



## Characterizing the course of non-suicidal self-injury: A cognitive neuroscience perspective



Richard T. Liu

Department of Psychiatry and Human Behavior, Alpert Medical School of Brown University, Bradley Hospital, 1011 Veterans Memorial Parkway, East Providence, RI, 02915, United States

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### ABSTRACT

Non-suicidal self-injury (NSSI) has received increasing recognition as a clinically significant phenomenon. Although in most individuals who engage in NSSI, this behavior is short-lived, for a significant proportion of these individuals, NSSI follows a chronic course. There is a need for research advancing our understanding of the mechanisms of risk for NSSI, and how these mechanisms may change over time to account for the persistence of this behavior. In the current paper, a conceptual framework is proposed for characterizing the processes underlying the transition from initial engagement in NSSI to a chronic trajectory of this behavior. In particular, a case is made for conceptualizing NSSI as a habitual behavior as defined within a cognitive neuroscience perspective, with support from the existing theoretical and empirical literature. Finally, potential mechanisms are articulated for the development of chronic NSSI within this conceptual framework and recommendations presented for empirically evaluating this conceptualization of NSSI in future research in this area.

### 1. Introduction

Non-suicidal self-injury (NSSI), defined as the direct and deliberate destruction of one's own bodily tissue in the absence of any suicidal intent (Nock, 2010), has only relatively recently received recognition as a clinically important phenomenon. That is, although NSSI has traditionally received less empirical attention than suicidal behaviors, it is increasingly recognized as a distinct and important clinical phenomenon in its own right (Muehlenkamp, 2005). In fact, NSSI as a distinct syndrome is included in DSM-5 as a disorder in need of further investigation (American Psychiatric Association, 2013). The neglect of NSSI in earlier research stemmed from the view that it exists on a continuum of severity with suicidal behaviors, with NSSI simply being a less severe form of self-injurious behavior (Brent, 2011; Liu et al., 2016). There is accumulating evidence, however, to challenge this assumption, with several recent studies suggesting that NSSI is a stronger predictor of future suicidal behavior than is its past history, particularly in adolescents (Asarnow et al., 2011; Wilkinson et al., 2011). Furthermore, a recent meta-analysis has found NSSI to be a significant predictor of prospective suicide attempts (Ribeiro et al., 2016). These findings highlight the clinical importance of this behavioral phenomenon.

NSSI is a highly prevalent behavior. This is especially true among adolescents, with lifetime prevalence rates of 13% to 24% in non-clinical samples (Heath et al., 2009; Jacobson and Gould, 2007;

Muehlenkamp et al., 2012; Swannell et al., 2014), and 12-month prevalence rates ranging from 55% to 68% among psychiatric inpatients (Cha et al., 2016; Guerry and Prinstein, 2010). Although less research has focused on the course of NSSI than its prevalence, a review of longitudinal studies suggests that NSSI persists into adulthood for a substantial portion of individuals who initiate this behavior in adolescence (Selby et al., 2015). Indeed, although the majority of individuals who engage in NSSI more than once cease this behavior within a few years, it persists for more than five years for approximately 20% of these individuals (Whitlock et al., 2006). These findings regarding the persistence of NSSI are congruent with recent evidence that of all the risk factors studied to date, a past history of NSSI is the strongest predictor of its future recurrence, with a large pooled effect size observed for this relationship (Fox et al., 2015).

Although most studies to date have focused on identifying risk factors (i.e., what) for NSSI, there is a stated lack of research examining how risk develops and influences this behavior (Nock, 2012). Given that even a single incident of NSSI may be associated with significantly greater risk for negative psychiatric outcomes (Whitlock, 2010; Whitlock et al., 2006), there is a clear clinical need for studies delineating the mechanisms driving the transition from initial engagement in NSSI to a more persistent pattern of this behavior. Such work is important because, although many commonly studied risk factors for NSSI (e.g., female sex; Bresin and Schoenleber, 2015; Fox et al., 2015) help identify *who* is at risk, they are limited in their ability to advance

E-mail address: [rtliupsych@gmail.com](mailto:rtliupsych@gmail.com).

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our understanding of *how* to intervene with these individuals. In contrast, longitudinal studies designed specifically to elucidate the processes underlying risk for persistent NSSI can greatly inform the selection of meaningful targets for clinical intervention. Clarifying these underlying mechanisms is important for breaking the strong link that has been observed between past and future NSSI (Fox et al., 2015).

The current paper presents a conceptual framework for understanding and characterizing the processes underlying the transition from initial engagement in NSSI to a chronic trajectory of this behavior. Specifically, within a cognitive neuroscience perspective (Graybiel, 2008), habitual behaviors have been defined as: (i) not innate; (ii) evoked by specific contexts or stimuli; (iii) repetitive and becoming fixed over time; and (iv) occurring with little effort once fully acquired. With support from existing conceptualizations of NSSI models and empirical studies, a case is made for NSSI meeting this definition of a habitual behavior, focusing specifically on the latter two characteristics, and potential mechanisms are articulated for the development of chronic NSSI within this framework. Finally, included in this discussion are specific examples of how this conceptualization of NSSI may be empirically evaluated, with the view of guiding future research in this area. To guide this discussion, the main components of this cognitive neuroscience conceptualization of NSSI, along with specific hypotheses for testing each component, are presented in Fig. 1.

## 2. NSSI as a repetitive behavior that becomes fixed over time

In certain cases, behaviors become repetitive and fixed over time if they possess self-reinforcing properties. Based on DSM-5 criterion B (contingent response) for NSSI disorder (American Psychiatric Association, 2013), this may be the case for NSSI. This view is also consistent with the four-function model of NSSI (Bentley et al., 2014; Nock and Prinstein, 2004).<sup>1</sup> This model posits that NSSI is maintained by positive and negative self-reinforcing processes. These self-reinforcing processes include intrapersonal positive reinforcement (generating positive affective or cognitive states), intrapersonal negative reinforcement (reducing negative affective or cognitive states), interpersonal positive reinforcement (eliciting attention and help-seeking), and interpersonal negative reinforcement (facilitating removal from aversive social situations or decreasing interpersonal demands). In the case of intrapersonal negative reinforcement, for example, insofar as NSSI immediately reduces negative affect, the tendency to engage in this behavior should become stronger when confronted with negative affect in the future. This model has received empirical support, with intrapersonal negative reinforcement being the most commonly endorsed function (Bentley et al., 2014; Zetterqvist, 2015). Similarly consistent with this self-reinforcing conceptualization of NSSI, the experiential avoidance model of self-harm conceptualizes NSSI as a maladaptive emotion regulation strategy, specifically a form of emotional avoidance (Chapman et al., 2006). According to this model, when the individual experiences an aversive emotional response to a stimulus, avoidance behaviors such as NSSI are adopted. The short-term relief produced by NSSI serves to reinforce the adoption of this behavior as an avoidance strategy when confronted with future aversive stimuli. Furthermore, and of direct relevance to the conceptualization of NSSI as a repetitive and fixed behavior, its self-reinforcing nature is believed to lead over time to an automaticity in its adoption as an avoidance strategy.

Although these self-reinforcing characteristics of NSSI have been increasingly studied, they remain poorly characterized in the empirical literature. Specifically, the existing literature has been almost entirely

reliant on self-report methodologies (Bentley et al., 2014). This is an important limitation for several reasons. First, recent studies have consistently revealed low congruency between self-report and behavioral or physiological measures of several constructs, including impulsivity (Cyders and Coskunpinar, 2012, 2011), self-control (Duckworth and Kern, 2011), emotion regulation in general (Vasilev et al., 2009), and distress tolerance in particular (Bernstein et al., 2011; McHugh et al., 2011). Therefore, self-report data on self-reinforcing properties of NSSI cannot be generalized to other measures of these properties. Second, self-report measures are limited inasmuch as individuals have imperfect insight into the processes underlying their behavior, and this is especially true for cognitive and affective processes that may exist, at least in part, outside of conscious awareness (Nisbett and Wilson, 1977). Thus, the validity and accuracy of self-report data regarding behavioral contingencies relating to NSSI must be viewed with a degree of caution (Nock et al., 2009), and laboratory tasks are required to clarify the mechanisms underlying NSSI (Bentley et al., 2014).

A few studies employing such tasks have been conducted, with one, for example, demonstrating a physically aversive stimulus (a frequently used experimental analogue for NSSI) to be associated with subsequent reduction in negative affect, as indexed by startle eye-blink reactivity (Franklin et al., 2010). Another study, albeit with a small college sample, has observed cessation of a physically aversive stimulus to be associated with a positive affective response and a reduced negative affective response, as indexed by the post-auricular reflex (PAR; Franklin et al., 2013a; Hebert et al., 2015; Quevedo et al., 2015) and startle eye-blink reflex, respectively (Franklin et al., 2013a). These findings were replicated in another study that included participants with NSSI (Franklin et al., 2013b). Although these studies are consistent with the view that NSSI has self-reinforcing properties, their cross-sectional nature cannot inform our understanding of the temporal dynamics of their relation to the development or maintenance of NSSI. Specifically, it is unclear to what degree these psychophysiological indices are prospectively predictive of NSSI re-engagement (i.e., a risk factor rather than concomitant or consequence; Kazdin et al., 1997; Kraemer et al., 1997). Moreover, it is unclear how the self-reinforcing properties of NSSI change over time in relation to the course of NSSI, particularly the trajectory of chronic NSSI.

Delineation of potential neural mechanisms underlying changes in self-reinforcing properties of NSSI during the course of this behavior is needed to identify promising targets for clinical intervention. That is, moving beyond a focus on self-reinforcement of NSSI solely at the physiological level to a study of changes in their associated neurocircuitry over the course of NSSI may yield specific, modifiable targets of intervention. The study of the neural processes underlying NSSI, however, is still in its infancy, and has predominantly involved assessing this behavior within the context of psychiatric diagnoses rather than as a transdiagnostic clinical phenomenon (Westlund Schreiner et al., 2015). One study of individuals who had engaged in NSSI (Osuch et al., 2014) observed a positive association between degree of relief after a physically aversive stimulus and blood oxygen level-dependent (BOLD) response in the dorsal striatum, a brain region involved in processing rewards (Everitt and Robbins, 2013; O'Doherty et al., 2004) and habitual behavior formation (Schultz, 2006). This finding is notable because it mirrors prior research on habit formation in the broader literature, particularly in the context of other forms of psychopathology that similarly follow an often chronic course (e.g., substance use disorders and anorexia nervosa). Specifically, according to basic instrumental (operant) learning principles, if a behavior (e.g., NSSI) is followed immediately by a reward (e.g., reduced negative affect), the behavior is likely to be reinforced. Specific neural circuits, including the ventral striatal – posterior dorsomedial striatal network, have been linked with this effortful form of learning and involved in the acquisition of new behaviors (Everitt and Robbins, 2013; Walsh, 2013). With repeated engagement in the behavior (overtraining), followed

<sup>1</sup> In contrast to a syndromal approach focusing on categorizing behaviors based on topographical features (i.e., symptoms), functional approaches categorize behaviors based on functional processes underlying their occurrence and maintenance (i.e., their antecedents and consequences).

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