSI may be influencing physiological arousal. Seeing blood in films leads to initial heart rate deceleration [107]. Studies of blood phobia show parasympathetic rebound following initial sympathetic response to seeing blood [108].

Solomon's [109] opponent-process theory may be helpful as a way of understanding the physical changes brought about by NSSI. The opponent-process theory suggests that with repeated exposure to a stimulus over time, the initial process decreases while the secondary process increases [109]. Joiner [110] applied this theory to suicide, and Chapman et al. [37] suggested that its application to NSSI may be fruitful as well. For NSSI, the initial process would be the experience of fear, physical pain and sympathetic nervous system activation. The secondary process would be relief, analgesia and parasympathetic nervous system activation. Over time, individuals engaging in NSSI would experience less of the initial fear, pain and sympathetic activation, and more of the relief, analgesia and parasympathetic response. The findings by Franklin et al. [72] that the control group also experienced a reduction in negative emotion following an NSSI proxy offers some support for the opponent-process theory of NSSI. The secondary process of relief and parasympathetic response may be detectable in all individuals, but it is possible that only a certain subset stumbles upon this mechanism and turns to it as a method of emotion regulation.

Directions for Future Research

NSSI is widely believed to regulate problematic emotions, and several decades of research seem to bear out this idea. In this review, we have shown how an emotion
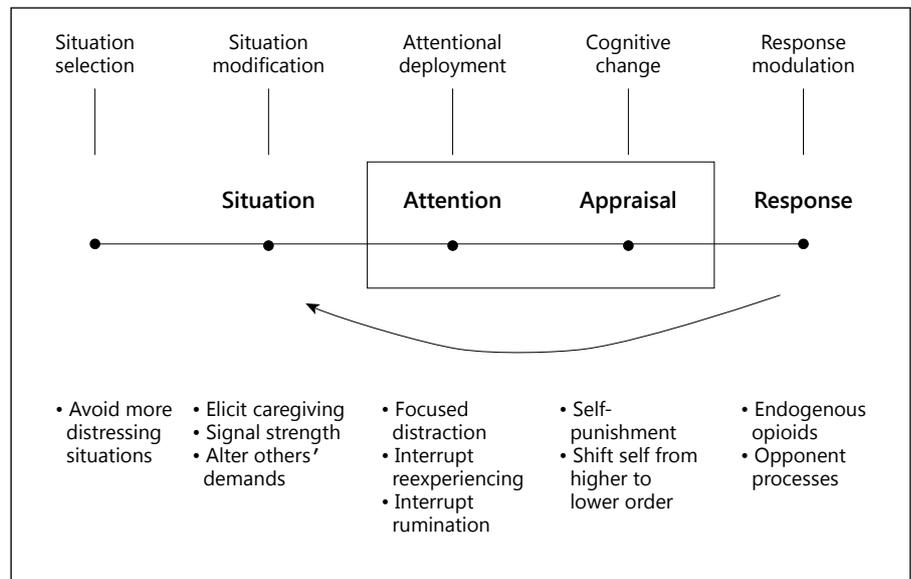
Fig. 1. Process model of emotion regulation and NSSI. Adapted from Gross and Thompson [75].

regulation perspective may be used to organize these findings. Our review suggests that multiple families of emotion regulation may be engaged by NSSI. As summarized in figure 1, individuals may engage in NSSI as an alternative to more distressing situations, using situation selection. Individuals may use NSSI to modify their social environment, resulting in situation modification. Individuals may also shift their attention away from unpleasant emotions or thoughts via NSSI. NSSI may change cognitions about the self via self-punishment or transformation of the self away from higher-order to lower-order awareness. NSSI may also bring about various physiological effects, such as changes in endogenous opioids or parasympathetic nervous system activation, as a way of modulating emotional responses. These findings have a number of broad implications and suggest many different directions for future research.

Momentary Functions of NSSI

One of the most important points to emerge from examining NSSI through the framework of the process model of emotion regulation is that simply labeling NSSI as 'emotion regulatory' does not tell us precisely what is going on. This is because, at any given moment, NSSI can serve to regulate emotions in many ways. NSSI may act to select or modify the individual's environment, to shift attention, to change cognitions about the self or environment, and to modulate the individual's physiological re-

sponses. It could draw upon just one of these processes or many at once. For this reason, it would be unwise for researchers or clinicians to assume that they know which purpose any given instance of NSSI serves.

One important direction for future research is to clarify the precise functions NSSI may be serving for a given individual in a particular context. In analyzing the processes engaged by NSSI in a particular context, it will be useful to clarify how each of these momentary functions relates to one another. For instance, an act of NSSI which is prompted by feelings of guilt may modify the expectations of others via preemptive punishment, restore the individual's self-image, and shift the individual's self-view from a troubling higher-order to a less-fraught lower-order self. For an individual struggling with traumatic reexperiencing, NSSI may distract, provide suppression through dissociation and soothe via activation of an opponent process.

Some research has been conducted on the relationships between these functions. Glassman et al. [94] found that self-criticism scores were significantly associated with endorsement of self-punishment as a reason for engaging in NSSI, but not with automatic-negative, social-negative or social-positive reinforcement. In addition to finding that peer victimization among young adolescent girls was related to the social functions of NSSI, Hilt et al. [76] found that peer victimization was *not* related to the automatic functions. Additionally, individuals whose friends engaged in more NSSI reported feeling more pain during NSSI [88]. This may mean that individuals who

are using NSSI for social reasons are not the same individuals experiencing dissociation during NSSI (the relationship noted by Hilt et al. [76]). Clearly, however, much more remains to be learned about the specific functions NSSI serves in any given context, and how these various functions may be linked to one another and related to specific families of emotion-regulatory processes.

Heterogeneity of Individuals and Timing

Building upon evidence of heterogeneity among momentary methods of emotion regulation, this review suggests evidence for heterogeneity among individuals who engage in NSSI. As noted in Klonsky's [15] prevalence estimates, while 5.9% of US adults engaged in NSSI at least once, only 1.3% reported 10 or more occasions. This suggests that a significant proportion of NSSI-engaging individuals have only done so on 9 or fewer occasions. It is plausible that individuals using NSSI on only a handful of occasions would engage different aspects of the emotion regulation family than those for whom NSSI becomes habitual. For example, it may be that if NSSI serves to signal distress and mobilize caretaking, only a small handful of episodes are needed. As research has found a general deficit in emotion regulation skills among individuals engaging in NSSI [111, 112], it may be that individuals who sample NSSI but do not find it sufficiently reinforcing to continue are able to turn to other emotion-regulatory strategies.

Another area of heterogeneity concerns the age of individuals who engage in NSSI. Adolescence is the most common time period for this behavior to occur, although Klonsky's [15] survey found that almost a third of individuals continued to engage in NSSI beyond the age of 25 years. This may relate to the development of different (perhaps more adaptive or more socially acceptable) means of regulating emotions with increasing age. It may also relate to improvements in executive functioning with the maturation of the frontal lobes. Engagement in self-injury has not been found to correlate with performance on common neuropsychological tests of executive functioning, however [113].

A third area of heterogeneity among individuals who engage in NSSI concerns the experience of physical pain during NSSI. It appears likely that the individuals who do not experience pain during NSSI are benefiting from the emotion-regulatory strategies of response modulation and/or attentional shift. One explanation for the heterogeneity found among individual traits and emotion regulation families would be the existence of separate subgroups. One subgroup dissociates during NSSI – leading to reduced pain sensation during the act of self-injury – and experiences physiological relief and reduction in tension during the act as well. Another subgroup feels pain during NSSI and is motivated by cognitive change or social factors.

Many questions arise from contemplating the potential existence of these subgroups. For instance, does an individual begin NSSI for social reasons at one point in life (e.g. early adolescence) and then subsequently transition to engaging in NSSI for automatic reinforcement? The opponent-process theory supports this transition from one subgroup to another, as it would take time (and multiple episodes of NSSI) for the secondary process to strengthen enough to become reinforcing. If the secondary process is not immediately reinforcing, there must be some other property of NSSI that the individual finds worthwhile; this may initially be a cognitive or social factor. NSSI may always serve an emotion-regulatory purpose, but the method may shift from operating via situation modification to response modulation. More longitudinal studies of NSSI may illuminate this relationship. As suggested by Bloom and Holly [114], the existence of two subtypes suggests that treatment effectiveness may vary by group.

Underlying Mechanisms

As this review makes clear, it is unlikely that there is one single mechanism underlying the diverse phenomena gathered together under the umbrella term of NSSI. One of the important challenges for future research will be to more precisely define the physiological and psychological mechanisms that underlie particular instances of NSSI.

Physiological mechanisms may be particularly important among individuals for whom NSSI becomes habitual. Differences in levels of endogenous opioids may be either the cause or the result of NSSI – individuals may be engaging in NSSI in order to release endogenous opioids as a way of making up for a natural deficit, or lower levels may be the result of repeated NSSI. Better understanding of the physiology of NSSI will also inform treatment decisions, such as the use of naltrexone. For example, naltrexone may be effective with individuals who use NSSI for response modulation, but not with those who use NSSI for situation modification. Research on stress response and cortisol may also prove enlightening. A case study showed a pattern involving NSSI and cortisol levels – over

3 months, when cortisol excretion increased above a certain threshold, the individual engaged in NSSI and cortisol dropped down again [115]. A recent study found that the hypothalamic-pituitary-adrenal axis is hyporesponsive in adolescents with NSSI, with the resulting hypothesis that reduced secretion of cortisol could lead to maladaptive stress responses such as NSSI [116].

Regarding psychological underpinnings, there is a major lack of understanding of the moment-to-moment experiences – particularly cognitions – in episodes of NSSI. Partly this is based on the difficulty of studying the actual behavior in a laboratory setting, and the need for more innovative methods of gathering these data. This information is important because the relationship of NSSI to self-punishment, rumination, intrusive recollections and trauma reminders can be elucidated by investigating exactly what thoughts and images an individual experiences immediately prior to and following an episode of NSSI. The temporal relationship between NSSI and particular cognitions and emotions is an essential part of understanding how to treat and prevent this behavior, and it is clear that much remains to be learned about how NSSI serves to regulate negative and positive activation in different individuals in different contexts.

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