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The Four-Function Model of Nonsuicidal Self-Injury: Key Directions for Future Research

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Abstract

Nonsuicidal self-injury is receiving increasing attention in empirical and clinical realms. Indeed, the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* designated nonsuicidal self-injury as a condition that requires further study, which signals possible future official adoption. Despite growing interest in this perplexing phenomenon, much remains unknown about why nonsuicidal self-injury occurs, including fundamental features of its etiology and underlying mechanisms. In addition, no evidence-based interventions that directly target this maladaptive behavior currently exist. The recently developed, empirically supported four-function model posits that nonsuicidal self-injury is maintained by four distinct reinforcement processes. In this review, we used the four-function model to guide the understanding of important unanswered questions and suggest much-needed studies for future research in the field of self-injury.

Keywords

nonsuicidal self-injury, functional analysis, research methods and experimental design, prevention, evidence-based treatments

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Recent years have witnessed a proliferation of research exploring the phenomenon of nonsuicidal self-injury (NSSI); however, a great deal remains unknown about this alarmingly pervasive behavior. Our aim in the present review was to use the recently developed, empirically supported four-function model (FFM) of NSSI (Nock, 2009, 2010; Nock & Prinstein, 2004) as a conceptual base to generate important next steps for research on self-injury. Functional approaches have guided the understanding of a wide range of disorders, including anxiety (e.g., Barlow, 2002), depression (e.g., Dimidjian et al., 2006), and substance use (e.g., Dutra et al., 2008). Drawing from this functional model of self-injury may similarly help identify research initiatives necessary to advance knowledge of NSSI and bolster the development of much-needed evidence-based treatments. In this review, we first briefly discuss the classification, prevalence, clinical significance, and transdiagnostic nature of NSSI. Next, we present the evidence-based FFM of NSSI. We then use the model to inform the understanding of seven unanswered questions

about self-injury and a research agenda for studies aimed to answer them.

Classification, Prevalence, and Clinical Significance

Nonsuicidal self-injury refers to the deliberate destruction of one's own bodily tissue in the absence of suicidal intent and for reasons not socially sanctioned (Favazza, 1996; Nock & Favazza, 2009). Methods of NSSI include cutting, scratching, burning, hitting, banging, and interfering with wound healing (Klonsky, 2011; Nock & Prinstein, 2004). The method of choice for 70% to 90% of individuals who engage in NSSI is skin cutting (Klonsky, 2007), followed by 21% to 44% who use banging or

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hitting, and 15% to 35% who use burning (Briere & Gil, 1998; Nijman et al., 1999; Rodham & Hawton, 2009). NSSI is most prevalent in young adult and adolescent populations (Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007; Nock, 2010), with individuals between the ages of 18 and 25 considered to be highest risk group for engagement in NSSI (Rodham & Hawton, 2009). Estimates of the lifetime prevalence rates of NSSI in adolescents fall between 13% and 45% (e.g., Muehlenkamp, Claes, Havertape, & Plener, 2012; Plener, Libal, Keller, Fegert, & Muehlenkamp, 2009; Ross & Heath, 2002); among clinical samples, rates rise to between 40% and 60% (e.g., Darce, 1990; DiClemente, Ponton, & Hartley, 1991). Lifetime prevalence rates of NSSI in adults in the United States are estimated to fall between 4% and 28%, and among adult clinical populations, prevalence rates range from 19% to 25% (Briere & Gil, 1998; Shaffer & Jacobson, 2009). In sum, epidemiological studies have suggested that NSSI is pervasive across individuals of all ages.

NSSI also leads to troubling consequences with clinically significant implications. The most observable consequence of NSSI is physical harm. However, self-injuring individuals tend to evidence other short- and long-term consequences, including heightened aversive feelings and emotions (e.g., anger, guilt, shame) and academic difficulties for children and college students (Briere & Gil, 1998; Klonsky, 2009). NSSI behavior is also a prospective predictor of suicide attempts (e.g., Asarnow et al., 2011; Guan, Fox, & Prinstein, 2012; Klonsky, May, & Glenn, 2013; Wilkinson, Kevin, Roberts, Dubicka, & Goodyer, 2011), and a longer history of NSSI is associated with increased prevalence of suicidal behaviors (Nock, Joiner, Gordon, Lloyd-Richardson, & Prinstein, 2006). Furthermore, research has shown that NSSI can result in other medical complications, including heightened risk for contracting infectious diseases (e.g., HIV; DiClemente et al., 1991), and that more frequent NSSI is associated with lower overall functioning (Klonsky & Olino, 2008).

A Transdiagnostic Behavior

In the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; American Psychiatric Association, 2000), NSSI appeared only as a symptom of borderline personality disorder (BPD). However, studies have indicated that NSSI co-occurs with many other externalizing and internalizing disorders, including major depressive disorder, post-traumatic stress disorder, generalized anxiety disorder, obsessive-compulsive disorder, substance use and eating disorders, as well as a range of personality disorders (e.g., Briere & Gil, 1998; Haw, Hawton, Houston, & Townsend, 2001; Klonsky, 2003; Muehlenkamp, Miller, & Turner, 2008; Nock et al., 2006;

Zlotnick, Mattia, & Zimmerman, 1996). In a recent interesting study, researchers sought to address lingering concerns that NSSI is solely associated with severe BPD (Selby, Bender, Gordon, Nock, & Joiner, 2012). Results showed that individuals with BPD (with or without NSSI; $n = 24$) and individuals with NSSI (without BPD; $n = 65$) displayed similar levels of functional impairment and psychopathology. Also, most individuals in the NSSI without BPD group endorsed fewer than four symptoms of BPD and did not have a diagnosis of personality disorder not otherwise specified, which suggests that NSSI is not better accounted for by these disorders. Other recent research has indicated that adolescents engaging in NSSI (with substance abuse or dependence) evidenced higher levels of negative affect and lower levels of positive affect than did addicted adolescents without NSSI (Claes et al., 2012). These findings, in addition to others (e.g., Baetens, Claes, Willem, Muehlenkamp, & Bijttebier, 2012), emphasize the significant role of transdiagnostic, higher-order dimensions of temperament in NSSI. Considered together, recent research supports the growing conceptualization of NSSI as transdiagnostic, rather than as a specific symptom of one disorder.

Given that NSSI is transdiagnostic, highly prevalent, and associated with significant distress and impairment, proposals have been made to include NSSI as an autonomous disorder in future versions of the *DSM* (Shaffer & Jacobson, 2009). In the current version of the *DSM* (5th ed.; *DSM-5*; American Psychiatric Association, 2013), NSSI disorder is included in Section III as a condition that requires further study, which signals possible future official adoption. It has been argued that a narrowly defined category for describing NSSI in the *DSM* may improve interprofessional communication, facilitate efforts to monitor prevalence of NSSI, foster research initiatives to better understand self-injury, and, perhaps most important, improve clinical care (Plener & Fegert, 2012; Shaffer & Jacobson, 2009). The adoption of NSSI disorder in future iterations of the *DSM*, if it occurs, may hold significant benefits across important areas in the field of self-injury.

FFM of NSSI

During the past several decades, researchers, academics, and clinicians alike have articulated a broad range of theories to address why people engage in self-injurious behavior. Early perspectives suggested that self-injury is enacted to create boundaries between the self and others (Suyemoto, 1998), replace suicide (Firestone & Seiden, 1990; Suyemoto, 1998), stop or elicit dissociation (Herpertz, 1995; Himber, 1994; Miller & Bashkin, 1974), control one's sexuality (Friedman, Glasser, Laufer, Laufer, & Wohl, 1972; Suyemoto, 1998), or externalize and control emotion to punish the self or protect others (e.g.,

Friedman et al., 1972; Herpertz, 1995; Himber, 1994). The importance of interpersonal influence has also been widely emphasized across conceptual accounts of self-injury (e.g., Bennum, 1984; Offer & Barglow, 1960; Simpson, 1975). Although these theories collectively cover a variety of issues pertinent to self-injury, they lack strong empirical support. Each of these individual perspectives also falls short in addressing the multitude of reasons why an individual might engage in NSSI. Thus, the need for an evidence-based, comprehensive model of self-injury has persisted into the 21st century.

A recently developed functional model of NSSI may satisfy this need. Functional approaches propose that behaviors are largely controlled by events that immediately precede and follow them (i.e., antecedents and consequences). Thus, hypotheses suggested by functional theories lend themselves well to experimental testing; for example, when one presents stimuli expected to reinforce the behavior of interest, the behavior should increase. Conversely, when one removes stimuli expected to reinforce the behavior of interest, the behavior should decrease. This approach has directly guided insight into and the assessment and treatment of a variety of psychological and behavioral problems (e.g., Hayes, Wilson, Gifford, Follette, & Strosahl, 1996) and has the potential to be equally informative for the field of self-injury.

The FFM of self-injury (Nock, 2009, 2010; Nock & Prinstein, 2004) posits that NSSI is maintained by four distinct functional reinforcement processes (see Table 1 for the key tenets of the FFM). Each process falls along two dichotomous dimensions: negative versus positive and automatic (i.e., intrapersonal) or social (i.e., interpersonal) contingencies. The four processes include automatic negative reinforcement (ANR; i.e., NSSI that serves to reduce aversive affective or cognitive states), automatic positive reinforcement (APR; i.e., NSSI that serves to generate positive feelings or stimulation), social negative reinforcement (SNR; i.e., NSSI that serves to facilitate escape from social situations or remove interpersonal demands), and social positive reinforcement (SPR; i.e., NSSI that serves to elicit attention, facilitate access to resources, or promote help-seeking behavior). The FFM was developed by building directly on voluminous research on the functions of self-injurious behavior among individuals with developmental disabilities (e.g., Iwata et al., 1994) and has garnered a considerable amount of research support in typically developing

samples to date (e.g., M. Z. Brown, Comtois, & Linehan, 2002; Haines, Williams, Brain, & Wilson, 1995; Lloyd-Richardson et al., 2007; Nock & Mendes, 2008; Nock & Prinstein, 2004, 2005). Another key proposition of this model is that the combination of general vulnerabilities to experience difficulties regulating one's affective/cognitive states or influencing one's social environment and self-injury-specific factors increases the risk of engagement in NSSI (Nock, 2010).

Although the FFM may not explain all factors that contribute to NSSI (e.g., biological predispositions, environmental influences), this model represents a marked advancement from prior accounts of self-injury for several important reasons. First, previous research has focused largely on identifying psychosocial characteristics associated with NSSI (e.g., suicidality, depression, anxiety, impulsiveness), which although useful in helping to identify individuals at high risk for self-injury, does not explain why individuals perform this behavior. The FFM, however, classifies self-injury according to the specific antecedents and consequences that cause and maintain it, thereby delineating specific reasons individuals perform NSSI, rather than the topographical characteristics associated with it. Second, other theoretical models often focus narrowly on the role of affect regulation in self-injury and deemphasize social functions (e.g., Chapman, Gratz, & Brown, 2006; Klonsky, 2007), whereas this model integrates automatic and social reinforcement, and distal and specific risk factors, within one comprehensive account. Third, a key component of the FFM is that specific factors influence the use of NSSI, instead of other behaviors (e.g., substance use), to serve the aforementioned functions. To date, hypotheses about these self-injury-specific processes, as well as other functional relationships suggested by the model (e.g., the removal of a purported reinforcement leads to a decrease in NSSI), remain largely untested. Thus, this integrated theoretical account proposes novel lines for future research critical to improving the understanding of NSSI.

Key Research Directions

In the following section, we use the FFM as a conceptual guide to outline seven important unanswered questions concerning NSSI and suggest theoretically based research initiatives needed to answer them (see Table 2 for a summary). We do not intend to imply that this set of

Table 1. Key Tenets of the Four-Function Model of Nonsuicidal Self-Injury

Reinforcement type	Negative	Positive
Automatic	Decrease or eliminate aversive affective or cognitive state or states	Increase or generate desired affective or cognitive state or states
Social	Decrease or eliminate aversive social event or events	Increase or generate desired social event or events

Table 2. Functionally Guided Research Questions and Needed Initiatives

Research question	Initiative
What mechanisms are involved in the automatic negative reinforcement function?	Laboratory-based studies Transdiagnostic samples
Are the automatic functions distinct?	Laboratory-based studies Experimental manipulation
How can we better study the social reinforcement functions?	Performance-based measures Longitudinal studies Moderator analyses
How do risk factors contribute to self-injury?	Longitudinal studies Multimethod assessment Experimental manipulation
Can self-injury be prevented?	Efficacy and effectiveness Component analyses Longitudinal studies
How should we treat self-injury?	Experimental manipulation Component analyses Mechanism studies
Can self-injury studies be prioritized in current psychopathology research initiatives?	Mechanism studies Transdiagnostic samples Multimethod assessment Longitudinal studies

questions captures all that is currently unaddressed about self-injury; instead, this set represents seven foci directly informed by the FFM that we believe are particularly important in elaborating the nature of NSSI and related transdiagnostic systems. First, we address unresolved issues and key directions for research specific to the automatic functions of NSSI. Second, we propose high-priority studies for the social-reinforcement components of self-injury, which are only moderately understood to date. Third, we identify several remaining questions about risk factors for self-injury across the four functions and functionally guided prevention efforts. Fourth, we detail the need for experimental studies that employ functional-analysis methodologies to isolate and test relevant treatment procedures for NSSI. Finally, we suggest key research directions for examining self-injury in the context of transdiagnostic systems more broadly and as they are informed by a functional approach to NSSI.

Question 1: What are the mechanisms involved in the ANR function?

The ANR function of self-injury has long been acknowledged by several prominent theoretical models (e.g.,

Chapman et al., 2006; Klonsky, 2007) in addition to the FFM. The affect-regulating properties of NSSI are also highly endorsed; studies consistently have shown that ANR is the most prevalent function (e.g., Klonsky, 2011; Nock & Prinstein, 2004). Although the automatic functionality of NSSI is supported by a great deal of self-report data, less focus has been placed on laboratory studies examining this contingency. As a result, the specific mechanisms that explain exactly how NSSI regulates affect have yet to be identified. Potential mechanisms have been proposed, including distraction from negative affect, endorphin release, self-punishment, and self-care (e.g., Franklin, Puzia, et al., 2013; Klonsky, 2007); however, systematic experimental testing of these hypotheses is needed. Researchers interested in delineating mechanisms involved in ANR might also choose to examine why some emotional states (e.g., anger, rejection, self-criticism) are more strongly associated with engagement in NSSI than are other states (e.g., sadness). For example, is it that these affective states are characterized by more elevated arousal or heightened approach motivation, which accounts for their relationship to subsequent engagement in self-injury (Nock, Prinstein, & Serba, 2009)? Traditional self-report measures should be considered as only a starting point for this line of research, whereas psychophysiological measures and other laboratory indices are methods to prioritize.

One specific direction for drilling down to these mechanisms is to examine the experience of physical pain during NSSI episodes. Considerable research has indicated that the experience of pain is strongly related to the affect-regulating properties and, thus, the automatic functions that NSSI serves (e.g., Ballard, Bosk, & Pao, 2010; Franklin, Aaron, Arthur, Shorkey, & Prinstein, 2012). Specifically, researchers have hypothesized that negative early life experiences lead individuals to use pathways involved in physical-pain processing for regulation of their emotions, which, in turn, influences pain perception (Ballard et al., 2010). Other studies have suggested that emotion dysregulation increases individuals' willingness to endure pain via the belief that physical pain and self-punishment are deserved (e.g., Hooley, Ho, Slater, & Lockshin, 2010) and have clarified that emotion dysregulation influences pain tolerance but not pain threshold or intensity (Franklin et al., 2012). Along these lines, pain offset relief has been proposed as a specific mechanism that may drive affect regulation during NSSI, in that the offset from physical pain simultaneously generates relief from emotional pain during self-injurious episodes. Laboratory-based findings support this notion and have suggested that pain offset relief is distinct from distraction, another potential mechanism of affect regulation in self-injury (Franklin, Lee, Hanna, & Prinstein, 2013; Franklin, Puzia, et al., 2013; Nock, 2010).

Taken together, future research that aims to better elucidate the interacting relationships between emotion dysregulation and pain-related processes, including pain-offset relief, in NSSI may hold promise for a better understanding of the mechanisms accounting for the automatic functionality of this behavior. Given that the majority of research on pain processing in NSSI has used samples consisting of individuals with BPD, future work must use samples comprising diverse participants to address NSSI as it presents across many forms of psychopathology. This knowledge may assist in the development of evidence-based interventions for self-injuring individuals that address the physical pain component of NSSI. For instance, treatment strategies focused on blocking the soothing physical effects of NSSI (Ballard et al., 2010) or promoting healthy, alternative behaviors that also activate the pain offset relief mechanism (e.g., exercise; Wallenstein & Nock, 2007) may prove valuable.

Question 2: Are the automatic functions distinct?

Researchers have yet to resolve whether an automatic positive mechanism is truly distinct from an ANR function. Although data gleaned from several self-report studies have provided evidence for an independent APR mechanism (e.g., Muehlenkamp et al., 2009; Nock & Prinstein, 2004), findings have indicated that this function is strongly correlated with that of ANR (e.g., Nock & Prinstein, 2004). It has also been suggested that the generation of positive affect during self-injurious acts is a result of diminished negative affect; thus, an independent APR mechanism cannot be differentiated from that of ANR (e.g., Klonsky, 2009). Studies in which researchers have the capability to directly test whether the removal of numb or empty feeling states through engagement in self-injury is positively or negatively reinforced are needed to resolve the controversy surrounding an APR mechanism.

Laboratory NSSI studies that employ well-validated physiological measures of positive and negative affect are a promising avenue for addressing this issue. Studies of pain offset relief, which has been shown to stimulate positive affect as well as reduce negative affect during self-injurious episodes (e.g., Franklin, Lee, et al., 2013), may be particularly informative in this area. For example, results from a recent investigation that used psychophysiological indices of positive and negative affect after electric shocks indicated that pain offset relief during NSSI generates simultaneous but independent positive and negative reinforcement (Franklin, Puzia, et al., 2013). Future research that uses other explicit, implicit, and biological measures to disentangle changes in positive and negative affect must replicate these findings, and

potentially offer incremental support for the existence of an automatic positive mechanism in self-injury.

Studies that use functional-analysis methodologies may also help disentangle APR and ANR mechanisms in self-injury. As previously described, the FFM posits that specific antecedents and consequences maintain NSSI through distinct reinforcement processes. However, to date, there is a lack of studies that experimentally manipulate hypothesized function-specific antecedents and consequences. Research that demonstrates, for individual functions, that the application of stimuli expected to reinforce NSSI increases the behavior and that the removal of stimuli expected to reinforce NSSI decreases the behavior may strengthen the understanding of all four facets, including APR. For example, data showing that NSSI occurs or increases when feelings unique to the APR function (e.g., numbness, emptiness; Nock & Prinstein, 2005) are induced in the absence of feelings associated with the ANR function (e.g., hopelessness, anger) would support the existence of an independent APR mechanism. The use of experimental manipulation to isolate specific types of automatic reinforcement poses significant challenges, given that it requires differentiating between closely related automatic-reinforcing events.

Distinguishing between forms of social reinforcement is more straightforward because it involves demonstrating that NSSI is maintained by attention (SPR) or escape (SNR)—both clearly observable, distinct contingencies. This type of research exists for individuals with developmental disabilities who engage in stereotypic self-injury (e.g., Iwata et al., 1994); however, it has not yet been extended to NSSI in normally developing populations. This line of work may be useful in guiding the process of treatment selection for self-injuring individuals (e.g., Iwata, Vollmer, Zarccone, & Rodgers, 1993). In other words, if APR is differentiated from ANR, distinct treatments that take into account the idiosyncratic contingencies of self-injury may be appropriate for individuals whose NSSI is reinforced by the generation of desired thoughts/feelings (APR) versus the reduction of negative thoughts/feelings (ANR). For example, interventions that focus on the cultivation of positive emotions via adaptive methods (e.g., Seligman, Rashid, & Parks, 2006) may be more relevant when self-injurious behavior is maintained by APR, whereas treatments that foster an accepting, nonjudgmental stance to negative emotions may be more applicable when self-injury is maintained by ANR.

Question 3: How can we better study the social functions?

The social functions of NSSI are both understudied and underreported in comparison with the automatic functions (Hagen, Watson, & Hammerstein, 2008; Nock, 2008). This

is in part due to social-desirability bias, given that reporting automatic reinforcement, as opposed to social influence, as the reason for engaging in NSSI is seen as more socially acceptable. Thus, NSSI that develops and is maintained via social reinforcement remains a top priority direction for future research that aims to expand both the FFM and the understanding of self-injury. First and foremost, this research would benefit from employing performance-based methods (e.g., the Stroop test, the dot-probe test, lexical decision tasks) that measure implicit cognitions about engaging in NSSI. Use of these objective assessment tools would help buffer the influence of social-desirability bias on data concerning social functions of NSSI. For example, preliminary research using self-injury implicit-association tests (e.g., Glenn & Klonsky, 2011; Nock & Banaji, 2007) might be extended to address social functions specifically. Similarly, as a result of observed problems with a range of communication skills in self-injuring individuals, researchers may consider the employment of objective measures of specific interpersonal skills (e.g., facial emotion recognition, facial mimicry; In-Albon, Bürli, Ruf, & Schmid, 2013) in future studies on NSSI. Findings from this research may illuminate fundamental characteristics of social-reinforcement functions and continue to invalidate the common belief that socially reinforced NSSI is unrelated to psychopathology (Nock & Prinstein, 2005).

Another potentially illuminative direction for research on social reinforcement in self-injury is the study of how individuals come to use self-injury as a form of interpersonal communication. It has been posited that NSSI enacted for social reinforcement may serve as a high-intensity mode of communication at one extreme along a continuum of signals of distress (e.g., Hagen et al., 2008; Nock, 2008). In other words, when language fails to elicit a desired response from others, individuals tend to increase the intensity of their communication (e.g., yelling), and if that attempt is unsuccessful, the intensity of their communication may increase further (e.g., crying). If again denied their desired response, some individuals may turn to the severe, nonverbal behavior of NSSI to communicate. Although this theory is supported by evidence from a variety of literatures (e.g., animal models, cultural anthropology), studies in which researchers test whether self-injuring individuals escalate to highly intense forms of verbal communication more easily or more rapidly than do non-self-injurers may offer additional support.

Furthermore, factors that moderate the intensity and speed of this pattern of escalation in response to stress are unknown. Studies in which researchers seek to identify key environmental (e.g., parental criticism), temperamental (e.g., neuroticism), and skill-based (e.g., social problem-solving deficits) moderators of escalation from verbal to nonverbal communication may inform

preventative and treatment efforts for individuals at risk of engagement in self-injury for social contingencies. For instance, if parental criticism is identified as an important factor that renders individuals more likely to turn to NSSI for communication, parental training programs or family-focused interventions that emphasize the facilitation of corrective feedback, positive interactions, and effective support may prove beneficial in reducing the occurrence of self-injurious behavior. Moreover, if deficits in social skills are determined to influence the escalation to NSSI as a form of communication, social skills training may help prevent initial engagement in self-injury and effectively treat the repeated behavior.

Question 4: How do risk factors contribute to self-injury?

Two types of risk factors are known to contribute to the etiology of NSSI. First, distal risk factors render individuals vulnerable to experiencing difficulties regulating their own cognitive/affective states or influencing their social environment (Nock, 2010). These general vulnerabilities span genetic, neurobiological, and environmental domains and include childhood maltreatment, genetic predispositions, physical hyperarousal, deficits in communication skills, and parental criticism. These factors are also theoretically consistent with a functional approach to NSSI, given that certain factors (e.g., high emotional reactivity) may render individuals more likely to engage in NSSI for automatic reinforcement, whereas others (e.g., poor communication skills) may increase the likelihood of NSSI for social reasons.

Studies in which researchers seek to identify the causal mechanisms by which established general risk factors contribute to engagement in NSSI are needed. For instance, does childhood maltreatment contribute to neurobiological abnormalities in the frontal cortex, which elicits increased startle response and emotional reactivity, thereby rendering individuals more likely to use NSSI to manage their emotional responses (i.e., for automatic reinforcement)? Alternatively, does childhood maltreatment contribute to the development of poor communication skills and, thus, increase the likelihood of engagement in NSSI as a signal of distress (i.e., for social reasons)? Results that have indicated that symptoms of major depressive disorder and posttraumatic stress disorder uniquely predict engagement in NSSI for APR (Nock & Prinstein, 2005) suggest a need for research on the potential link between experiencing a significant loss or abuse during childhood and subsequent NSSI, as well as whether this pathway is unique to the feeling-generation function. Findings that have shown that dissociation/emptiness mediates the relation from childhood emotional abuse to NSSI, and that this relationship is unique to the APR function (Rallis, Deming, Glenn, & Nock,

2012), provide preliminary support for the notion that general risk factors may be function specific in their influence on self-injury. Furthermore, studies that have suggested that childhood sexual abuse, a widely studied risk factor for many mental disorders, does not cause engagement in NSSI but instead is related to self-injury through other mediating factors (Glassman, Weierich, Hooley, Deliberto, & Nock, 2007; Klonsky & Moyer, 2008) could be extended to improve the understanding of how childhood sexual abuse relates to self-injury specifically.

In a similar vein, research on how distal risk factors interact to bring about engagement in self-injurious behavior would help clarify whether NSSI develops as a result of multiple interrelated risk factors or only one or two predominant vulnerabilities. This line of work may also shed light on whether specific combinations of risk factors can accurately predict the individual functions associated with NSSI. Knowledge in this area may contribute to the development of a clinically useful algorithm to identify who is at high risk for future engagement in NSSI, which may be well suited for a range of diverse medical settings. This type of algorithm could even identify what function individuals' future self-injurious behavior is most likely to serve and, thus, what strategies may be the most effective in preventing NSSI onset.

Although distal factors predispose individuals to problems with regulating their cognitive/affective or social experiences and increase the risk of using maladaptive self-regulation methods, self-injury-specific risk factors may explain why individuals may choose NSSI over other potentially less harmful coping skills (e.g., drinking, drug use, eating). Existing research has shown that even within one NSSI episode, individuals who have previously engaged in multiple pathological behaviors may consider using other forms of self-harm before choosing NSSI (Nock, Prinstein, & Sterba, 2009). These other maladaptive behaviors often serve the same functions as NSSI; thus, understanding the specific processes that lead individuals to choose self-injury, compared with other means, is critical. Several self-injury-specific hypotheses have been proposed, including social modeling, self-punishment, favorable implicit attitudes about NSSI, social signaling, and pain analgesia (Nock, 2009, 2010). Another hypothesis points to the pragmatic features of NSSI, a behavior that can be performed quickly, quietly, and almost anywhere—characteristics that other coping mechanisms (e.g., drugs, alcohol, binge eating) do not share. Finally, the emotional cascade model posits that for individuals with BPD, NSSI serves as a powerful distraction method from intense “emotional cascades” (i.e., cycles of rumination and negative affect; Selby, Anestis, Bender, & Joiner, 2009; Selby, Anestis, & Joiner, 2008; Selby & Joiner, 2009). For this reason, it has been proposed that individuals with BPD choose NSSI because the emotional cascade process is too intense to be effectively

managed by other methods of distraction (e.g., taking a cold shower).

With the exception of the emotional cascade model, these theories have largely not been submitted to empirical testing. Studies in which researchers systematically test the aforementioned hypotheses through a combination of self-report and more ecologically valid methods may allow for identification of the process or processes that account for instances in which individuals select NSSI over other functionally similar behaviors and accelerate the understanding of how some individuals overcome common barriers (e.g., pain, aversion to mutilation stimuli) that prevent most people from engaging in NSSI. In addition, studies that focus on the co-occurrence of NSSI and other potentially harmful behaviors known to serve similar functions may be informative. For example, do individuals who engage in NSSI and bingeing/purging for automatic reinforcement experience different processes leading up to NSSI episodes compared with individuals who solely engage in NSSI? Resulting findings may inform methods of treatment selection that take into account mechanisms that drive NSSI for individuals who engage in multiple behaviors on the spectrum of self-injury versus NSSI in isolation. Finally, evidence has suggested that individuals are more likely to choose other behaviors over NSSI when the alternative behavior is active (e.g., engaging in activities, socializing) as opposed to passive (e.g., sleeping, watching television; Nock et al., 2009). However, testing of these alternatives through experimental manipulation is necessary to obtain specific knowledge about viable healthy behaviors that fulfill the same function as NSSI. Improved knowledge in this area may inform the development of adjunctive or stand-alone ecological momentary interventions that use technologies to maximize the likelihood of self-injuring individuals' engaging in alternative behaviors (e.g., exercising, talking to a friend) instead of NSSI in real time.

Question 5: Can self-injury be prevented?

Although broad varieties of distal and specific risk factors that render individuals more vulnerable for engagement in self-injury have been identified, there is much yet to know about how to prevent this behavior. Various school-based preventative interventions that aim to increase awareness and education about self-injurious behavior for students and staff exist (Jarvi, Jackson, Swenson, & Crawford, 2013); however, most have not been subjected to well-controlled empirical testing (Nock, 2012). Thus, whether existing prevention efforts are truly effective in preventing engagement in NSSI remains largely unknown. One program that shows initial promise is the recently developed Signs of Self-Injury (SOSI; Jacobs, Walsh, McDade, & Pigeon, 2009) program, a school-based

initiative designed to increase knowledge about NSSI, improve attitudes about individuals engaging in NSSI, increase help-seeking behaviors for NSSI, and reduce engagement in NSSI among adolescents (Muehlenkamp, Walsh, & McDade, 2010). Preliminary results for the SOSI program are encouraging, given that small, significant changes in self-reported knowledge and attitudes about NSSI were observed in the absence of iatrogenic effects (Muehlenkamp et al., 2010). However, results did not show significant increases in help-seeking behavior or decreases in self-injurious behavior. Thus, the need for strong empirical evidence that existing prevention programs decrease NSSI persists.

The field may also benefit from systematic analysis of existing multicomponent preventative interventions to isolate their most important components and thereby potentially improve efficiency. Whether comprehensive programs such as SOSI, which contains two modules and a combination of psychoeducational material, video segments, and in-person discussions, could be made more efficient, and potentially more efficacious, by prioritizing the critical elements remains a key area for future research. Other unresolved issues pertaining to extant programs involve whether they are more effective when administered independently or when included as elements of other programs and whether they are universally beneficial or are critical only among those individuals designated as at risk (e.g., Eggert, Thompson, Herting, & Nicholas, 1995). Moreover, individual psychotherapy and school-based prevention programs may not be sufficient to efficiently prevent NSSI and that a more comprehensive portfolio of preventative models and methodologies is necessary (Kazdin & Blase, 2011; Nock, 2012). Questions such as these represent important future directions for the study of prevention in self-injury.

In addition to more well-controlled research on extant prevention programs, additional studies that specifically focus on the influence of social contagion in the transmission of self-injury would be informative in this area (for a review, see Jarvi et al., 2013). Research on the degree to which intensity and form of exposure to others engaging in NSSI are causally linked to initial and subsequent self-injurious acts may be crucial in improving the understanding of why individuals begin engaging in self-injury and, thus, may directly inform the development of effective prevention programs. Evidence has indicated a dose-response effect of social contagion on NSSI (e.g., Claes et al., 2010); in light of these findings, studies in which researchers systematically manipulate exposure dose (e.g., number of self-injuring peers) and type (e.g., observing a dialogue about NSSI, direct contact with a self-injuring individual) are warranted. This type of work may inform the development and refinement of initiatives directed toward preventing NSSI onset and reducing occurrence of this problematic behavior.

Moreover, an improved understanding of the specific antecedents that precede initial episodes of NSSI and those that reinforce subsequent acts could help bolster prevention efforts for self-injury. Researchers have hypothesized that individuals often begin engaging in NSSI for social reasons (e.g., via social contagion; Jarvi et al., 2013) but that the behavior maintains as a result of other reinforcement processes that subsequently develop (Nock, 2010). Other researchers have suggested that NSSI may initially be enacted to generate desired feelings (APR) but later serves to reduce or escape from aversive emotional experiences (ANR; Franklin et al., 2010). Studies in which researchers collect data on functional reinforcement across multiple time points may allow for distinguishing between the antecedents to initial NSSI episodes and the contingencies that reinforce the behavior over time. These questions warrant the use of ecological momentary assessment methods or computerized assessment tools (e.g., personal digital assistants, smartphones) that provide the capacity to measure behaviors as they naturally occur in real time (Shiffman, Stone, & Hufford, 2008). Ecological momentary assessment and other ecologically valid approaches (e.g., a daily diary; Victor & Klonsky, 2013) well suited to measuring behaviors that are difficult to observe in the clinic will be critical for researchers who seek to identify subtle differences in antecedents and consequences of initial NSSI episodes and repeated self-injurious behavior over time. Evidence that initial NSSI episodes are enacted for different reasons than are subsequent acts potentially would suggest that prevention and intervention efforts should use functionally distinct strategies. For example, if it is demonstrated that people begin engaging in NSSI as a result of social contagion, prevention programs that prioritize building barriers to social modeling of NSSI may be effective. Conversely, if repeated NSSI behavior is typically maintained via automatic reinforcement, interventions that focus on adaptive emotion regulation may be more effective.

In a similar vein, individual differences factors that predict initial engagement in NSSI for automatic versus social reasons are understudied. Data have suggested that certain factors (e.g., elevated physiological arousal in response to stress) are strongly related to automatic functions, whereas others (e.g., social problem-solving deficits) are more closely related to social functions (e.g., Nock et al., 2009). In addition, there is some knowledge of clinical correlates that are uniquely related to each of the model's four functions (e.g., Nock & Prinstein, 2005); however, other constructs that also may be differentially related to initial engagement in NSSI for automatic and social functions (e.g., dissociation, social skills) warrant further exploration. Increased understanding in this area may inform the development of prevention efforts that target individual-specific vulnerabilities. For instance, if it is demonstrated that youth with poor communication

skills often begin engaging in NSSI for social reinforcement, social problem-solving training may prove highly beneficial for preventing self-injury in these individuals.

Question 6: Can we effectively treat self-injury?

The FFM offers a useful framework to identify the reinforcements of NSSI on an individual basis and, thus, may be valuable in guiding methods of treatment selection for self-injury. As previously noted, functional behavior analysis of many types of psychopathology (e.g., anxiety, depression, substance use) has directly informed the development of corresponding evidence-based treatment programs and may be similarly useful for NSSI. Systematic analysis of the therapeutic effects of applying and removing idiosyncratic contingencies of NSSI in typically developing populations is lacking; however, several well-established psychological procedures have demonstrated compelling potential for future work in this area (see Table 3 for a summary). The following suggestions represent a sampling of interventions directly connected to each tenet of the FFM that may be useful for future research aimed to develop functionally based, effective treatments for self-injurious behavior.

For individuals who endorse the ANR function, NSSI serves as an effortful attempt to downregulate or regulate away from uncomfortable emotional experiences and, therefore, is conceptualized as a maladaptive emotion-regulation strategy. A considerable literature focuses on the centrality of emotion dysregulation in self-injury (e.g., Adrian, Zeman, Erdley, Lisa, & Sim, 2011; Chapman & Dixon-Gordon, 2007; Chapman et al., 2006; Gratz, 2007; Gratz & Roemer, 2004; Howe-Martin, Murrell, & Guarnaccia, 2012; Perez, Venta, Garnaat, & Sharp, 2012),

which, within the FFM, manifests prominently in the ANR function (Najmi, Wegner, & Nock, 2007; Nock et al., 2009). This line of work collectively suggests that deficits in the willingness to experience or accept negative emotions may serve as a critical target for treatment when NSSI is maintained by an inability to tolerate aversive emotions. Thus, fostering the acceptance of uncomfortable emotional experiences, rather than disengaging from and suppressing them through self-injurious acts, may be a viable, functionally informed treatment strategy for NSSI maintained by ANR (Nock et al., 2007).

To this end, procedures that facilitate mindful emotion awareness may be useful (Gratz, 2007; Walsh, 2006). Through mindfulness practice, patients learn to observe and describe their thoughts, feelings, and behaviors without ascribing judgmental attributions or attempting to change them, which, in turn, facilitates the pursuit of productive, goal-directed behavior while distressed (Craske & Barlow, 2007). By practicing strategies that promote emotional acceptance, individuals adopt a more tolerating affective style for regulating their emotions (Hofmann, Sawyer, Fang, & Asnaani, 2012), which may reduce maladaptive attempts to downregulate negative emotions, such as NSSI (Anderson & Crowther, 2012); however, systematic experimental research is needed to test this hypothesis.

Similarly, distress tolerance training also serves to bolster one's ability to tolerate and accept strong emotional experiences, rather than removing oneself from crisis situations through avoidance or escape. Interventions that focus on increasing levels of distress tolerance may also target unwillingness to experience and accept negative emotions within the ANR function. The emotional cascade model further supports the use of both mindfulness and distress-tolerance strategies with self-injuring individuals. As we have described, this model posits that

Table 3. Functionally Relevant Interventions

Function	Intervention
Automatic negative reinforcement (ANR)	Mindful emotional awareness Distress tolerance training Cognitive restructuring, reappraisal
Automatic positive reinforcement (APR)	Mindful emotional awareness Cognitive restructuring, reappraisal Behavioral activation Savoring
Social negative reinforcement (SNR) and social positive reinforcement (SPR)	Interpersonal skills training Distress tolerance training Problem-solving skills training
All functions	Identifying and rehearsing functionally equivalent, adaptive behaviors

individuals with BPD engage in NSSI to distract themselves from cycles of rumination and negative affect; thus, by practicing mindfulness and distress tolerance for heightened attention control, these patients may be able to better disengage from emotional cascades and inhibit dysregulated behaviors, such as self-injury (Selby et al., 2009).

Recent research has supported the notion that NSSI may manifest as an effort to distance oneself from aversive thoughts and, thus, fulfill a cognitive-emotion-regulating function (Najmi et al., 2007; Nock et al., 2009). For individuals who self-injure to decrease or escape from negative thoughts, the learning of skills to modulate distorted cognitions (e.g., self-injury is necessary to reduce aversive feelings; Walsh & Rosen, 1988) may be beneficial. To this end, cognitive restructuring may serve as a key component of NSSI treatment (Klonsky & Muehlenkamp, 2007; Muehlenkamp, 2006; Zila & Kiselica, 2001) for the ANR function. In the restructuring process, occasions during which patients have been successful in reducing negative emotions without NSSI are examined, and patients are encouraged to modify their maladaptive beliefs by replacing them with more adaptive thoughts (Newman, 2009). Cognitive reappraisal may also serve as an effective intervention strategy in the context of NSSI maintained by ANR. Through reappraisal, which is a strategy that involves entertaining different appraisals and attributions about negative emotion-laden topics in a flexible manner (Aldao & Nolen-Hoeksema, 2010; Campbell-Sills, Ellard, & Barlow, in press; Gross & John, 2003), individuals who engage in NSSI may begin to better understand how they tend to interpret emotionally laden situations and how their appraisals influence maladaptive patterns of emotional responding, thereby facilitating the readjustment of negative emotional experiences that often trigger self-injury.

Similar to the ANR function, engaging in NSSI for feeling generation may also be conceptualized as an attempt at emotion regulation. However, although ANR serves to downregulate negative thoughts or feelings, APR serves to increase desired thoughts or feelings, or upregulate emotions (Turner, Chapman, & Lauren, 2012). Studies have indicated that the APR function is associated with a restricted range of affect (Nock & Prinstein, 2005) and a lack of emotional clarity and awareness (Turner et al., 2012). These findings suggest that individuals who experience their emotions as unclear or confusing are more likely to engage in self-injury to achieve desired thoughts and feelings. For these individuals, numb or depersonalized emotional states are likely to feel aversive; thus, such individuals may be driven to perform NSSI to consciously experience the affective states they otherwise do not acknowledge or recognize. Therefore, interventions that focus on increasing mindfulness may also be helpful in treating individuals whose self-injury serves an APR

function. By promoting nonjudgmental awareness of emotions as they occur naturally, individuals may become less likely to experience the numbness that contributes to engaging NSSI to elicit desired emotional states. Furthermore, cognitive restructuring and reappraisal strategies may be relevant to NSSI maintained by APR (Muehlenkamp, 2006; Zila & Kiselica, 2001). Key dysfunctional beliefs associated with NSSI, such as "cutting is the only way to feel alive," must first be identified; then, instances in which the individual has experienced desired emotional states without resorting to NSSI should be used to challenge maladaptive beliefs and provide alternative attributions of situations that previously triggered self-injury.

Other psychological procedures that cultivate positive emotions through engagement in positive events, rather than through self-injury, may be useful in targeting the APR contingencies of NSSI. One such intervention that may be particularly effective is behavioral activation (BA; N. S. Jacobson et al., 1996; Martell, Dimidjian, & Hermann-Dunn, 2011). During BA, the consequences of problematic behaviors (e.g., self-injury) are considered relative to the consequences of alternative behaviors (Hopko, Sanchez, Hopko, Dvir, & Lejuez, 2003), and patients are encouraged to access sources of positive reinforcement in their environment that counter maladaptive behavioral patterns. Using BA methods to target NSSI for APR, patients work toward increasing engagement in rewarding, healthy behaviors, thereby potentially reducing the drive to generate desired feeling states with self-injurious acts. Savoring, a strategy that aims to enhance positive emotions by consciously attending to daily activities through which individuals often rush, as well as replaying past positive events and relating them to anticipation of future events (e.g., McMakin, Siegle, & Shirk, 2011; Seligman et al., 2006), may serve as another effective, functionally informed intervention for individuals who endorse the APR function. The therapeutic effects of applying BA and savoring components to NSSI maintained by APR warrant future empirical testing.

Although clear differences exist between them, both SNR and SPR functions refer to engagement in NSSI as a strategy to manage one's social environment (Nock, 2008; Prinstein, Guerry, Browne, & Rancourt, 2009). Individuals who report engaging in NSSI for social reinforcement often report interpersonal problems, which may reflect significant deficits in social skills. Research has indicated that individuals who engage in NSSI to influence others' behavior have difficulty managing their interpersonal relationships, and individuals who engage in NSSI as a form of communication with others have problems expressing their wants or needs (Turner et al., 2012). Thus, strategies that promote effective interpersonal communication and emotional expression skills may be

relevant when NSSI is maintained by SNR or SPR (Klonsky & Muehlenkamp, 2007; Turner et al., 2012).

To this end, learning more adaptive social skills may allow patients to become better able to communicate their thoughts, feelings, and concerns to others (Linehan, 1993; Lynch, Trost, Salsman, & Linehan, 2007) and, thus, less likely to resort to extreme forms of communication, such as self-injury (Nock et al., 2007). Despite a lack of systematic research aimed to isolate this putative mechanism, it has been hypothesized that remediating deficits in interpersonal communication skills may be a mechanism of NSSI treatment (Muehlenkamp, 2006; Washburn et al., 2012) when self-injurious behavior serves an interpersonal function. When NSSI is enacted to escape from unpleasant social situations, it also may be important to increase individuals' tolerance for aversive interpersonal experiences (Walsh & Rosen, 1988). Thus, desensitization or distress-tolerance techniques may also be useful when NSSI is maintained for SNR. Given the conceptual applicability to both functions, research that aims to specify the effects of distress tolerance training on ANR versus the social-reinforcement functions of NSSI is warranted.

Individuals who engage in NSSI also tend to evidence poor social problem-solving skills (e.g., Howat & Davidson, 2002; Nock & Mendes, 2008). Deficits in the ability to generate, select, or enact adaptive behavioral responses to interpersonal stimuli and communicate effectively during stressful interpersonal situations render individuals who self-injure more likely to select maladaptive, potentially detrimental social responses (Nock, 2008; Prinstein et al., 2009). When individuals select self-injury as a strategy to communicate negative emotions or seek attention from others, NSSI can be conceived as an ineffective way of coping with interpersonal problems and, thus, the promotion of interpersonal problem-solving skills during treatment may be beneficial. Through problem-solving procedures, NSSI is approached as a maladaptive solution to presenting problems, and improved interpersonal problem-solving skills are expected to decrease reliance on NSSI. Studies in which researchers have tested the effectiveness of problem-solving protocols in treating NSSI have resulted in mixed findings (e.g., Crowe & Bunclark, 2000; Muehlenkamp, 2006; Slee, Garnefski, van der Leeden, Arensman, & Spinhoven, 2008; Taylor et al., 2011; Townsend et al., 2001); however, problem-solving protocols may be more efficacious when applied specifically to individuals who use NSSI as a method of solving interpersonal communicatory or relationship problems.

Across both automatic and social functions, it may be critical to identify specific, adaptive behaviors that serve the same idiosyncratic function as self-injury to successfully replace NSSI with goal-oriented actions (Nock & Prinstein, 2004). For example, releasing anger on a

punching bag or easing sadness by confiding in a friend may be applicable for individuals who engage in NSSI for ANR, whereas other more adaptive communication strategies, such as writing a letter or raising one's voice, may be relevant to individuals who use NSSI to communicate with others. Once functionally equivalent behaviors have been selected, engaging in systematic exposure exercises to practice replacing maladaptive behaviors (Barlow et al., 2011), such as self-injury, with alternative actions may be useful. Exposure exercises facilitate the rehearsal of adaptive behaviors during emotional states that may have previously elicited self-injury and thereby promote individuals' learning that they are able to inhibit these problematic behaviors during similar situations in the future. A focus on behavioral modification and rehearsal, both in session and in daily life, has been hypothesized as an active mechanism of change in NSSI treatment (Lynch, Chapman, Kuo, Rosenthal, & Linehan, 2006; Muehlenkamp, 2006; Verheul et al., 2003); however, well-controlled studies in which researchers examine the utility of exposure-based procedures with self-injuring individuals are needed.

Experimental studies in which researchers test whether the aforementioned functionally relevant interventions are more effective in reducing NSSI than are irrelevant interventions are sorely needed. Components of existing multidimensional protocols may be useful to draw from when conducting such research; for example, dialectical behavior therapy (Linehan, 1993), emotion regulation group therapy (Gratz & Gunderson, 2006), mindfulness-based cognitive therapy (Segal, Williams, & Teasdale, 2002), BA for treatment of depression (Lejuez, Hopko, Acierno, Daughters, & Pagoto, 2011), and positive psychotherapy (Seligman et al., 2006) all contain empirically validated mindfulness, cognitive restructuring, BA, or savoring elements. As a result of its flexible, modularized approach, the recently developed unified protocol for transdiagnostic treatment of emotional disorders (UP; Barlow et al., 2011) is another cognitive-behavioral program that may be particularly promising for future research in this area. The UP seeks to target underlying temperamental vulnerabilities (e.g., neuroticism) across anxiety, depression, and related disorders by addressing key aspects of emotion processing and regulation and has shown efficacy in treating anxiety and co-occurring mood disorders in initial trials (Ellard, Fairholme, Boisseau, Farchione, & Barlow, 2010; Farchione et al., 2012). Each core strategy of the UP (e.g., present-focused emotion awareness training; cognitive reappraisal; identifying and changing maladaptive, emotion-driven behaviors; exposure exercises) is relevant across multiple functions of NSSI. Moreover, the modular structure of the UP may be particularly well suited to research focused on testing functionally relevant strategies for NSSI treatment, given that specific modules can easily be extracted from

the full protocol and employed individually. In fact, research that uses single-case experimental design methodology to test the effects of the first two core UP modules on NSSI maintained by ANR is currently under way.

Studies in which researchers examine whether application of relevant interventions results in meaningful changes in self-injury may also strengthen the validity and utility of the FFM; that is, such a functional approach would be supported by data showing that interventions explicitly designed to eliminate or alter hypothesized contingencies are more effective at reducing NSSI than are irrelevant interventions (Iwata et al., 1994). For example, results indicating that during distress tolerance training, changes in levels of distress tolerance are associated with changes in self-injury would lend additional credibility to the automatic functions. Findings demonstrating that during interpersonal skills training, changes in communication skills are associated with changes in NSSI would support the existence of distinct social-reinforcement functions and, thus, further solidify the FFM in its entirety.

Question 7: Can self-injury studies be prioritized in current psychopathology research initiatives?

There is clear agreement in the field that we are moving to more dimensional approaches to classification, even though the editors of the *DSM-5* were unable to achieve a consensus on just what these dimensions would be (Widiger & Edmundson, 2011). In recent years, proposals have been advanced for dimensional approaches to the classification of personality disorders (South, Oltmanns, & Krueger, 2011) and emotional disorders (T. A. Brown & Barlow, 2009). Perhaps the best known of these initiatives is the Research Domain Criteria (RDoC) project, launched by the National Institute of Mental Health in 2008. RDoC's principal aim is to inform the development of a new dimensional classification system for mental disorders that will translate into improved clinical decision making (National Institute of Mental Health, 2011). This novel approach to classifying psychopathology attempts to focus on fundamental mechanisms underlying a broad range of phenomena (e.g., Morris & Cuthbert, 2012; Sanislow et al., 2010), thereby representing a marked change from the current categorical system based on clinical observation and patients' symptom reports (e.g., Insel et al., 2010). It is likely that RDoC's focus on psychological and biological mechanisms will play a significant role in psychopathology research.

There are several reasons why the study of self-injury is germane to RDoC's long-term goal of developing interventions that target underlying mechanisms and, thus,

can be prioritized within this large-scale research initiative. First, functional approaches to NSSI are consistent with the RDoC framework. As previously described, the FFM focuses on classifying the behavior according to functional processes that produce and maintain it, rather than according to topographical characteristics (e.g., symptoms). Thus, on a conceptual level, functionally guided NSSI research is consistent with the RDoC agenda to progress from the current reliance on self-reported symptoms and clinical observation for diagnosis. RDoC also delineates several fundamental constructs to guide areas for future research, including negative valence systems (e.g., anxiety, loss), positive valence systems (e.g., reward learning), and social communication—all of which have clear relevance to the functions of NSSI. Furthermore, although currently there are no formal guidelines for classifying subtypes of NSSI, there is consensus that NSSI varies on a scale from mild to moderate to severe (Nock, 2010). Given that RDoC calls for a dimensional system with established severity cut points (National Institute of Mental Health, 2011), research that aims to formalize these clinically meaningful subgroups would be closely in line with the project's agenda.

Second, NSSI may be best conceptualized on a spectrum of self-harm behaviors spanning indirectly harmful acts (e.g., smoking, eating unhealthy foods) to direct self-harm (e.g., NSSI, suicide attempts; Nock, 2010). Although conceptual differences exist between them (e.g., Victor, Glenn, & Klonsky, 2012), the degree to which these self-harm behaviors reflect similar aberrant mechanisms is largely unknown. Findings have suggested that the emotional antecedents and consequences of NSSI are similar to those of bingeing and purging episodes (Muehlenkamp et al., 2009; Smyth, Wonderlich, & Heron, 2007). These results, and others showing the functional similarity of NSSI and many other problem behaviors (e.g., Kingston, Clark, & Remington, 2010), have provided some support for the notion that similar mechanisms may drive distinct modes of self-harm. Research on the underpinnings of diverse forms of self-harm, including NSSI, may offer valuable knowledge as to why individuals engage in a wide variety of behaviors to intentionally harm themselves. This work is consistent with the RDoC emphasis on how fundamental mechanisms drive psychological symptoms broadly, rather than sticking to one specified diagnostic category.

Third, an important component for RDoC-guided studies is the use of samples that span multiple *DSM* diagnostic categories (National Institute of Mental Health, 2011). As we have discussed, similar proposals have been made concerning studies of self-injury, given recent research that has shown that NSSI cuts across many mental disorders as they have been traditionally defined (e.g., Selby et al., 2012; Shaffer & Jacobson, 2009). Although the

inclusion of NSSI disorder as a condition in need of further study in the *DSM-5* represents increasing recognition of NSSI as a transdiagnostic phenomenon, whether NSSI is best conceptualized as a formal diagnosis, symptom, or behavior is still subject to debate (e.g., Butler & Malone, 2013). Studies in which researchers have used and tested the NSSI disorder criteria are emerging in the literature, and preliminary results are promising (e.g., Glenn & Klonsky, 2013; Selby et al., 2012; Zetterqvist, Lundh, Dahlström, & Svedin, 2013); however, continued research in this area will undoubtedly help determine the ideal classification for this prevalent phenomenon.

Studies in which researchers examine NSSI behavior occurring across a variety of psychological problems may also improve the understanding of the relationship between NSSI and other well-established disorders. For example, is NSSI related to other disorders because they generate negative thoughts and feelings to be reduced or eliminated via engagement in self-injury? Alternatively, does the presence of other disorders impair social functioning such that NSSI is used as an attempt to communicate with others? The answers to these questions are for the most part unknown and represent an important direction for self-injury research that is highly applicable to the RDoC agenda. Research on NSSI that uses other samples, even apart from typical patient populations, may also be germane to this aspect of RDoC. For instance, considerable literature on stereotypic self-injury among individuals with developmental disabilities already exists (e.g., Iwata et al., 1994). In addition, animal models may represent a key potential avenue for research that focuses on the neurochemical pathways of NSSI (e.g., Bloom & Holly, 2011). Studies in which researchers seek to determine how findings from these diverse literatures could be integrated to offer valuable perspectives on NSSI as a broad dimension of psychopathology are warranted (Nock, 2010). Thus, future research efforts in the field of self-injury that employ diverse subjects, including animal models, may pose vital implications for how NSSI is defined in future dimensional classification systems that arise from RDoC.

Fourth, RDoC emphasizes the importance of using different units of analysis to examine a construct of interest. Although past studies on NSSI were limited mostly to self-report methods, researchers recently have used other indices (e.g., physiological activity, behavioral tasks, real-time assessment; Franklin, Puzia, et al., 2013; Nock & Banaji, 2007; Nock et al., 2009; Nock & Mendes, 2008; Plener, Bubalo, Fladung, Ludolph, & Lulé, 2012; Schmahl et al., 2006) to circumvent the methodological and ethical barriers to direct observation of NSSI. The continued use of multiple methods to assess NSSI holds promise for better elucidating the countless questions that remain about this perplexing phenomenon. Accumulating evidence

also has suggested a divergence between self-report and other measures of NSSI (e.g., Glenn, Blumenthal, Klonsky, & Hajcak, 2011; Janis & Nock, 2009), which underscores the need for multimethod assessment in future studies of self-injury. Research that bridges multiple units of analysis not only is in concordance with RDoC but also represents a critical direction for the field of self-injury.

Finally, addressing developmental and environmental aspects of psychopathology is considered critical to the RDoC framework (National Institute of Mental Health, 2011). Specifically, RDoC seeks to identify the factors associated with perturbations in normal development and, therefore, the etiology of psychopathology. Recent evidence from longitudinal imaging studies has shown that neurobiological maturation and associated emotional and cognitive abilities continue to develop into young adulthood (e.g., Lenroot & Giedd, 2006). Onset of NSSI typically also occurs during adolescence. These factors collectively suggest the need for research on how departures from normal neurobiological-system development contribute to engagement in self-injury and other related forms of psychopathology. Although still in its infancy, researchers have begun to attend to how the expression of NSSI influences, and is affected by, abnormal adolescent brain maturation—particularly with regard to pathways involved in pain processing (e.g., Ballard et al., 2010). As previously noted, studies in which researchers aim to delineate the precise mechanisms by which negative early life experiences (e.g., childhood abuse, illicit drug use) increase risk for engagement in NSSI are also warranted. Research focused on how environmental risk factors interact with genetic and neural pathways to contribute to a variety of self-injurious behaviors is pertinent to RDoC's agenda to advance knowledge of developmental influences on psychopathology, as well as critical stages for targeted prevention efforts. Taken together, functionally guided research on NSSI not only may hold promise as a potential funding opportunity within RDoC but also may contribute to an improved, dimensionally guided system for classification and treatment of psychopathology.

Conclusions

There is much yet to know about the perplexing phenomenon of self-injury, including fundamental aspects of its etiology, underlying mechanisms, and, most important, the most effective ways to prevent and treat this behavior. Recent years have witnessed considerable research highlighting the importance of reinforcement-based processes in self-injury, including the contemporary FFM. This model may help guide the understanding of the research critical to the advancement of knowledge of self-injury, including many of the potential studies

discussed in this review. Considered broadly, the highest priority directions for future research in the area of self-injury involve developing and testing evidence-based, functionally informed methods for preventing and treating NSSI. With regard to prevention, researchers must first focus on improving the ability to predict self-injurious behavior. As previously discussed, researchers have identified a multitude of risk factors and characteristics associated with NSSI; however, currently there is no empirically validated system for determining the individuals at highest risk of future engagement in self-injury. Development of such an algorithm would require integrating the multitude of known risk factors, generating a variety of methods for assessing and weighting this information, and finally, conducting longitudinal studies of many individuals to determine what method is best suited to accurately determining future risk of self-injurious behavior (Nock, 2012). Although highly ambitious, this line of research would be invaluable for several key reasons.

For example, resultant findings could potentially provide evidence that risk factors are function specific (e.g., high aversive emotions as a risk factor for engagement in NSSI for automatic contingencies, poor communication skills as a risk factor for engagement in NSSI for social contingencies) and, thus, further strengthen the FFM. Most important, however, this knowledge could be translated into a practical system for clinicians to use in screening youth and adolescents, identifying individuals at risk for self-injurious behavior, and intervening accordingly, perhaps with the functionally relevant preventative efforts described earlier (e.g., remediating communication skills, developing more adaptive methods of emotion regulation). This line of research may also directly inform the development of a multifaceted approach to preventing self-injury (e.g., Kazdin & Blase, 2011), given that school-based programs alone may not have the capacity to do so.

In a similar vein, another significant direction for research in the field of self-injury is to categorize the key components of reinforcement-based approaches to treatment, for no evidence-based psychological interventions for NSSI currently exist. Comprehensive, multidimensional programs for NSSI may be more effective than isolated procedures; however, given that mechanisms are only speculative at this point in time, component analyses and dismantling studies in which researchers test the functionally relevant interventions covered in this review are desperately needed. The adaptation of modules from multicomponent protocols to target the specific functionality of self-injury may prove particularly informative to researchers who aim to strengthen the FFM and establish core mechanisms of change of the treatment of NSSI. Studies in this area would benefit from the initial use of idiographic approaches (e.g., single-case experimental

design methodology), which offer the opportunity to flexibly tailor interventions to the individual as needed, thereby leading to efficient treatment development (Barlow, Nock, & Hersen, 2009). This type of research could be followed by large-scale randomized controlled trials that would permit further evaluation of both mechanisms of change and moderators of outcomes. Advanced knowledge in this area has the potential to identify the most efficacious psychological treatments for NSSI and to lend further support to the FFM (i.e., Do targeted, functionally relevant strategies reduce self-injury more efficiently and effectively than do irrelevant or multidimensional treatment packages?). Across many potential directions for future research on NSSI, including those covered in this review, the field is encouraged to consider adopting a functional approach in the much-needed movement toward a comprehensive understanding of self-injury.

Author Contributions

All authors developed the study concept. K. H. Bentley drafted the initial versions of the manuscript, which were revised by both M. K. Nock and D. H. Barlow. All authors approved the final version of the manuscript for submission.

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The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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