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Early Adolescent Non-Suicidal Self-Injury and Sensory Preference Differences:

An Exploratory Study

BY

Jacquelyn S. Christensen

A Dissertation submitted to the Faculty of Claremont Graduate University in partial fulfillment

of the requirements for the degree of Doctor of Philosophy in Psychology

Claremont Graduate University  
2012

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APPROVAL OF THE REVIEW COMMITTEE

We, the undersigned, certify that we have read the dissertation of Jacquelyn Christensen and approve it as adequate in scope and quality for the degree of Doctor of Philosophy in Psychology.

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## ABSTRACT

Early Adolescent Non-Suicidal Self-Injury and Sensory Preference Differences:

An Exploratory Study

by

Jacquelyn S. Christensen

Claremont Graduate University: 2012

**BACKGROUND:** Non-suicidal self-injury (NSSI) occurs in 13% to 20% of adolescents, and is often indicative of deeper internal or social problems. A close review of current explanatory models of NSSI suggested that underlying individual sensory preferences may contribute substantial explanations for the self-regulatory functions of NSSI, as well as have implications for treatment approaches. In the context of integrating sensory processing models with prominent functional NSSI models, this dissertation research compared sensory preferences in youth who engaged in NSSI to sensory preferences of youth who did not engage in NSSI.

**OBJECTIVE:** NSSI-engaging youth were hypothesized to have lower threshold sensory preferences (sensation avoiding and sensory sensitive), and higher sensitivity (low threshold) in touch processing, auditory processing, and modulation of sensory input affecting emotional response. Sensory preferences were hypothesized to predict NSSI functionality, and trauma history and symptomology were hypothesized to predict NSSI and sensory preferences.

**METHODS:** Youth (n = 108; 56% female; 43% Hispanic) aged 8-14 completed self-report items regarding knowledge, thoughts, and engagement in NSSI, the Functional Assessment of Self-Mutilation (FASM) to evaluate type and functionality of NSSI, and the Adolescent / Adult Sensory Profile to evaluate sensory preferences (low registration, sensation

seeking, sensory sensitive, sensation avoiding). Parents (90% female;  $M_{\text{age}} = 39.4$  (SD = 6.9)) completed the Sensory Profile as a secondary measure of youth sensory preferences and the UCLA post-traumatic stress disorder reaction index (PTSD-RI) to evaluate youth trauma history and symptomology.

RESULTS: NSSI-engaging youth ( $N = 14$ ) scored significantly higher than Non-NSSI-engaging youth ( $N = 85$ ) in the sensation avoiding (*Cohen's d* = .83) and low registration (*Cohen's d* = .66) domains. Auditory sensitivity (youth-reported) significantly predicted NSSI after controlling for age. While parent-reported sensory preferences and trauma history and symptomology were not predictive of NSSI, auditory sensitivity (parent-reported) predicted PTSD symptomology in youth with trauma history.

CONCLUSIONS: Results provide preliminary insight into better understanding the self-regulatory role of NSSI, and offer insight into specific sensory preferences of young adolescents who engage in NSSI. In combination with future research, findings contribute to existing comprehensive models of NSSI, and provide evidence for sensory considerations in NSSI treatment.

## DEDICATION

In memory of Dr. Enid Gruber, my mentor and friend, who nurtured my love of research and learning. I will always remember our trip to Hawaii for my first conference. Even though you are gone, I know you are proud of me.

For Dr. Joye Swan who told me to ask myself, "What would I do today if I was brave?"

And to all of those who struggle with self-injury. This, and much of my future research, is for you.

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# CHAPTER ONE

## INTRODUCTION

Adolescents are often misrepresented and misunderstood, often viewed as unmanageable, over-emotional, dramatic, and even disturbed. Unfortunately, they frequently act out accordingly to these stereotypes (e.g., Brophy, 2006; Muuss, 1996). Consider the following real-life scenarios from my own clients, students, and other personal encounters:

At a party, a 16 year-old boy walks around with a razorblade, while slicing his arms in horizontal increments from wrist to shoulder, and flaunting the display for everyone to see. When asked why he is doing it, he merely states, “It is fun, I like to do it.”

In the rear of a school bus, a 14 year-old girl picks at her wrist with a safety pin. She explains that it is the only way that she can feel pain, and it makes her feel better.

A 15 year-old boy engages in a rageful fight with his mother, who has recently been diagnosed with lung cancer. After storming out of the room, he returns minutes later with the word “hate” carved into his arm, and verbally accuses his mother of driving him to this point.

While sitting in class, a seventh-grade boy makes dramatic gestures as if he is cutting his wrists and says, “Look at me, I’m Emo.” When queried about where he learned this, he nonchalantly responds, “Some kids at school. I would never do that.”

The thread that connects these adolescents is that they engaged in or displayed knowledge of deliberate self-injurious behavior. In addition, a different explanation or justification is implicated for their behavior. These and myriad similar scenarios beg clinical and developmental researchers to wonder: why do some youth choose to engage in intentional self-destructive behavior, while others, who may have knowledge of self-injurious behavior, never engage in it at all?

Non-suicidal self-injury (NSSI), or the act of purposefully harming one’s physical self without suicidal intent, is an increasingly prevalent phenomenon that occurs in 13% to 20% of

adolescents (e.g., Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007; Ross & Heath, 2002).

This maladaptive behavior is often indicative of deeper internal or social problems and can act as a gateway to other negative risk behaviors, including drug use, smoking, bulimic behavior, aggression, sexual behavior, and, in some cases, suicide (Brown, Houck, Hadley, & Lescano, 2005; Guertin, Lloyd-Richardson, Spirito, Donaldson, & Boergers, 2001; Laye-Gindhu & Schonert-Reichl, 2005; Webb, 2002). Research over the past few decades has ventured to describe and deconstruct this dangerous behavior (Favazza, 1989, 1998; Klonsky, 2007; Nock, 2009). Until recently, NSSI research focused primarily on exploring the homogenous characteristics underlying NSSI, by seeking to identify commonalities across risk behavior patterns, clinical diagnoses, emotional traits, social support, and trauma history. Yet, the examination of primarily socio-emotional and environmental variables has failed to adequately elucidate why some adolescents choose to engage in NSSI instead of or in addition to other risk behaviors.

To better understand the onset and maintenance of self-injurious behavior, researchers must further examine possible contributing factors, such as inherited and biological sources of individual differences. Emerging explanatory models tend to avoid omnibus explanations by accounting for multiple pathway possibilities and accommodating the heterogeneous nature of this behavior. These complex models suggest that NSSI serves as both a form of communication and a coping or regulation strategy employed to buffer against internal factors and environmental stressors (Nock, 2009; Yates, 2009). Though some of these models account for the social, cognitive, emotional, and neurochemical aspects of NSSI, there is a general lack of focus on why some adolescents are more sensitive or reactive to their environment and choose such a sensory

specific- visceral, tactile, or proprioceptive- means of regulating their bodies and emotions or communicating their needs.

In this dissertation, the definition, prevalence, characteristics, and risk factors associated with NSSI are reviewed. Next, the neurorelational framework (Lillas & Turnbull, 2009) is used as a lens for synthesizing current explanatory NSSI research models and illustrating the relationship between the sensory system and the regulatory, emotional, and cognitive processes underlying NSSI. After introducing Dunn's Model of Sensory Processing and briefly describing different ways individuals perceive and respond to the stimuli in the environment, it is suggested that underlying sensory preferences contribute to the self-regulatory functions of NSSI. This dissertation research was designed to compare sensory preferences in youth who engage in NSSI to sensory preferences of youth who do not, as well as examine the relationship of sensory preferences and origins of NSSI in context with prominent NSSI functional models. As a secondary goal, the relationships between trauma history and PTSD symptomology, NSSI, and sensory preferences were also explored.

## CHAPTER TWO

### LITERATURE REVIEW

#### **Overview of Nonsuicidal Self-Injury**

**Definition and history.** Non-suicidal self-injury (NSSI), also referred to as self-injurious behavior, self-harming behavior, deliberate self-harm, and self-mutilation, is broadly defined as deliberate, self-inflicted injury to one's own body tissue without conscious suicidal intent (Laye-Ghindu & Schonert-Reichl, 2005; Nock & Prinstein, 2005). Culturally sanctioned NSSI behaviors are forms of body modification that are done under cultural, ritualistic, or religious pretext, but are not typically included in NSSI research (Bolognini, Plancherel, Laget, Stephan, & Halfon, 2003). Circumcision, body piercing, scarification, neck elongation, and foot wrapping are a few examples of culturally sanctioned NSSI. In Western cultures, ear piercing and tattooing are more common forms of culturally sanctioned self-injury. Again, these socially acceptable behaviors, along with indirect harmful behaviors, such as drinking or drug use, are not typically included in NSSI research; rather, NSSI research focuses on deviant (i.e., not culturally sanctioned) NSSI behaviors (e.g., Bolognini, Plancherel, Laget, Stephan, & Halfon; Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007; Shannon, 2008).

Historically, NSSI was first described as deviant mutilation and a psychological issue by Karl Menninger. In his book, *Man Against Himself* (1938), Menninger defined the phenomena as “local self-destruction [as] a form of partial suicide (p. 237).” In the 1960's and 70's, young, attractive, intelligent women were observed to be engaging in wrist cutting, which became a clinical concern to Western psychologists. Throughout the 70's and 80's, NSSI received more attention in psychological research and clinical diagnoses (e.g., “wrist-cutting syndrome,”

“deliberate self-harm syndrome,” and “repetitive self-mutilation syndrome”), and became associated with eating disorders (e.g., Matsumoto, Azekawa, Yamaguchi, Asami, & Iseki, 2004). Recent research focuses on contextual factors and underlying reasons behind NSSI, such as sexual or physical abuse or childhood trauma. Thus, the identification and recognition of deliberate or deviant NSSI that was not considered culturally sanctioned began only about 75 years ago and has been a focus of research for less than 50 years. Though NSSI has gone through numerous definitions and interpretations, social scientists agree on the basic characteristics, prevalence, and associated risk factors of NSSI.

**Characteristics of NSSI.** The *Diagnostic and Statistical Manual of Mental Disorders-IV-TR* (American Psychiatric Association [DSM-IV-TR], 2000) divides NSSI into four major categories: stereotypic, major, compulsive, and impulsive. Stereotypic NSSI includes behaviors such as self-hitting and head-banging, and is most often associated with neurological disorders or developmental delay. Major NSSI includes more extreme and dangerous behaviors, such as amputating limbs or castration, and is often associated with extreme psychosis. Compulsive NSSI, as observed in individuals with obsessive-compulsive disorder, includes mild to moderately severe behaviors, such as skin picking, nail biting, and hair pulling, and is thought to be a form of anxiety reduction. Impulsive NSSI includes skin cutting, self-burning, and mild to moderate self-hitting, and is considered isolative or habitual, depending on whether the behavior occurs in a singular instance or multiple instances. Impulsive NSSI is the most common form found among adolescents and occurs more sporadically than stereotypic or compulsive NSSI. Triggered by internal and external mechanisms, impulsive NSSI is often associated with mood and depressive disorders (White Kress, 2003). Specifically, NSSI is associated with borderline personality disorder (BPD), in that up to 80% of individuals diagnosed with BPD self-injure.

NSSI is also commonly reported as a symptom in those diagnosed with mood and depressive disorders, PTSD, dissociative identity disorder, sexual masochism, obsessive-compulsive disorder, eating disorders, anxiety disorders, and schizophrenia (e.g., Briere & Gil, 1998; Matsumoto, et al., 2004; Suyemoto & Macdonald, 1995; White Kress, 2003; Yip, 2005).

Emerging models regard NSSI as a coping behavior that intertwined with deeper issues, such as neurobiological abnormalities and trauma history (Messer & Fremouw, 2007; Nock & Prinstein, 2004, 2005; Nock, 2009; Yates, 2004, 2009), making it difficult to tease out NSSI as a distinct behavior. While earlier research defined NSSI as an impulse behavior used to relieve a symptom (e.g., Favazza, 1998; Herpertz, Sass, & Favazza, 1997; Winchel & Stanley, 1991) or a symptom itself of a disorder (e.g., Briere & Gil, 1998; White Kress, 2003), recent research posits that NSSI is more than a symptom of psychological disorders and represents a unique, complex behavior pattern that is linked to environmental factors and individual differences (Nock, 2009).

Cutting to break the top layers of the skin, often drawing blood, is the most commonly reported method of NSSI, followed by self-biting, self-burning, rubbing an eraser on skin to draw blood, self-hitting, self-poisoning, inserting objects under skin, hair pulling, and self-tattooing (Laye-Gindhu & Schonert-Reichl, 2005; Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007; Lundh, Karim, & Quilisch, 2007; Madge, Hewitt, Hawton, Jan de Wilde, Corcoran, et al., 2008; Matsumoto, Imamura, Chiba, Katsumata, Kitani, et al., 2008; Ross & Heath, 2002; Yates, Tracy & Luther, 2008). Some adolescents limit themselves to one method, while others use multiple methods or change methods over time (Nock, 2009). Behaviors such as picking at skin or scabs are included on some measures of NSSI (e.g., *Functional Assessment of Self-Mutilation*, Lloyd, Kelley, & Hope, 1997), but since these may be more common, unintentional behaviors,

responses regarding these behaviors are often excluded from research data due to the high prevalence and murky definition (Yates, Tracy & Luther, 2008).

Recent research regarding adolescents who engage in impulsive NSSI elucidates typical characteristics of this behavior. The average of age of onset for engaging in NSSI is between 12 and 14 years (Nock & Prinstein, 2004; Rodham & Hawton, 2009). Most NSSI is impulsive, contemplated for only a few minutes before being carried out, is done alone, and little to no pain is reported to be experienced during each incident (Nock & Prinstein, 2004; Nock, Prinstein, & Sterba, 2009). While thoughts about NSSI are most often preceded by worry (36%), pressure (32%), and bad memories (26%), hierarchical linear modeling examining thoughts preceding NSSI and incidents of NSSI revealed that none of these factors increased the likelihood that youth would engage in NSSI behaviors. Alternatively, feelings of rejection, self-directed anger, numbness, and anger at others significantly increased the odds of engaging in NSSI, while feelings of sadness/worthlessness decreased the odds of engaging in NSSI (Nock, Prinstein, & Sterba, 2009). These findings suggest that while certain thoughts, such as worry or perceived pressure, may lead to ideation about NSSI, the shift from cognition to emotion to behavior is driven by more extreme, specific feelings, such as anger, that are directed at self or other. The desire and motivation to take action, in the form of NSSI, may be an underlying component of emotions such as anger or numbness. Alternatively, sadness or worthlessness are less action-oriented emotions and may not contribute to an underlying motivation to change or control the environment or internal state of being. While drugs and alcohol are not typically used while engaging in NSSI, a recent study demonstrated that co-occurring thoughts of drug / alcohol use or bingeing / purging behaviors were reported 15-20% of the time in youth who also reported thinking about NSSI (Nock, Prinstein, & Sterba, 2009). These findings have implications not



only for better understanding co-occurring psychological disorders, but also illustrate that some youth contemplate multiple means of self-destructive behavior before picking one. This may also illustrate the self-regulatory nature underlying NSSI and similar behaviors, as risk behaviors are often used as coping strategies (e.g., Felitti, 2002).

Gender differences also play a role in the characteristics of NSSI among adolescents. While some studies suggest that girls are the primary engagers of NSSI (Hawton, Rodham, Evans, & Weatherall, 2002; Laye-Gindhu & Schonert-Reichl, 2005; Madge, et al., 2008; Matsumoto, et al., 2008; Ross & Heath, 2002), other studies do not find such gender discrepancies (e.g., Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007). Girls are reported to engage in more impulsive self-injury, such as self-laceration, self-poisoning, and self-biting than boys (Madge, et al., 2008; Webb, 2002; White Kress, 2003). Girls are also more likely to report feeling the need to hurt oneself and report feeling unhappy or depressed as primary reasons for engaging in NSSI (e.g., Laye-Gindhu & Schonert-Reichl, 2005). For example, in a sample of female college students, emotional inexpressivity was associated with a greater frequency of NSSI (Gratz, 2006). Alternatively, boys are more likely to engage in head-banging than girls (White Kress, 2003) and report more self-battery and deliberate recklessness (e.g., Webb, 2002). When asked why they engage in NSSI, boys listed reasons such as boredom, group membership (e.g., gang affiliation, Goth or Emo social group), to avoid doing something, and because they think it would be fun (e.g., Laye-Gindhu & Schonert-Reichl, 2005). The nature of these potential gender differences potentially rests in the internalization and management of negative or unpleasant emotions, especially in adolescents who choose sensory strategies to self-regulate and cope with negative emotions.

**Prevalence of NSSI.** Incidence of adolescent NSSI is between 5% and 47% of the general adolescent population, and occurs in 20% to 60% of clinical adolescent populations (Favazza, 1998; Gratz, 2006; Laye-Gindhu & Schonert-Reichl, 2005; Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007; Nock & Prinstein, 2005; Ross & Heath, 2002). While the majority of studies conducted in the past used clinical samples, more recent studies included community populations, which reveal prevalence ranging from 13% to 47% (Bjarehed & Lundh, 2008; Laye-Ghindu & Schonert-Reichl, 2005; Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007). Despite this range, examining self-injury in community samples may yield more generalizable results over time. Self-injurious behavior can extend beyond adolescence, as young adults aged 18 to 25 are also at risk for NSSI, with 5% to 38% of college students studied reporting engaging in NSSI (Rodham & Hawton, 2009). The wide range of reported prevalence illustrates that collecting accurate data is still challenging. Though some studies report that NSSI has been increasing over the past 20 years (e.g., Hawton, et al., 2000; Ross & Heath, 2002), this observed increase could be misleading due to changes in nomenclature (e.g., self-injury, self-harm, self-mutilation, cutting behavior), definition (e.g., intent to die versus superficial), included behaviors (e.g., cutting, self-poisoning, skin picking), measurement differences (e.g., dichotomous presence or absence versus continuous variable), public awareness, presence in social media, and cultural understanding of NSSI over time (Favazza, 1989; Nock & Favazza, 2009; Zila & Kiselica, 2001). Adolescent NSSI is a global phenomenon, with studies conducted in Canada (e.g.; Laye-Ghindu & Schonert-Reichl, 2005; Ross & Heath, 2002), Great Britain (e.g., Hawton, Fagg, Simkin, Bale, & Bond., 2000; Evans, Platts, & Liebenau, 1996), multiple countries in Europe (e.g., Bolognini, Plancherel, Laget, Stephan, & Halfon, 2003; Brophy, 2006), Australia (Aoun, 1999; DeLeo & Heller, 2004), and Japan (e.g., Matsumoto, Azekawa, Yamagichi, Asami, &

Iseki, 2004). These studies have revealed that adolescents across the globe engage in NSSI and are prone to similar risk factors and other negative behaviors.

**Associated risk factors.** Various biosocial and environmental risk factors precede and coincide with NSSI. Adolescents who self-injure are more likely than non-injurers to have experienced birth complications, as evidenced by higher levels of in utero complications (25% vs. 6%) and cesarean section births (29% vs. 10%) (Deliberto & Nock, 2008). These types of complications are predictive of later symptoms of trauma, poor attachment, or difficulties with self-regulation or sensory integration (Ayres, 2005; Greenspan & Porges, 1984; May-Benson, Koomar, & Teasdale, 2009). Environmentally, adolescents who engage in NSSI are more likely to come from homes with a history of drug abuse, alcoholism, suicidal ideation, and violence as compared to adolescents who do not engage in NSSI (Deliberto & Nock; Nock, 2009; van der Kolk, Perry, Herman, 1991). Youth exposed to these negative factors may be more likely to adopt external coping strategies, such as NSSI, or may be subject to abuse or neglect which results in feelings of rejection and anger- emotions that often precede NSSI (Nock, Prinstein, & Sterba, 2009). On the other hand, adolescents who engage in NSSI were not more likely to come from families with histories of anxiety, bipolar disorder, depression, or other psychiatric disorders. This variation in findings is potentially attributed to the ways in which children from abusive or violent environments learn how to express or internalize negative emotions (Deliberto & Nock, 2008). Specifically, addictive or violent behaviors represent a more active coping strategy in response to negative emotions, which may compel youth to take external actions in coping with their own frustration, sadness, or anger. Maladaptive symptoms such as antisocial behavior and anger management difficulties are more highly associated with NSSI. In a community sample of adolescents 13 to 17, Laye-Gindhu and Schonert-Reichl (2005) found that

both male and female adolescents who engage in NSSI had higher antisocial behavior scores than adolescents who did not engage in NSSI. When taken as a whole, these studies regarding environment and upbringing provide emerging evidence that certain developmental risk factors may contribute to the onset of NSSI.

In addition to childhood risk factors and associated mental health issues, research indicates that NSSI is often associated with other unhealthy, maladaptive behaviors. Bolognini and colleagues (2003) surveyed 308 males and females aged 14 to 25, finding that 27% of the sample engaged in NSSI ( $n = 83$ ). NSSI was reported primarily by individuals who reported drug use (42%) and eating disorders, such as anorexic or bulimic behaviors (37%). Alternatively, only 20% of control participants engaged in NSSI. Regarding unhealthy sexual behavior, Webb (2002) reported that adolescents who self-injure are also more likely to engage in sexual activities, and Brown and colleagues (2005) found that even after accounting for gender, sexual abuse history, impulse control, race, and self-efficacy, adolescents who engaged in NSSI were over three and a half times more likely to report using condoms inconsistently during sexual activity. Hilt and colleagues reported no differences in sexual activity among adolescents who did and did not report engaging in NSSI, though they did find that adolescents who engaged in NSSI were more likely to report substance use during sexual activity within the past year, indicating a propensity for greater risk-taking behavior (Hilt, Nock, Lloyd Richardson, & Prinstein, 2008). Adolescents who engaged in NSSI reported more health risk behaviors, including illicit drug use, thrill seeking behaviors, and smoking cigarettes (in girls only) (Laye-Gindhu & Schonert-Reichl, 2005). These studies indicate that many adolescents who self-injure are also prone to displaying other risk taking behaviors. Still, there are many adolescents who engage in risk behaviors without ever engaging in NSSI, so it is critical to understand the

mechanisms behind why certain adolescents choose NSSI instead of or in tandem with other risk behaviors.

**Initiation of NSSI.** Before exploring the deeper functions that contribute to the adoption and perpetuation of NSSI, the concept of initiation should be considered as few studies have thoroughly explored the onset of NSSI. In terms of initiation, generally speaking, NSSI behaviors are either learned from an outside source or self-discovered. Richardson (2006) suggests that initiation may begin when adolescents accidentally hurt themselves, discover that they enjoy the temporary feeling, and then engage in the behavior again to replicate the feeling. Unfortunately, there is a paucity of evidence illustrating self-discovery as a primary path for the adoption of NSSI as a regular behavior. Other means of exposure to NSSI behavior include media sources, peer influence, or family members (Nock, 2009; Yates, 2004). Nearly half of adolescents who self-injure report social sources for how they learned about NSSI, including observing or learning from peers (38%) and media (13%), while 17% to 20% report that NSSI behavior is not socially learned (e.g., “I just wanted to try”). Surprisingly, 28% to 39% were unable to pinpoint where or how they learned about NSSI (Deliberto & Nock, 2008; Heath, Ross, Toste, Charlebois, & Nadecheva, 2009), which highlights the need for in-depth research regarding the means through which NSSI knowledge is acquired, as well as an exploration of potential differences between adolescents who recall the origin of NSSI behaviors and those who do not. Future research in this area should also explore source overlap (e.g., those who self-discovered but were also socially influenced to try NSSI regularly or use specific methods). A developmental approach should also be taken in looking at the psychopathology and differentiating factors of those who self-discover versus those who learn socially. It is plausible that self-discovery is more likely in children or adolescents with trauma history, poor attachment,

or sensory integration difficulties, and onset age differences may exist between those who self-discover and those who learn socially. Research is needed to dissect the relationship between source of NSSI knowledge and the functions served by NSSI, especially in better understanding why some youth engage only once while others adopt NSSI as a regular pattern of behavior.

The limited research and understanding regarding the origins of NSSI makes apparent the critical need to explore developmental factors that may be predictive of how and why adolescents choose to initiate engaging in NSSI. Instead of targeting one explanation, recent literature demonstrates that multiple factors, including biological differences, potential trauma, disrupted attachment, and combined external and internal motivations for NSSI are often at play. Yet, there are few models or frameworks that account for how all of these components fit together and interact in contributing to adolescents' adoption of NSSI as a regular behavior.

### **Introduction to the neurorelational framework and its potential for enhancing our understanding of etiology and function of NSSI**

In previous literature reviews, authors summarized and categorized research findings in various ways to help conceptualize and compare explanatory models, pathways, and perspectives on NSSI. Webb (2002) divided research studies into those that underscore primary explanations for NSSI (psychosocial factors, family dysfunction, and psychological factors) and antecedents of NSSI (parental influence, peer influence, and sociocultural contexts). Suyemoto (1995) grouped NSSI by hypothesized impetus, such as environmental, anti-suicide, sexual, affect regulation, dissociation, and boundary maintenance. Klonsky (2007) similarly described seven functions of NSSI: affect regulation, anti-dissociation, anti-suicide, interpersonal boundaries (assert distinction between self and other), interpersonal-influence, self-punishment, and sensation seeking, and reviewed these functions among multiple studies of NSSI. More recently,

Messer and Fremouw (2008) critically examined seven explanatory models of self-injury, ordered by the breadth and fidelity of empirical support, including the sexual model, depersonalization model, interpersonal / systemic model, suicide model, physiological / biological model, affect regulation model, and behavioral / environmental model. These reviews take various approaches examining NSSI, as the number of different categories proposed illustrates the multitude of factors hypothesized to influence the onset and maintenance of self-injury. Reorganizing and dividing the mechanisms behind NSSI into varying groups seems to result in fragmentation instead of unification; highlighting and synthesizing the commonalities under a comprehensive structure would flexibly allow for individual differences and similar pathways to be taken into account.

One comprehensive way to organize the mechanisms underlying NSSI is by using the neurorelational framework (NRF) (Lillas & Turnbull, 2009), an interdisciplinary organizational system that consolidates neurodevelopmental and behavioral information into four systems: *regulatory*, *sensory*, *relevance*, and *executive*, and explores how they interact in relation to each other (Figure 1). The NRF integrates research in neurodevelopment, trauma and the brain, arousal states, sensory integration, occupational science, behavior, socio-emotional development, memory, executive functions, and various developmental models. The four global systems discussed in the NRF correspond to the structure and function of related brain regions. As illustrated in Figure 1, the relationship between these four systems can be conceptualized as linear or non-linear. In the context of development and increased specialization, these systems are viewed as interdependent, dynamic, and reciprocal. After briefly describing the characteristics of each system, the four systems and overall framework are used to connect existing NSSI research and identify areas of deficit among current NSSI explanatory models.

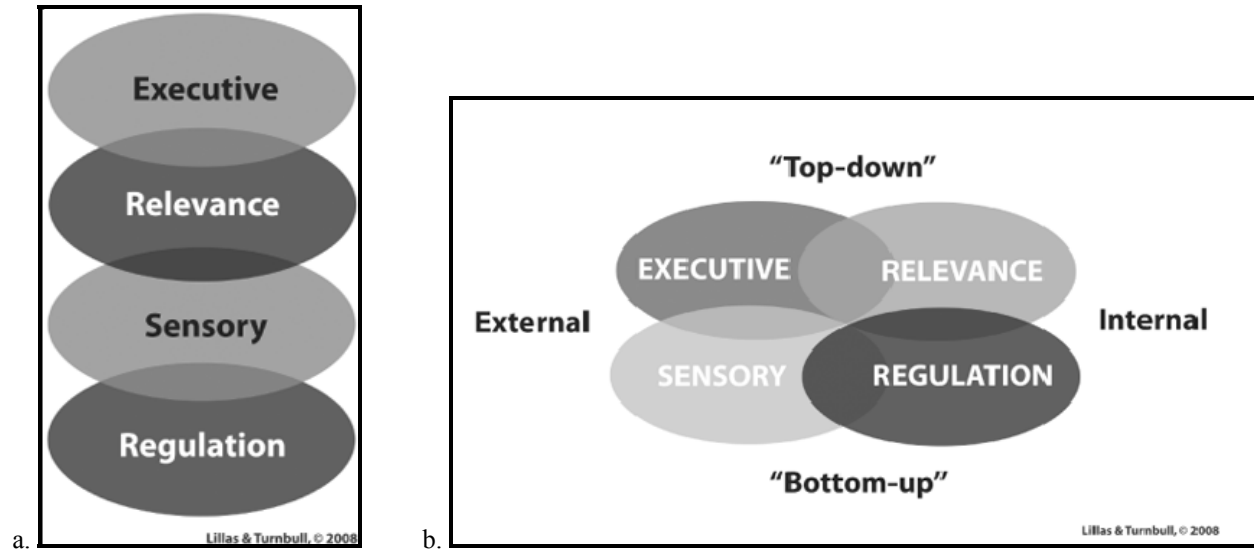


Figure 1a & 1b. *Linear (a) and non-linear (b) diagrams of four brain systems as conceptualized through the NRF. From Infant / child mental health, early intervention, and relationship-based therapies: A Neurorelational framework for interdisciplinary practice. (p.41), by C. Lillas, & J. Turnbull, J, 2009, New York, NY: W.W. Norton & Company. Copyright 2008 by Lillas & Turnbull. Reprinted with permission.*

The regulation system includes the neurochemical aspects of arousal and stress response. From a linear perspective, processes that begin here and work through the other systems are classified as “bottom up” processes. In the context of NSSI, the regulatory system accounts for the role of arousal states before, during, and after self-injurious behavior, as well as provides context for the biological models proposed as explanations for NSSI.

The sensory system, which includes sensory processing and modulation, provides the brain with ‘raw data’ from the external world (relationships, external stimuli) and the internal milieu (the body, internal stimuli). Sensory processing is associated with the accuracy of information transmitted through different cortical regions of the brain. Part of sensory processing includes discrimination, the sensitivity with which individuals detect stimuli.



Disruption in sensory processing can result in learning disorders or an inability to appropriately interpret social cues, which can, in some cases, increase propensity for traumatic experiences and victimization from bullying (Ben-Sasson, Carter, & Briggs-Gowan, 2009; Lillas & Turnbull, 2009). Sensory modulation is associated with activation and inhibition, and helps decide what stimuli are taken in and what is filtered out. Disruptions in sensory modulation can result in over-reaction and under-reaction and have negative effects across domains, especially when habituation, the ability to adapt to stimuli, and sensitization, the ability to become responsive to stimuli, become imbalanced. A deeper understanding of the sensory system in relation to the other systems in the NRF can potentially offer new perspectives on seemingly complex and counterintuitive actions such as NSSI.

The relevance system refers to the limbic system and links sensory and motor information to emotional and behavioral significance. This system supports the ability to use past experience to inform current or future behaviors, and supports the motivations for behaviors in relation to emotional reactivity, learning and memory, and private and shared “meaning making”- the transformation of sensation into words and emotional ideas (Lillas & Turnbull, 2009). The executive system corresponds to behavioral control, interpersonal interaction, and motor activity. This system is responsible for the activation or inhibition of behavior, the balance of emotions and cognitions, the balance of self and other, and the relation of the self to the achievement of goals (self-efficacy). Processes that initially utilize the executive and relevance systems are considered “top-down” processes, while those that initially utilize the sensory and regulation systems are considered “bottom up” processes. According to Lillas and Turnbull (2009), these four systems work together in all aspects of cognition, behavior, perception, and self-regulation.

The multiple aspects of NSSI behaviors have the potential to fit neatly within the four systems of the NRF. For example, NSSI is potentially a sensory method used to re-attain regulatory system balance, while “meaning making” of NSSI is reinforced (e.g., “When I cut myself, I feel better”) within the relevance system. Through this process, executive functioning is restored and balance is regained among the systems. To further demonstrate the connection between the four systems and the role of NSSI, the following sections review current NSSI explanations and models while using the NRF as a means of synthesizing various aspects of NSSI research. Current explanatory perspectives of NSSI include biological models, the impact of trauma on brain development and regulation, and a functional model of internal and external reinforcement, as well as more complex models that account for various pathways and multiple social and internal factors. While these models explore isolated components underlying NSSI, current conceptualizations have not accounted for the variability in behavior and function often found within these models. As part of this study, it is argued that while current models primarily address regulatory, emotional (relevance), and behavioral or cognitive (executive) underpinnings of NSSI, the integration of the sensory system remains relatively underexplored. More integrative NSSI models may be attained by explicitly addressing the role of the sensory system.

### **Current Theories and Models Underlying the Etiology and Function of NSSI.**

**Organic origins of NSSI.** Biological models of self-injury suggest that NSSI is related to psychophysiological arousal and chemical reactions or neurotransmitter deficiencies in the brain (e.g., Brain, Haines, & Williams, 1998; Herpertz, Sass, & Favazza, 1993; Sher & Stanley, 2009). Specifically, the tension reduction hypothesis is a biological explanation of NSSI that suggests that NSSI is a means to reduce psychophysiological arousal when faced with aversive stimuli (Bennun, 1984; Haines, Williams, Brain, & Wilson, 1995). Evidence from a sample of

prison inmates who had a history of NSSI, as compared to those without a history of NSSI, revealed that psychophysiological arousal, as measured by skin resistance level, heart rate, and blood flow, decreased when self-injury was introduced as a solution during scripts containing negative, aggressive scenarios (Haines, Williams, Brain, & Wilson, 1995). In a similar, subsequent study with a community sample, participants with a history of NSSI also displayed a decrease in psychophysiological arousal when presented with scripts that portrayed NSSI one of four possible reactions to a negative scenario (Brain, Haines, & Williams, 1998). These results support the tension reduction hypothesis and suggest that a decrease in arousal occurs just prior to engaging in self-injury, and arousal continues to decrease after the self-injurious behavior is completed. These findings are supported by a growing body of evidence regarding variations in neurochemical levels during stress response reactions, specifically dopaminergic and serotonergic system abnormalities, endogenous opioid abnormalities, and hypothalamic-pituitary-adrenal (HPA) axis abnormalities- all of which are linked to the regulatory system.

While limited evidence is available supporting the association of lower dopamine levels in individuals who self-injure (as summarized in Sher & Stanley, 2009), more research supports the association of decreased serotonin levels. One treatment study regarding self-biting rhesus monkeys demonstrated a reduction in self-injuring-behavior following regular administration of L-tryptophan – a biochemical precursor to serotonin (5-HT) that increases 5-HT synthesis (Weld, Mench, Woodward, Bolesta, Suomi, et al., 1998). Additionally, treatment with selective serotonin reuptake inhibitors (SSRIs) elicited mild NSSI reduction in participants with borderline personality disorder (Markovitz & Wagner, 1995).

More empirical support exists regarding the connection between NSSI and endogenous opioids, which are linked to pain perception and interact with the serotonergic system and the

HPA stress system, especially since both endogenous opioid levels and the HPA stress system can be severely altered by trauma (Sher & Stanley, 2009). This association between opioid levels and NSSI illustrates the relationship between the regulatory and sensory systems. This association is supported by evidence from treatment research, pain sensitivity research, and examinations of altered opioid levels with rhesus monkeys and groups at increased risk of NSSI, including psychiatric patients diagnosed with bipolar disorder, borderline personality disorder (BPD), or schizophrenia, and individuals with developmental disabilities (i.e., autism and mental retardation) (Kemperman, Russ, & Shearin, 1997; Tiefenbacher, Novak, Lutz, & Meyer, 2005; Tiefenbacher, et al., 2003). As compared to individuals diagnosed with BPD who did not engage in NSSI, individuals with BPD who engaged in NSSI had lower levels of endogenous opioids (Sher & Stanley, 2009). Additionally, NSSI was associated with a decrease in negative affect and an increase in positive affect in patients diagnosed with BPD (Kemperman, Russ, & Shearin, 1997). Trauma, childhood maltreatment, and stress may alter opioid levels by creating an opioid deficiency or by creating a habituation to abnormally high levels of opioids due to prolonged or recurrent exposure to stressful stimuli (Sher & Stanley, 2009). Evidence suggests that activation of opioid transmitters contributes to affect regulation (Zubieta, et al., 2002), which further illustrates the connection of the regulatory and sensory systems to individual's emotional states and behavioral responses, and provides support for the underlying implication of the sensory system in NSSI.

In regards to the HPA axis, trauma and early aversive experiences can lead to long-term changes in peripheral and central stress response systems (Schore, 2001; Siegel, 1999). As compared to non-self-injuring rhesus monkeys, self-biting rhesus monkeys showed lower levels of plasma cortisol, and cortisol levels were negatively correlated with self-biting episodes

(Tiefenbacher, Novak, Jorgensen & Meyer, 2000). Such findings provide evidence for HPA dysregulation in monkeys that display self-injurious behavior. Following episodes of NSSI in humans, beta-endorphins increased independently of ACTH plasma levels, which is typically uncharacteristic in stress responses and supports a relationship between the opioid and HPA systems (Sandman, Hetrick, Taylor, & Chicz-DeMet, 1997). When shown neutral and negative pictures, along with thermal sensory stimulation, individuals with BPD demonstrate higher pain threshold and greater limbic activation (amygdala, insula, and anterior cingulate cortex) than individuals without BPD (Niedtfeld, Schulze, Kirsch, Herpertz, Bohus, & Schmahl, 2010). Though NSSI was not looked at specifically in the aforementioned study, these results contribute to our understanding of emotion regulation from a physiological perspective. These findings are promising, but highlight the need for increased research examining opioid neurotransmissions and HPA axis stress responses in relation to NSSI, especially in non-clinical samples.

More broadly, Sher and Stanley (2009) proposed a biological model of NSSI where aversive childhood experiences and genetic factors influence the levels of endogenous opioids and other neurotransmitters, eliciting the perpetual need to restore homeostasis. Research data suggest that stress-induced analgesia is partially responsible for the decrease in pain sensitivity among those who self-injure (Haines, Williams, Brain, & Wilson, 1995; van der Kolk, Greenberg, Orr, & Pittman, 1989; van der Kolk, Perry, & Herman, 1991; Zubieta, et al., 2002), which further implicates the role of the sensory system. These biological models overall demonstrate the functions of the regulatory system and contribute a partial explanation of NSSI, but do not explicitly unpack the complex relationship between the neurochemical biology and the other emotional, cognitive, sensory, and interpersonal factors related to NSSI.

**Relation between trauma and NSSI.** Trauma is commonly studied as a precursor to NSSI, and, though trauma is not present in all adolescents who self-injure, research suggests that trauma simultaneously disrupts regulatory, sensory, emotional, and cognitive functioning (Ayres, 2005; Greenspan & Porges, 1984; Lillas & Turnbull, 2009). Research regarding suicidal behaviors and NSSI demonstrated that trauma accounted for approximately 20% of the variance in NSSI (van der Kolk, Perry, & Herman, 1991), and trauma has been identified as a correlate of NSSI in numerous other studies (e.g., Briere & Gil, 1998; Farber, 2008; Nock, 2009; Yates, 2004, 2009). Examining the biological impact of trauma aids in understanding how aversive experiences often have such lasting impressions (e.g., Felitti, 2002). An abundance of research exists exploring the impact of trauma on development, much of which is linked to the neurochemical and vagal systems (For detailed reviews see Porges, 2006; Schore, 2001b, 2009; Siegel, 1999; Van der Kolk, Pelcovitz, Roth, Mandel, McFarlane, & Herman, 1996; and van der Kolk, Perry, & Herman, 1991). Specifically, the impact of trauma on the capacity to appropriately modulate arousal states and form appropriate attachment is relevant to NSSI research.

Dissociation, a type of internal dysregulation, is highly associated with NSSI (Farber, 2008; Yates, 2009). Situational variables or risk factors, such as sexual abuse or abandonment, are highly correlated with severe internal neurological dysfunctions, such as PTSD or poor attachment (van der Kolk, Perry, Herman, 1991; Yates, 2004, 2009), that often leave children and adolescents with diminished emotion regulation capabilities. In turn, NSSI is potentially one method of regulating internal states. Excessive time spent with a disrupted regulatory system is manifested through irregular emotional states and poor cognitive functioning - indicating a lack of homeostasis among regulatory, sensory, emotional, and cognitive systems. In this

dissertation, it is argued that NSSI is more than just a manifestation of this imbalance; it may be a reaction to perceived noxious stimuli resulting in lost homeostasis and a tactile means of utilizing the sensory system to regain lost homeostasis.

**Internal functions of self-injurious behavior.** In addition to biological components and traumatic symptomology, explanations synthesizing affective, behavioral, and social aspects of self-injury have been proposed. Nock and Prinstein's (2004) four-function model suggests that environmental factors initiate and maintain NSSI, and the NSSI behavior is subsequently reinforced by external or internal variables. Prominent research supports the functional approach of understanding NSSI, as it includes and flexibly supports components from other NSSI explanatory research, such as affect regulation and dissociation (Messer & Fremouw, 2008; Nock, 2009).

The four-function model by Nock and Prinstein (2004) categorizes the functions, or individual reasons, underlying NSSI along two dichotomous dimensions: automatic versus social contingencies and positively versus negatively reinforcing. Many studies use these functional categories, as they reliably categorize adolescent engagement in NSSI (Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007; Nock, 2009; Nock & Mendes, 2008; Yates, Tracy, & Luthar, 2008).

The intrapersonal, internal functions of the four-function model imply that NSSI is a means of coping with internal dysregulation. *Automatic-negative reinforcement* is one of the functions in the four-function model that represents individuals' engagement in NSSI to reduce tension or other negative internal states (e.g., "to stop bad feelings"), which implicates NSSI as a self-regulation strategy. Results from an innovative "real-time" study, where adolescents used hand-held personal data assistants to record their thoughts and actions about suicide and NSSI,

revealed that adolescents engaged in NSSI for automatic-negative reinforcing functions in 65% of episodes. Adolescents reported engaging in NSSI to escape negative affective states, such as anxiety (35%), sadness (24%), and anger (20%), and negative cognitive states, such as having bad thoughts (29%) or bad memories (14%) (Nock, Prinstein, & Sterba, 2009). Research indicates that the most vulnerable individuals report automatic-negative reinforcement, as it is associated with hopelessness and suicide attempts (Nock & Prinstein, 2005). *Automatic-positive reinforcement* refers to individuals using NSSI to produce a desirable psychological state (e.g., “to feel something, even pain” or “to get a rush”), which again implicates NSSI as a self-regulation strategy. Adolescents reported automatic-positive reinforcing functions in 25% of episodes (Nock, Prinstein, & Sterba, 2009). This function is indicative of individuals with post-traumatic stress disorder symptoms and depressive symptoms, especially when dissociation is present (Nock & Prinstein, 2005; van der Kolk, Perry, & Herman, 1991). These automatic or internally motivated functions illustrate the connection between actions and arousal states. Hypothetically, negative thoughts and emotions trigger disrupted regulation or act as indications of disrupted regulation, both of which represent a lack of arousal state homeostasis. Whether the need is to come out of dissociation, “turn off” bad thoughts, or reduce anger, adolescents hypothetically use NSSI as a means to return to an alert processing state, thereby regaining optimal regulatory, and, consequently, executive and relevance functioning. Again, the role of the sensory system in connecting the regulatory system to the higher level systems is implied, but not explicitly credited.

In addition to the intrapersonal functions, NSSI also serves interpersonal, social functions that implicate the communicatory role of NSSI. *Social-negative reinforcement* represents an individual’s engagement in NSSI to escape or avoid interpersonal tasks or demands



(e.g., “to avoid something undesirable” or “to avoid punishment”). *Social-positive reinforcement* refers to engaging in NSSI to gain other’s attention or manipulate (e.g., “to get a reaction out of someone” or “to show how I am feeling”). Adolescents report rarely engaging in NSSI for social-negative reinforcement (15% of episodes) and social-positive reinforcement (4% of episodes) (Nock, Prinstein, & Sterba, 2009). Both social-negative and social-positive reinforcing functions are correlated with social perfectionism and depression. As many as 82% of adolescents who self-injure reported having at least one friend who also engaged in NSSI within the past year (Nock & Prinstein, 2005), which supports the social functions and transmissions of NSSI. Since many adolescents face daunting tasks or difficult social situations, but not all of them engage in NSSI, the central issue regarding why some adolescents choose NSSI as a method of influencing the environment is not addressed by this model.

The four-functional model (Nock & Prinstein, 2004) supports the intrapersonal (self-regulation) and interpersonal (communication) roles of NSSI, but still fails to account for the deeper factors and pathways that motivate self-injurious behavior. An in-depth look at the four-function model suggests that internal responses to aversive external stimuli underlie outwardly socially motivated functions. For example, if “to get attention” is reported as a motivation for NSSI, the function is categorized as *social-positive reinforcing* and is considered an external motivation. Though socially induced instances of NSSI may not appear to be related to regulatory functioning, the four brain systems as demonstrated by the NRF do play a role in the decision-making process. While the need to gain attention may appear to be external on the surface, it may alternatively stem from internal needs to feel accepted. Further, feeling left out or ignored has the potential to be associated with emotional or physical dysregulation (Denham, 1998). Previous research and reviews demonstrate that common threads such as affect

regulation, dissociation, and negative or complex interpersonal relations are intertwined with NSSI, but also reveal the need for more comprehensive models that allow for individual variability and account for the multiple factors that influence the onset, maintenance, and offset of NSSI, including biological models and the negative effects of trauma.

**Comprehensive explanatory pathways and models.** Two prominent models by Yates (2009) and Nock (2009), along with the combination of previously proposed explanatory components, attempt to account for the biological, affective, cognitive, and interpersonal components in the etiology of NSSI. These complex models aid in synthesizing the multiple elements that contribute to adolescents' decisions to engage in NSSI. While these multifaceted models illustrate the interplay between the four brain systems within the NRF, there remains an absence in the explicit role of the sensory system. Instead, sensation is subsumed into other areas within these models and is not specifically researched as a separate, albeit integrated, component.

**Pathway model.** Yates (2009) proposed the pathway model, which combines the impact of attachment, the roles of affect and cognition, the impact of trauma on neurophysiological dysregulation, and the role of the body in relation to the development of NSSI behaviors. The underlying structure of the pathway model assumes that attachment history in combination with child maltreatment may negatively impact development along one of three domains- representational, regulatory, or reactive- leading toward a path of self-injury. The pathway model indirectly addresses the role of the sensory system by describing how the body is used as a tool in reaction to internal processes.

The representational pathway leading to NSSI exemplifies children's core beliefs of self-efficacy and self-worth and their expectations for others' care and emotional responsiveness, all

of which corresponds with the relevance system. Prolonged trauma or abuse negatively impacts these beliefs, in that the self is viewed as defective, others are viewed with malevolence, and relationships are perceived as dangerous or destructive. The body is used as a site for punishment or soothing to compensate for defective relationships or the flawed views of self or others. Research by van der Kolk, Perry, and Herman (1991) supports the representational pathway in that neglect was found to be most predictive of NSSI in adolescents in mental health treatment. This representational pathway exemplifies a “top-down” connection, where the sensory system is implied as the connection between the higher level emotional (relevance) and cognitive (executive) systems and the underlying regulatory system.

The regulatory pathway leading to NSSI relates to children’s emerging “capacities for cognitive-affective integration, symbolization, reflection, and ultimately regulation” (Yates, 2009, p.124). According to the regulatory pathway within the pathway model, maltreatment results in a disconnect between cognition and affect and delays the ability to symbolize emotional experience using language. Over- or under-aroused children may switch from perception (arousal) to action (fight, flight, or freeze) with very little cognition or symbolization (Schoore, 2001; Van der Kolk, et al., 1996), and instead resort to sensation, somatization, and behavior. “In this view, NSSI may constitute an action and bodily based emotion regulation strategy in the absence of adaptive integrative, symbolic, reflective capacities” (Yates, 2009, p. 124), where reduced executive or cognitive functioning results in the emotional system relying on the sensory system to bring the regulatory system back to homeostasis out of necessity. This pathway bridges components of the aforementioned biological models, the impact of trauma, and functions of NSSI, as it closely mirrors the neurorelational framework and potentially reinforces

the crucial role of the sensory system in relation to arousal states, regulation, and higher level cognitive processes.

Finally, the reactive pathway leading to NSSI implicates the potential restructuring and altering of the neurobiological stress response systems, and illustrates that the act of NSSI uses the body to alter arousal and biological reactivity (Yates, 2009). Similar to the biological model proposed by Sher and Stanley (2009), this pathway demonstrates a “bottom-up” trajectory in relating the regulatory system to the sensory system, without bringing in higher level systems.

These three pathways represent a fairly comprehensive approach in explaining NSSI, though they remain fairly limited in generalizability by assuming maltreatment as a precursor to NSSI. Still, they highlight the connection between the brain systems and allude to the role of the sensory system.

*Nock’s (2009) integrated NSSI model.* Whereas Yates’ (2009) model suggested multiple pathways leading to NSSI, Nock’s (2009) integrated NSSI model includes external and internal risk factors that contribute to adolescents’ propensity to engage in NSSI. The model proposes distal risk factors, interpersonal vulnerability factors, intrapersonal vulnerability factors, and stress response factors, as well as six NSSI-specific vulnerability factors that contribute to individual decision-making processes regarding NSSI. The primary tenet of this model builds on the four-function model by proposing that NSSI is both a method of self-regulation and a form of communication.

Distal risk factors, such as genetic predisposition, childhood maltreatment, and familial hostility or criticism, act as “behind-the-scenes” influences. Such factors correspond to the previously mentioned work on biological models and the impact of trauma on brain development

and attachment, and, as viewed through the lens of the neurorelational framework, represent the complex relationship between the regulatory, relevance, and executive systems.

Interpersonal vulnerability factors (poor communication and social skills), which align with the executive system, and intrapersonal vulnerability factors (high levels of aversive emotions and cognitions; poor distress tolerance), which align with the relevance system, contribute to individual variation in affect regulation, moderating internal cognitions, and successfully influencing an individual's social milieu. This vulnerability is connected to an individual's stress response, where stressful events are linked to dysregulation or to social demands perceived as unmanageable. Higher vulnerability is expected to be related to risk factors and increased likelihood of engaging in other maladaptive behaviors (Nock, 2009).

Variability in stress response and regulation implicate the biological regulatory functions of NSSI. This aspect of Nock's (2009) integrated model accounts for differences in arousal states (over- or under-arousal) depending on individual regulatory thresholds and whether they perceive social demands as unmanageable. The compounding of distal, interpersonal, and intrapersonal factors can contribute to heightened, prolonged, or more frequent disruption in regulation. This dysregulation, in combination with NSSI specific vulnerability factors (subsequently discussed), results in NSSI. A feedback loop is then developed from NSSI back to the stress response as a regulation of both affective experience and social situation, reinforcing the regulatory function of NSSI.

Finally, Nock's (2009) NSSI model suggests that the risk of engaging in NSSI as a result of the previously described components is moderated by possible NSSI-specific vulnerability factors that increase an individual's likelihood to choose NSSI over other behaviors. These hypothetical vulnerability factors are based on previously researched constructs linked to NSSI,

including the social learning hypothesis, self-punishment hypothesis, social signaling hypothesis, pragmatic hypothesis, pain analgesia / opiate hypothesis, and implicit identification hypothesis (for further description see Nock, 2009). In combination with the stress response, these vulnerability factors act as the final impetus for NSSI.

In viewing Nock's (2009) model as a whole, a combination of distal factors (e.g., birth trauma) results in or compounds difficulties in interpersonal factors, such as communicating with peers, and intrapersonal factors, such as poor distress tolerance. In accordance with the integrative model, NSSI is precipitated by the interaction between regulatory dysfunction (stress response) and one of the vulnerability factors, such as the social learning hypothesis (e.g., individual observing and internalizing NSSI as a coping behavior) or pain analgesia / opiate hypothesis (e.g., individual engages in NSSI to reinforce biochemical, regulatory impact of NSSI). The act of NSSI reinforces the regulatory functions and results in a cycle of NSSI as a coping response. As illustrated, Nock's model (2009) avoids subscription to a single explanation, and instead combines factors or explanations proposed in previous research to create a more comprehensive model that allows room for heterogeneity. Despite this, the model requires further exploration of the origins of NSSI and the reasons why this behavior is chosen in place of or in addition to other maladaptive behaviors. Short of the inclusion of the pain / analgesia hypothesis as a possible impetus for NSSI, which is linked to both the sensory system and the neurochemical, regulatory aspect of NSSI, the role of the sensory system is skimmed over, despite its underlying connection between regulatory factors and the higher level systems.

Figure 2.

*Model components and explanatory factors categorized using the neurorelational framework*

Model Components / Factors	Regulatory	Sensory	Relevance	Executive
<b>Biosocial models</b>				
Biological model	●	○		
Affect regulation	●		●	
Trauma / PTSD	●	●	●	●
Dissociation /depersonalization	●	○	●	●
<b>Comprehensive models</b>				
Four-function model	●		●	●
Pathway Model				
“Representational”– punishment or soothing		○	●	●
“Reactive” – alter arousal / reactivity	●	○		
“Regulatory” – symbolize affect	○	○	●	
Integrated Model				
Distal risk factors	◇	◇	◇	◇
“Stress response” / Poor distress tolerance	●	◇		
Intrapersonal factors	◇		●	●
Interpersonal interaction			●	●
Pain tolerance / analgesia hypothesis	●	●		
Social learning hypothesis			●	●
Social problem solving			●	●

● = Evident, ○ = Implied, ◇ = Theoretical / Potential link

By reviewing current explanatory models of NSSI using the structure of the neurorelational framework (NRF), it becomes apparent that the various perspectives, models, and theories work in tandem and complement each other (see Figure 2). The more comprehensive models by Yates (2009) and Nock (2009) incorporate the biological basis of NSSI (e.g., Sher & Stanley, 2009), impact of trauma, and the role of interpersonal relationships. Much of the combined evidence implicates NSSI as a regulatory function, with various pathways and factors impacting the conditions under which NSSI occurs. According to the NRF, the sensory system works together with the regulatory system in processing information and acts as the conduit for responding to the demands of the regulatory system (Lillas & Turnbull, 2009). Further

exploration of the crucial role of the sensory system will contribute to these comprehensive models by increasing our understanding of how NSSI-engaging individuals perceive their environment and use sensation to adapt.

### **Sensory Preferences: The Missing Piece**

Current functional and explanatory models of self-injury fall short of explicitly incorporating the role of the sensory system. As previously discussed, sensory processing refers to how sensory input is detected and registered by the central nervous system; whereas sensory modulation refers to the interpretation and organization of sensory input on both a neurological and behavioral level (Ayres, 2005; Williamson & Anzalone, 2001). Individuals constantly balance internal cues (e.g., body sensations, regulatory states) with external cues (e.g., auditory or visual stimuli), which impact cognitive functioning, including attention, memory, and problem solving. “Cognitive processing is optimal when internal and external information processing afford task performance together” (Dunn, 2001, p.609). Additionally, sensation impacts affect, as it provokes emotional reaction and is an integral part of social relationships between individuals (Williamson & Anzalone, 2001). The relationship between sensory processing, cognition, and affect highlights the need for better understanding “bottom up” processes in human behavior, and may be useful in better understanding NSSI. According to Dunn’s Model of Sensory Processing (1997, 2007), individuals have varying neurological thresholds for processing information, as well as a range of self-regulation strategies that impact how much they ignore, seek, or avoid sensory stimuli. Differences in neurological thresholds (tolerance to receive sensory information) and regulatory strategies (tendency to be active or passive in reacting to stimuli) allow for an array of sensory processing types and variety in individuals’ responses to stressors and stimulus within the environment (Dunn, 1997, 2007). By accounting





perception, etc.). For example, an individual may have high thresholds in some domains, such as taste (e.g., seeking spicy food), but lower thresholds in others, such as smell (e.g., having strong, negative reactions to perfumes or scents in a restaurant).

**Self-regulation strategy.** Within Dunn's (1999) model, the self-regulatory dimension reflects a continuum in the level of action taken in response to stimuli. Passive regulation strategies include inactive or sedentary approaches when reacting to sensory information. Individuals on with more extreme preferences on the passive end of the spectrum may notice that a threshold is reached, but may do little to avoid or prolong a particular sensation. Active regulation strategies include seeking or avoiding sensations. Individuals on the active end of the spectrum may alter their actions or environment to induce or prolong a sensation or to halt or avoid a sensation.

**Variations in the sensory profile quadrants.** Variations in neurological threshold and self-regulation strategy can be organized in four sensory preference quadrants: *low registration*, *sensation seeking*, *sensory sensitive*, and *sensation avoiding*. The use of predominantly passive strategies is classified as low registration if neurological threshold is high, or sensory sensitive if neurological threshold is low. In tests of physiological responsivity, individuals who display more low registration tendencies habituate quicker to stimuli, whereas those who display more sensory sensitive preferences take longer to habituate to stimuli.

Individuals with predominantly active strategies are classified as sensation seeking if they have a high threshold, or sensation avoiding if they have a low threshold. As described in Figure 4, individuals classified as sensation seeking take longer to habituate physiologically to stimuli, whereas those with sensation avoiding preferences habituate more rapidly (Brown, Tollefson, Dunn, Cromwell, & Fillion, 2001).

If the dimensions are examined by threshold level, the model suggests that individuals with low neurological thresholds will either attempt to control subjection to aversive stimuli (sensory avoiding) or become passively distressed or distracted by aversive stimuli (sensory sensitive). Zuckerman (1994) reported that low threshold individuals demonstrate increased heart rate when presented with stimuli, presumably an indication of perceived fear or threat. Previous studies indicate tactile and auditory sensitivity reported most frequently (Ben-Sasson, Carter, & Briggs-Gowan, 2009). Alternatively, individuals with high thresholds tend to either seek stimulation to meet threshold needs (sensory seeking) or passively require additional stimulation to elicit reaction, while being unaware of stimuli (low registration). These individuals that have a higher sensation threshold demonstrate decreased heart rate when presented with new stimuli, presumably allowing for open acceptance or response to the stimuli (Zuckerman, 2004).

To measure sensory preferences, individual processing preferences are assessed in a range of domains (e.g., visual, tactile, auditory, taste, smell, etc.). Sensory preferences can be examined by domain (e.g., auditory) and within each quadrant (e.g., less or more sensation seeking). Individuals assessed using Dunn's model will have preferences that fit within each quadrant. Thus, all individuals are sensation seeking, sensation avoiding, sensory sensitive, and low registration, depending on the domain, but some individuals may have unique sensory preferences that indicate stronger or weaker preferences than others in certain quadrants. Each sensory preference quadrant illustrated in Figures 3 and 4 represents a range, extending from "much more than others" to "much less than others." "Similar to most people" is in the middle of each quadrant and is defined as a range that is within one standard deviation above and below the standardized mean (see Figures D1 and D2, Appendix D) (Dunn, 1999).

Figure 4.  
*Specific characteristics of sensory quadrants in Dunn’s Model of Sensory Processing*

	Low Registration	Sensation Seeking	Sensory Sensitive	Sensation Avoiding
Neurological Threshold	High	High	Low	Low
Regulatory Behavioral Response	Respond in accordance with threshold	Respond to counteract threshold	Respond in accordance with threshold	Respond to counteract threshold
Physiological Reactivity	Low / weak	Low / Weak	High / Intense	High / Intense
Habituation	Quickly	Slowly	Slowly	Quickly
Response to stimuli	Passive and weak response to stimuli that are not easily noticed	Seeks stimuli to maintain optimum level of arousal	Passive, yet intense response to stimuli that are easily noticed	Avoids stimuli to maintain optimum level of arousal
Response in environment	Focus in distracting environments	Enjoys “sensory rich” environments	Notices majority of sensory input in environment	Overwhelmed by “sensory rich” environments; need to control / create structured environment
Score similar to others on A / ASP or SP	Aware enough of sensory stimuli to be attentive or participate	Seeks new sensory experiences to intentionally reach threshold	Attentive to sensory input; highly aware of surroundings	Actively blocks or withdraws from sensations to manage input
Score less than or much less than others on A / ASP or SP	May notice unnecessary information / sensory input	May avoid seeking input to point of lack of sustained attention	May miss sensory input needed for sustained attention	May fail to be aware of input
Score more than or much more than others on A / ASP or SP	Easily misses information; requires additional sensory input to reach threshold	Easily bored; May be disruptive in seeking information	May be easily distracted by sensory input	May be easily overwhelmed by sensory input, which decreases function and attention

Note: A / ASP – Adolescent / Adult Sensory Profile; SP – Sensory Profile  
 Adapted from Dunn, 1999; Brown, et al., 2001; & Brown, & Dunn, 2002. *Adolescent/Adult Sensory Profile*. Copyright © 2002 NCS Pearson, Inc. *Sensory Profile*. Copyright © 1999 NCS Pearson, Inc. Reproduced with permission. All rights reserved. “*Sensory Profile*” and “*Adolescent/Adult Sensory Profile*” are trademarks, in the US and/or other countries, of Pearson Education, Inc. or its affiliates(s).

To better illustrate the four quadrants, consider the following example. If an individual has very passive regulation strategies, but is sensitive to input in certain domains (e.g., taste or smell) while fairly oblivious to other types of stimuli (e.g., high auditory threshold, fails to notice auditory input), then that individual may score more than others in low registration and sensory sensitivity. Meanwhile, the same individual may seek just enough information and stimuli to sustain attention and avoid certain sensations as much as others, so this individual would score similar to most people in sensation seeking and sensation avoiding. Alternatively, if an individual is similar to most people in low registration, sensory sensitive, and sensation avoiding quadrants, but scores “much more than others” in the sensation seeking quadrant, the individual may be classified as sensation seeking. This individual may demonstrate extra effort in attempting to experience certain stimuli to reach or exceed neurological threshold (e.g., a child with high auditory threshold who constantly makes noises or increases the volume on the television to very high levels), even though it may result in behavioral disorganization or over-arousal. While patterns in sensory processing exist, it is crucial to maintain that individual variation is an integral aspect of sensory processing and sensory modulation, such that patterns can vary in the presence of particular stimuli or under certain situations (Ayres, 2005). Broadly speaking, while individuals generally seek optimum arousal, others must counteract or meet their threshold levels to sustain optimal arousal. Some push their threshold while others actively avoid having their threshold met. By acknowledging individual differences in sensory preferences, while recognizing patterns that exist among individuals, researchers can apply these concepts to existing understanding of how individuals take in information and how sensory preferences contribute to affect regulation and behavioral choices.

**Sensory preferences and NSSI.** Much of the literature that connects sensory preferences and self-injurious behavior focuses on individuals with developmental disabilities, such as autism (e.g., Reynolds & Lane, 2008). Strong correlations exist between NSSI and intense sensory preferences (e.g., extremely high or extremely low thresholds) in individuals with developmental delay or sensory integration disorder (Ayres, 2005; Dunn, 1999; Lillas & Turnbull, 2009; Reynolds & Lane, 2008). The present research is informed by this body of literature, but does not focus on this population. Even without developmental delay or trauma-induced dysregulation, oversensitivity to specific stimuli (low auditory or visual threshold) or the need to modulate affect through the skin (tactile or proprioceptive / muscular senses) combined with passive or active regulation strategies may be an underlying component of what compels adolescents to engage in NSSI, as opposed to other behaviors (e.g., yelling, talking with a friend, exercising, etc.).

Negative environmental and relational factors, such as trauma and insecure attachment, often result in sensory processing deficits starting in childhood (Schoore, 2008). The senses act as a gateway for external information to enter the brain, and the central and autonomic nervous systems work together to regulate arousal states (Schoore, 2001). An over-reactive or under-reactive arousal system, especially when related to trauma, impacts the ability to process and modulate sensory arousal appropriately (Lillas & Turnbull, 2009; Shore, 2008). Additionally, sensory processing and modulation have been linked to temperament, indicating that some individuals may simply have a higher sensitivity to external stimuli and modulate arousal accordingly (Dunn, 2007; Lillas & Turnbull, 2009; Liss, Timmel, Baxley, & Killinsworth, 2005; Zentner & Bates, 2008). Sensory processing sensitivity and sensory modulation difficulties predict depression and anxiety in adulthood (Liss, Timmel, Baxley, & Killinsworth, 2005;

Moore, 2006; Moore & Henry, 2002; Pfeiffer & Kinnealey, 2003), as well as maladaptive risk behaviors such as delinquency and aggression, especially in adolescence (Fanchiang, Snyder, Zobel-Lachiusa, Loeffler, & Thompson, 1990; Mawson, 1999; Moore; Pfeiffer & Kinnealey, 2003).

Very few studies have examined the explicit link between NSSI and sensory preferences in populations without developmental disorders. Moore and Henry (2003) reported a case study of three women who engaged in NSSI and scored high on levels of sensory defensiveness, indicating that they have high reactivity to sensory stimuli. Treatment consisted of one month of sensory specific interventions including brushing of the skin and a joint compression protocol, and data collection included self-report and personal journal entries. Results from follow-up at nine months revealed a complete cessation of NSSI among all participants and a reduction in sensory defensiveness. Though limited in generalizability, the results support the need for larger scale research to further explore the connection between sensory preferences and NSSI.

Treatment approaches for NSSI also often include sensory components. For example, dialectical behavior therapy (DBT) (Linehan, 1993; McKay, Wood, & Brantley, 2007) provides sensory-based strategies to help individuals replace NSSI, including holding an ice-cube in one's hand until it melts (tactile input) or drawing on oneself in red marker or nail polish (tactile or visual input) in place of actual self-injury. Prescription of such strategies is part of a larger list of coping or distraction techniques design to prevent self-injury or suicide. As such, use of sensory strategies by NSSI-engaging individuals is fairly random. By examining the sensory preferences of those who self-injure, treatment approaches could be tailored to meet individual sensory needs. In line with Moore and Henry's (2003) use of sensory-based treatment of NSSI, sensory input could be combined with traditional treatment approaches in reducing NSSI behavior.

Using a cumulative, multi-dimensional model such as the neurorelational framework to synthesize NSSI research, many of the puzzle pieces of NSSI research come together. Neurochemical and biological differences, pain tolerance, trauma, dissociation, social problem-solving, and interpersonal relationships all exist interactively in explaining NSSI (see Figure 2). Instead of attempting to determine which models or paths hold more merit, it is more productive to continue to explore how they are related and how individuals relate to multiple variables. In putting the pieces together, it is clearer which aspects, such as sensory processing, require greater research attention in studying NSSI.

### **Summary and Conceptualization**

Within the past 15 years, NSSI research gained momentum and shifted toward more explanatory research that accounts for individual differences, investigates the underlying purposes or functions of NSSI, and explores the conditions under which NSSI occurs. Yet, there is not one simple answer as to why adolescents choose to engage in NSSI, as evidenced by the multiple models, theories, and pathways within NSSI research (Nock, 2009). Trauma, dissociation, impulsivity, poor attachment, depression, and anxiety have been linked to NSSI as explanation for the behavior (Nock, 2009; Yates, 2004), yet the need for deeper understanding persists. Current functional models posit that adolescents engage in NSSI to regulate internal emotional states or communicate with others (Nock, 2010). Though a consensus appears to be forming in regards to the purposes served by NSSI, debate continues over issues of initiation, such as onset and underlying explanation for how and why this behavior is initially chosen as a self-regulation strategy over other strategies (Nock, 2009).

In reviewing the previously researched models through the lens of the neurorelational framework (NRF), it is evident that the executive, relevance, and regulatory systems have



received more explicit attention in NSSI research than the sensory system. Current functional models address relevant internal and external functions and factors relating to NSSI, but neglect to explicitly address the integral role of the sensory system and explore how potential sensory preference differences play a role in adolescents' decision to engage in NSSI. Negative factors such as trauma and poor relationships often result in sensory processing deficits starting in childhood (Shore, 2008). Research by Liss, Timmel, Baxley, and Killinsworth (2005) found that sensory processing sensitivity predicts depression and anxiety in adulthood. Despite these findings, researchers have yet to explore the connection between sensory preferences and NSSI.

Dunn's Model of Sensory Processing demonstrates that differences in neurological thresholds (our tolerance to receive sensory information) and regulatory strategies (our tendency to be active or passive in reacting to stimuli) allow for an array of sensory integration types and variety in individuals responses to stressors (Dunn, 1997, 2007). Sensitivity to the environment, as evidenced by "low threshold" preferences and active or passive regulation strategies, combined with the need to regulate affect through the skin, or tactile sensory domain, may be an underlying component of what leads adolescents to choose NSSI as a coping strategy. "Sensory experiences provide the core foundation for how we perceive our bodies and the world (Lillas & Turnbull, 2009, p. 57)." A deeper understanding of the role of the sensory system will strengthen connections among the various components of current NSSI models and explanatory factors.

In this dissertation, I aim to incorporate sensory processing research with adolescent NSSI and self-regulation research. This research has potential implications for the development of interventions aimed at reducing NSSI. By exploring the role of the sensory system in relation to NSSI, while acknowledging the transactional and relational nature of all four systems within

the neurorelational framework, prevention and treatment efforts could reflect a multi-tiered approach considering not only the target behavior and emotional or cognitive factors, but also addresses individual differences in sensory preferences and regulatory needs.

### **Purpose and Hypotheses**

NSSI has typically been studied in adolescents because the reported average age of onset is 12 to 14 years (Deliberto & Nock, 2008; Heath, Ross, Toste, Charlebois, & Nadecheva, 2009). The paucity of literature describing the origins of NSSI knowledge in late childhood and early adolescence affords a valuable opportunity for us to discover more about where and when youth learn about NSSI. In the present study, NSSI is examined in the developmental period preceding adolescence to best capture risk factors for the emergence of NSSI. Youth aged 8 to 14 and their primary caregivers responded to questions regarding NSSI, sensory preferences, and trauma history.

The goals of this research were threefold. First, in this study I aimed to determine if sensory preference is associated with engagement in NSSI. It was hypothesized that adolescents who engage in NSSI would display more “low threshold” sensory preferences than youth who do not engage in NSSI. Specifically, the likelihood of NSSI would be predicted by extreme sensory preferences (defined as significantly higher scores than of children who do not engage in NSSI, and ideally above standardized cut-off scores) in the low threshold quadrants (sensation avoiding and sensory sensitive) and categorical areas of *touch processing*, *auditory processing*, and *modulation of sensory input affecting emotional responses*.

A secondary goal was to examine how sensory preferences fit with Nock and Prinstein’s (2004) four-function model. It was hypothesized that adolescents’ responses reflecting engagement in NSSI for primarily internal (automatic) positive or negative reinforcing reasons

would be correlated with scores reflecting “low threshold” sensory preferences (sensory sensitive or sensation avoiding).

Finally, the relationship between sensory preferences, NSSI as a form of self-regulation, and trauma was explored. It was hypothesized that trauma history would predict sensory preferences and use of NSSI as a self-regulation strategy, as categorized using the four-function model (Nock & Prinstein, 2004). Additionally, it was hypothesized that PTSD symptomology, specifically avoidance/numbing or hyperarousal would predict NSSI, and that there would be value added in including sensory preferences in the relationship between PTSD symptomology and NSSI.

## CHAPTER THREE

### METHODS

#### Participants

Of the 108 parent-child pairs with youth aged 8 to 14 years ( $M = 11.6$ ,  $SD = 1.5$ ) who participated, 85 previously took part in an earlier portion of an ongoing study and 23 were new to the sample. Youth were distributed fairly evenly across most age groups ( $n = 99$ ): age 8 (2%), 9 (17%), 10 (19%), 11 (19%), 12 (19%), 13 (19%), 14 (4%); age data were missing for nine youth. Over half (56%) of the youth were female. Parents' ages ranged from 27.4 to 58.9 ( $M = 39.4$ ,  $SD = 6.9$ ); 90% were female. The largest share of participants identified as Hispanic (43%), followed by White (non-Hispanic) (28%), African American (17%), Native American (3%), Asian (2%), and Other (7%) ( $n = 104$ ; ethnicity data missing for four participants).

Participants who participated in a previous study, and who had indicated that they would be willing to participate in future studies in our lab, were contacted via phone or email. New recruits responded to internet postings (via Craigslist) and posted flyers advertising the opportunity to participate in a psychology study. Once agreeing to participate, parents were informed that they would complete questionnaires about emotions, their parent-child relationship, sensory preferences, and their child's past experiences, such as trauma. Research assistants told them that their child would separately complete similar self-report questionnaires as well as computerized puzzle tasks which are not described here since they pertain exclusively to a separate larger, longitudinal study. Additionally, research assistants informed potential participants that participation was voluntary and that they would be compensated \$50 for their time.

## **Procedure**

Upon visiting the lab to complete self-report questionnaires and a problem solving task (as a separate aspect of an ongoing longitudinal study), written informed consent from the parent and assent from the youth were obtained. Parents and youth completed measures per the following protocols.

**Youth participant protocol.** After completing an initial battery of questionnaires and puzzle problem-solving tasks (not relevant to this aspect of study), youth completed a second battery of questionnaires which included the two pertaining to this study: the Functional Assessment of Self-Mutilation (FASM; Lloyd, Kelley, & Hope, 1997) and an adapted version of the Adolescent / Adult Sensory Profile (A/ASP; Brown & Dunn, 2002). To build up to direct questions about NSSI in the FASM, two questions regarding knowledge of NSSI (“Have you ever heard of people (kids, teens) who hurt themselves on purpose without wanting to die?” and “If so, describe a little bit about where you learned about this behavior or if you know people your age who do it?”), as well as one item from the Self-Injurious Thoughts and Behaviors Questionnaire (STBI; Nock., Holmberg, Photos, & Michel, 2007) regarding thoughts about NSSI (“Have you ever had thoughts of purposely hurting yourself without wanting to die? e.g., cutting or burning”), preceded the FASM. A fourth item, “Have you ever hurt yourself on purpose (for example, when you felt angry, sad, lonely, or bored)?” was also included (henceforth referred to as SH#4).

Prior to completing the A/ASP, the youth read a passage to prime thinking about his or her own sensory preferences (see Appendix A). The experimenter reminded youth that their

responses were confidential and to respond to items as accurately as possible. The experimenter remained in the room to be available to answer questions.

**Parent participant protocol.** While the youth completed the problem-solving task and the questionnaires, parents completed a battery of questionnaires on a computer. Pertaining to this study, parents read a statement (see Appendix B) describing how all individuals have different sensory preferences in order to help them become accustomed to thinking about the sensory system. Parents subsequently completed questionnaires regarding their own and their child's sensory preferences, using the A/ASP and Sensory Profile (SP; Dunn, 1999), respectively, as well as the University of California at Los Angeles Posttraumatic Stress Disorder Reaction Index for DSM-IV (UCLA-PTSD RI; Steinberg, Brymer, Decker, & Pynoos, 2004) regarding their child's trauma history and related behavioral symptoms. The experimenter remained available to answer any questions from the parents.

## **Measures**

**Functional Assessment of Self-Mutilation (FASM).** This self-report questionnaire includes items regarding the methods (11 items) and functions (22 items) of NSSI (Lloyd, Kelley, & Hope, 1997); however, due to researcher error, a shortened version with only 11 function items was used. The first eleven items assess various types of self-injurious behavior (e.g., "cutting/burning/scraping skin," "picking at a wound," "biting or hitting oneself," "inserting objects under skin," "hair pulling") engaged in during the past year, their frequency, and whether or not medical treatment was received. Six additional items inquire about other aspects of self-injury, including the presence of suicidal intent, how much pain was felt during self-injury, how long they thought about NSSI before doing it, whether or not they were taking drugs or alcohol at the time, how old they were the first time they harmed themselves, and

whether or not they had ever engaged in self-injurious behavior (if not in the last year). The reported methods were divided into more severe (cutting, burning, carving, self-tattooing) and less severe (head-banging, hair pulling, picking at skin) (Lloyd, et al., 1997). The final 11 items assessed the reasons why participants engaged in self-injurious behavior (e.g., “to feel something, even if it was pain,” “to receive more attention from your parents or friends.”). Participants rated each reason on a 0–3 scale (0 - never, 1 - rarely, 2 -some, and 3 - often). These subscales demonstrate adequate internal consistency in adolescent samples ( $r = 0.65$ ) (Guertin, et al., 2001). Structural and content validity were demonstrated in adolescent psychiatric samples by categorizing the functional item responses into Nock and Prinstein’s (2005) four-function model. Due to the inadvertent use of a shortened version of the functional scale, responses as categorized and subsequent analyses are interpreted with caution in the results of this research. Generalizability is limited given the range of poor to good reliability values for the subscales automatic-positive reinforcement ( $\alpha = .28$ ), social-positive reinforcement ( $\alpha = .55$ ), social-negative reinforcement ( $\alpha = .80$ ). Only one item was used for the automatic-negative reinforcement subscale.

**Adolescent / Adult Sensory Profile (A/ASP).** This 60-item assessment categorizes individuals’ self-reported responses to sensory preference statements by sensory domain, neurological thresholds (high or low), and self-regulatory behavioral responses (active or passive), as well as within four sensory quadrants (Brown & Dunn, 2002). Respondents rate items using a 5-point scale (AN- almost never, S – sometimes, O – often, F – frequently, AA – almost always), where ‘almost never’ has a value of 1 and ‘almost always’ has a value of 5. Though the A/ASP was originally intended for adults and adolescents 11 years and older, most

of the items are simple enough to be understood by children as young as 8 years. Examples were added to potentially confusing items for the profiles administered to youth.

***Sensory domain.*** The A/ASP is organized by sensory domain categories, which include taste / smell (e.g., adding spice, avoiding textures), movement (e.g., riding in a car), visual (e.g., missing signs, avoiding crowds, preferring bright colors), touch (e.g., going barefoot, wearing certain types of clothing), activity level (e.g., ability to multi-task), and auditory processing (e.g., not noticing when name is called, difficulty working with background noise). Summed domain scores provide information in regards to individual preferences for each domain.

***Neurological threshold.*** Within each sensory domain, each item demonstrates whether respondents have low or high threshold tendencies. As an example, becoming easily distracted in a noisy or crowded environment is illustrative of low threshold preferences. Alternatively, failing to notice people entering the room or being unaware of the origin of cuts and scrapes are illustrative of high threshold preferences. When low threshold items are summed, higher scores suggest that individuals have a lower neurological threshold and are more sensitive in their sensory processing. When high threshold items are summed, higher scores suggest that individuals have a higher neurological threshold and are less sensitive in their sensory processing.

***Regulation strategy.*** Each item is also intended to demonstrate whether respondents have active or passive regulation strategies. As an example, purposefully going to smell flowers is illustrative of an active regulation strategy. Alternatively, having difficulty working with background noise (but not taking steps to remove the noise or move locations) is illustrative of a passive regulation strategy. When active regulation strategy items are summed, higher scores suggest that an individual takes a more active role in seeking or avoiding sensory input. When



passive regulation strategy items are summed, higher scores suggest that an individual takes a less active role in controlling sensory input.

***Sensory quadrants.*** Finally, item responses correspond to one of each of the quadrants scores (15 items pertain to each quadrant), and the summing of these items results in a score for each quadrant. Each quadrant is associated with a different threshold level and response strategy: low registration (e.g., failing to notice when one's name is said indicates high threshold, passive strategy), sensation seeking (e.g., purposefully humming or making noises indicates high threshold, active strategy), sensory sensitivity (e.g., being easily bothered by strong odors indicates low threshold, passive strategy), and sensation avoiding (e.g., avoiding crowded areas indicates low threshold, active strategy). Total quadrant scores are compared to standardized means and cut-off scores (Brown & Dunn, 2002). As illustrated in Appendix D (Figures D1), respondent scores within each quadrant can be "similar to others" (within 1 standard deviation of the mean), "more than others" (1 standard deviation above mean), "much more than others" (2 standard deviations above the mean), "less than others" (1 standard deviation below the mean), or "much less than others" (2 standard deviations below the mean). For example, a score of 5 (almost always) on the auditory domain item regarding avoiding noisy settings demonstrates a low threshold and active regulation strategy, which falls into the sensory avoiding quadrant. If the responses on all of the items corresponding to the sensory avoiding quadrant are high, the total quadrant score would be categorized as "more than others."

***Validity and reliability.*** In a sample of 615 adolescents and adults, this measure demonstrated good validity, strong Pearson correlations between subscale items and subscale total scores, and adequate reliability of subscale items within each quadrant (low registration:  $\alpha = .78$ , sensation seeking:  $\alpha = .60$ , sensory sensitivity:  $\alpha = .78$ , sensation avoiding:  $\alpha = .77$ ) (Brown,

Tollefson, Dunn, Cromwell, & Filion, 2001). Using Cronbach's alpha to assess internal consistency of item sets (15 items per set) into each respective quadrant, the current sample demonstrated adequate reliability for each quadrant (low registration:  $\alpha = .76$ , sensation seeking:  $\alpha = .65$ , sensory sensitivity:  $\alpha = .63$ , sensation avoiding:  $\alpha = .66$ ).

**Sensory Profile (SP).** The SP is a 125 item caregiver-completed questionnaire that assesses children's sensory processing and modulation in their responses to sensations in everyday life (Dunn, 1999). Though the SP is intended for children aged 3-10, previous studies have used it with children up to age 13 (e.g., White, Mulligan, Merrill, & Wright, 2007). Additionally, email correspondence with the author of the measure, Winnie Dunn, indicated that she had used the SP with children up to age 14 by adding age appropriate examples (W. Dunn, October 18, 2010). Therefore, examples were added to ensure items are age appropriate (e.g., addition of "roller coaster" to the item regarding whether the child avoids fast-moving playground equipment). The SP scores were utilized in addition to the children's A/ASP scores to help obtain a more complete picture of youth's sensory preferences.

As subsequently detailed in the following paragraphs, the SP items can be tabulated along fourteen sensory domain subcategories or nine sensory factors. To convert SP scores into quadrant scores for comparison with the A/ASP, the Sensory Profile Supplement (Dunn, 2006) was used. Respondents rated all items using a 5-point scale (A - always, F - frequently, O - often, S - sometimes, N - never), where, opposite of the A/ASP, 'always' has a value of 1 and 'never' has a value of 5.

**Sensory domain subcategories.** The SP items are presented in order of the following subcategories: auditory processing (e.g., difficulty concentrating with background noise), visual processing (e.g., enjoys the dark, prefers bright colors), vestibular processing (e.g., avoiding

spinning or being upside-down), touch processing (e.g., disliking shoes, avoiding certain textures), multisensory processing (e.g., leaving clothes twisted while wearing them), oral sensory processing (e.g., reacting strongly to food textures), modulation related to endurance and tone (e.g., needing to support body during activities), modulation related to body position and movement (e.g., afraid of heights or falling motion), modulation of movement affecting activity level (e.g., enjoying sedentary activities), modulation of sensory input related to emotional response (e.g., failing to interpret facial expressions), modulation of visual input affecting emotional responses and activity level (e.g., avoiding eye contact with others), emotional / social responses (e.g., crying very easily), behavioral outcomes of sensory processing (e.g., talking to self to work through tasks), and items indicating thresholds for response (e.g., smelling objects deliberately). Summed subcategory responses reveal youth's sensory preferences in each sensory domain.

***Sensory factors.*** Items from each sensory domain can be combined differently to create nine sensory factors: sensory seeking (e.g., making noises purposefully), emotionally reactive (e.g., reacting sensitively to criticism), low endurance / tone (e.g., moving stiffly), oral sensory sensitivity (e.g., seeking out specific tastes), inattention / distractibility (e.g., working with background noise presents difficulty), poor registration (e.g., unaware of origin of scrapes and bruises), sensory sensitivity (e.g., avoiding bumpy ground or textures), sedentary (e.g., preferring quiet, solo activities), and fine motor / perceptual (e.g., having difficulty with games with small pieces, like puzzles). Sensory factor items are summed to reveal a factor score which is compared to standardized means and cut-off scores to determine whether youth have more or less sensitivity along specific factors than average peers.

**Sensory quadrants.** Using the Sensory Profile Supplement (Dunn, 2006), SP items were grouped and summed to tabulate scores for each quadrant: low registration (e.g., failing to respond when called, despite fine hearing), sensation seeking (e.g., spinning and twirling to purposefully feel dizzy), sensory sensitive (e.g., avoiding activities, like gymnastics, that involve being upside-down) and sensation avoiding (e.g., holding hands over ears when presented with unpleasant noise). Similar to the A/ASP, subcategory scores for each domain are compared to standardized means and reported in terms of distance from the mean; specifically whether scores are 1 or 2 standard deviations (SD) above or below the mean (see Appendix D, Figure D2). The scale is opposite of the A/ASP, in that lower scores indicate greater sensitivity than others, while higher scores indicate lower sensitivity.

**Reliability.** Previous research with 1200 children aged 3 to 14 with and without disabilities revealed low to good internal reliability (range  $\alpha = .47 - .91$ ) (Dunn, 1999). Using Cronbach's alpha to assess internal consistency of item sets into each respective quadrant, the current sample demonstrated good internal reliability for each quadrant (low registration (15 items):  $\alpha = .89$ , sensation seeking (26 items):  $\alpha = .85$ , sensory sensitivity (20 items):  $\alpha = .84$ , sensation avoiding (29 items):  $\alpha = .89$ ).

**University of California at Los Angeles Posttraumatic Stress Disorder Reaction Index for DSM-IV (UCLA-PTSD RI).** The parent report version of this measure addresses exposure to traumatic events, reaction to traumatic events, and observed affective symptomology within the past month for children age 3-18 and takes approximately 20-30 minutes to complete (Steinberg, Brymer, Decker, & Pynoos, 2004). Respondents mark "yes" or "no" on 13 items addressing potential events that children could have experienced, such as earthquakes, witnessing violence, or sexual abuse (e.g. [your child's experience] "Seeing someone in your

town being beaten, shot at or killed”). The subsequent item allows for respondents to pick one event which bothers the child most on which to focus for the remaining items. The next 13 items, addressing how the child felt during the most bothersome incident, are also scored “yes” or “no.” The final 20 items pertain to behavioral and emotional symptoms that are often indicative of having experienced or witnessed trauma (e.g., “My child tries not to talk about, think about, or have feelings about what happened”), and scored on a 5-point Likert scale (0- None, 1- Little, 2- Some, 3- Much, 4- Most). Respondents are provided with calendar-like, graphic representations of these scale categories to help increase internal validity. These last items correspond to DSM-IV-TR diagnostic criteria for PTSD and divide responses into three criterion categories: re-experiencing, avoidance/numbing, and hyperarousal. The UCLA PTSD-RI has good validity in both traumatized and control samples, including good sensitivity and specificity in comparison to clinical diagnostic interviews for PTSD. Authors also report above adequate test-retest reliability and high internal consistency (approximately  $\alpha = .90$ ) (Steinberg, Brymer, Decker, & Pynoos, 2004). The current sample demonstrated good reliability for the PTSD symptom scale ( $\alpha = .84$ ).

## CHAPTER FOUR

### RESULTS

#### Descriptive Data

**NSSI knowledge.** Over half of youth (56%) reported hearing about others who injure themselves on purpose without intent to die. When queried about the origins of their knowledge, youth ( $n = 105$ ) listed peers/school or family (33%) and media (12%) as primary sources, while 7% reported being unsure about where they learned about NSSI. Additionally, one youth reported self-discovery and three youth identified reasons why they believe children self-injure, but did not indicate where or how they heard about it. Youth who reported parents and peers as primary sources listed parents as educating them about NSSI, but listed peers as either engaging in NSSI or talking about it. Example statements of peer or family sources included, “I’ve learned about this at school and I knew a few people who were like this,” “Two of my friends. One used a razor to cut their wrists and the other used a tiny knife to cut their wrists. They don’t do it anymore. They just did it like three or four times,” and “I have learned about this from my sister and my parents and I don’t know anyone who does it.” Youth also referenced television and magazines as sources of NSSI knowledge. Examples statements of media sources included, “I have heard it on the internet or in magazines,” and “I’ve seen it on TV because something was wrong with their life and they didn’t want to deal with it anymore.” (See Appendix E for full list of youth responses by category).

Means comparison revealed a significant difference across age groups regarding knowledge of NSSI, in that older children (aged 11 to 14;  $M = 12.14$ ,  $SD = 1.40$ ) reported having NSSI knowledge more so than younger children ( $M = 10.79$ ,  $SD = 1.30$ ),  $t(97) = 4.889$ ,  $p < .001$ ,

95% CI mean difference [.80, 1.90]. Specifically, only 28% of 8 to 9-year-olds reported knowing about NSSI, as compared to youth aged 10 (45%), 11 (47%), 12 (74%), 13 (84%), and 14 (100%).

**NSSI engagement.** In line with Lloyd, Kelley, and Hope (1997), FASM item responses were divided into moderate/severe NSSI and mild NSSI. For all youth who answered FASM self-injury behavior questions (n = 99), moderate/severe NSSI item responses included scraping skin (20%), cutting or carving skin (8%), burning skin (6%), erasing skin (5%), and giving self a tattoo (4%). Mild NSSI item engagement included picking at wound (39%), biting self (20%), hitting self on purpose (15%), picking areas of body to point of drawing blood (11%), pulling out hair (7%), and inserting objects under nails or skin (1%). Of the 28 youth who reported moderate/severe NSSI, 18% reported only one item, 8% reported two items, and 3% reported three items. Of the 20 youth who engaged in mild NSSI, 22% reported only one item, 7% reported two items, 10% reported three items, and 8% reported four or more items (up to six). No gender differences were found for any of the types of NSSI. None of the youth reported suicidal intent or drug use during NSSI activities, and only 17% reported previously engaging in any of the listed NSSI item prior to the past year. FASM data were unavailable for nine youth, as seven were not given the measure and data were missing for multiple measures for the remaining two youth. As compared to youth who responded to FASM items, youth with missing data did not differ significantly in age, gender, ethnicity, or depressive symptoms.

Responses to the SH#4 item - “Have you ever hurt yourself on purpose (for example, when you felt angry, sad, lonely, or bored)?” -and FASM method items were used as indicators of youth NSSI engagement. Youths’ reports of NSSI were inconsistent across items regarding engagement in NSSI, as 15 youth responded positively to SH#4, indicating they had hurt

themselves on purpose, while 28 youth reported one or more moderate/severe NSSI items and one or more mild NSSI item, and 20 youth reported one or more mild NSSI only item.

To address the inconsistency between SH#4 and FASM responses, a qualitative and quantitative approach was taken to determine the number of children who appeared to engage in NSSI. First, a one-way ANOVA was conducted to explore differences between youth who reported engagement in moderate/severe and mild NSSI, youth who engaged in only mild NSSI, and youth who did not report any NSSI. Post hoc Tukey's HSD analysis revealed no differences in age, A/ASP or SP sensory quadrant scores, or trauma symptom severity between youth who engaged in only mild NSSI and no NSSI (see Table 1). Chi-square analysis also revealed no differences in age between the three groups. Thus, youth who reported only mild NSSI were excluded from the final NSSI-engaging youth sample and were included in the Non-NSSI-engaging group. Specific results regarding group differences in A/ASP quadrant scores are subsequently reported in the following section. Careful review of NSSI related item responses, including NSSI knowledge, positive response to SH#4, presence of moderate/severe NSSI behaviors, exclusion of cases with mild NSSI only engagement, qualitative responses to types of NSSI, and responses to NSSI functional items resulted in a final group of 14 youth, henceforth referenced as NSSI-engaging youth. The remaining 85 youth are hereafter referred to as Non-NSSI-engaging youth. No significant differences in age or gender were found between the NSSI-engaging and Non-NSSI-engaging youth. Ethnic differences were observed with 11 (85%) of the NSSI-engaging youth ( $n = 13$ ; ethnicity data missing for one youth) reported as Hispanic, compared to 30 (37%) of the Non-NSSI-engaging youth ( $n = 82$ ; ethnicity data missing for 3 youth). However, categorical chi-square analysis indicated these differences in ethnicity between groups were just short of significant,  $\chi^2 = 10.792$ ,  $df = 5$ ,  $p = .056$ .



Table 1.

*Tukey's HSD analysis comparing mean differences in age, A/ASP and SP quadrant scores, and trauma for youth who report moderate / severe NSSI, mild NSSI, and no NSSI (n = 99)*

	Moderate NSSI (n = 28)	Mild NSSI (n = 20)	No NSSI (n = 51)	Moderate NSSI vs. Mild NSSI	Moderate NSSI vs. No NSSI	Mild NSSI vs. No NSSI
	Mean (SD)			Mean difference [95% CI- LL,UL]		
Age <sup>a</sup>	11.01 (1.41)	12.48 (1.40)	11.66 (1.41)	1.47** [.43, 2.50]	-.64 [-1.48, .19]	.82 [-.12, 1.76]
A/ASP- LR	40.13 (8.40)	33.56 (7.11)	33.07 (8.22)	-6.58* [-12.20, -.96]	7.06*** [2.55, 11.58]	.48 [-4.58, 5.55]
A/ASP- SK	44.11 (8.85)	44.97 (7.29)	48.37 (8.22)	.86 [-4.89, 6.59]	-4.26 [-8.87, .35]	-3.41 [-8.58, 1.77]
A/ASP- SS	36.14 (7.76)	33.45 (6.96)	31.89 (8.37)	-2.69 [-8.23, 2.84]	4.25 [-.20, 8.70]	1.56 [-3.43, 6.54]
A/ASP- SA	37.68 (6.61)	33.55 (7.43)	33.24 (7.57)	-4.12 [-9.20, .95]	-4.44* [-8.51, -.36]	.31 [-4.27, 4.88]
SP- LR	59.24 (8.56)	63.64 (8.28)	64.44 (8.95)	4.40 [-1.67, 10.47]	-5.20* [-10.08, -.32]	-.80 [-6.27, 4.67]
SP- SK	95.07 (15.89)	97.50 (9.97)	98.94 (13.25)	2.43 [-6.98, 11.84]	-3.87 [-11.43, 3.69]	-1.44 [-9.92, 7.03]
SP-SS	80.43 (9.81)	84.45 (10.07)	84.83 (10.50)	4.02 [-3.10, 11.15]	-4.07 [-10.13, 1.31]	-.38 [-6.81, 6.04]
SP- SA	110.43 (16.65)	115.10 (17.12)	117.53 (15.28)	4.67 [-6.52, 15.85]	-7.10 [-16.09, 1.88]	-2.44 [-12.52, 7.64]
Trauma	7.57 (8.05)	5.13 (5.46)	7.92 (9.78)	-2.44 [-9.13, 4.26]	-.35 [-5.48, 4.78]	-2.79 [-8.98, 3.40]

Note: <sup>a</sup> Age (n = 93); all other variables (n = 99).

NSSI- non-suicidal self-injury; Moderate – Moderate / severe NSSI; A/ASP- Adult / Adolescent Sensory Profile; SP-Sensory Profile; LR- low registration; SK- sensation seeking; SS- sensory sensitive; SA- sensation avoiding; CI = confidence interval of mean difference; LL = lower limit; UL = upper limit; Trauma – PTSD symptomology score

\* p < .05, \*\* p < .005, \*\*\* p ≤ .001

**Characteristics of NSSI-engaging youth.** Qualitative results demonstrate that NSSI-engaging youth spend little time thinking about NSSI before engaging in it. Youth listed thoughts preceding NSSI primarily as lasting seconds to minutes, or stated, “Not long.” One youth reported, “I don’t really think about it, I just do it when I’m bored,” and another youth

indicated that the incidents were unplanned. The majority of NSSI-engaging youth experience little pain (n = 8) or no pain (n = 4) during NSSI activities; only one youth reported moderate pain and one reported severe pain during NSSI. One youth did not respond to the item regarding pain. Reported onset of NSSI behaviors ranged from age five to thirteen.

### **Hypothesis testing**

Quadrant scores (low registration, sensation seeking, sensory sensitive, sensation avoiding) for the Adult / Adolescent Sensory Profile (A/ASP) and Sensory Profile (SP) are ideally calculated using the sum of individual items corresponding to each quadrant. Quadrant scores are used to compare participants against A/ASP and SP measure cut-off scores and ranges (see Appendix D). To accommodate for missing item responses, mean scores were calculated by case for each quadrant and multiplied the value by the number of corresponding items. Initial analyses indicated that A/ASP quadrant scores distributions met normality assumptions for means testing analyses; however, SP quadrant score distributions were mildly negatively skewed. Box plot analyses of SP quadrant scores revealed three outliers of 107 cases for the low registration scores; one case was missing most parent report data. These SP low registration scores were Winsorized to bring in outliers and reduce skew.

**Relationship between NSSI and sensory preferences.** To assess group differences in sensory preferences between NSSI-engaging youth and Non-NSSI-engaging youth, t-tests for independent samples were used. *Cohen's d* is reported as the measure of effect size. Sensory preference differences between the two groups were examined by both A/ASP and SP quadrant scores, A/ASP neurological threshold and regulation strategy sub-scores, A/ASP and SP sensory subcategories, and SP sensory domain factor scores. Regression analysis was also employed to

test the predictive value of sensory preferences on NSSI; these analyses controlled for age to account for over-response or misinterpretation by younger participants.

**Quadrant scores and NSSI.** As compared to Non-NSSI-engaging youth, NSSI-engaging youth had significantly higher A/ASP quadrants low registration and sensation avoiding total scores (see Table 2). Though not significant, the data analysis shows an opposite trend in the sensation seeking quadrant with NSSI-engaging youth having lower scores. The mean low registration quadrant score for the NSSI-engaging youth fell 1 SD above the central (“similar to most people”) cut-off score mean (range 24-35) for that quadrant, and fits in the “more than most people” score range (36-44) (see Figure D1 and D2).

Table 2.  
Comparisons of NSSI-engaging youth’s A/ASP mean quadrant scores (n = 99)

A/ASP Quadrant	NSSI (n = 14)		Non-NSSI (n = 85)		<i>t</i> (97)	<i>p</i>	95% CI of difference		Cohen’s <i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			<i>LL</i>	<i>UL</i>	
LR	39.87	10.51	34.39	8.03	2.216	<b>.026</b>	.67	10.29	0.66
SK	44.50	10.47	46.81	8.02	-.953	.343	-6.97	2.68	-0.28
SS	36.29	7.43	32.94	8.11	1.447	.151	-.87	7.93	0.42
SA	39.62	7.21	33.72	7.22	2.829	<b>.006</b>	1.76	10.03	0.83

Note: NSSI- non-suicidal self-injury; A/ASP- Adult / Adolescent Sensory Profile; LR- low registration; SK- sensation seeking; SS- sensory sensitive; SA- sensation avoiding; CI = confidence interval; LL = lower limit; UL = upper limit

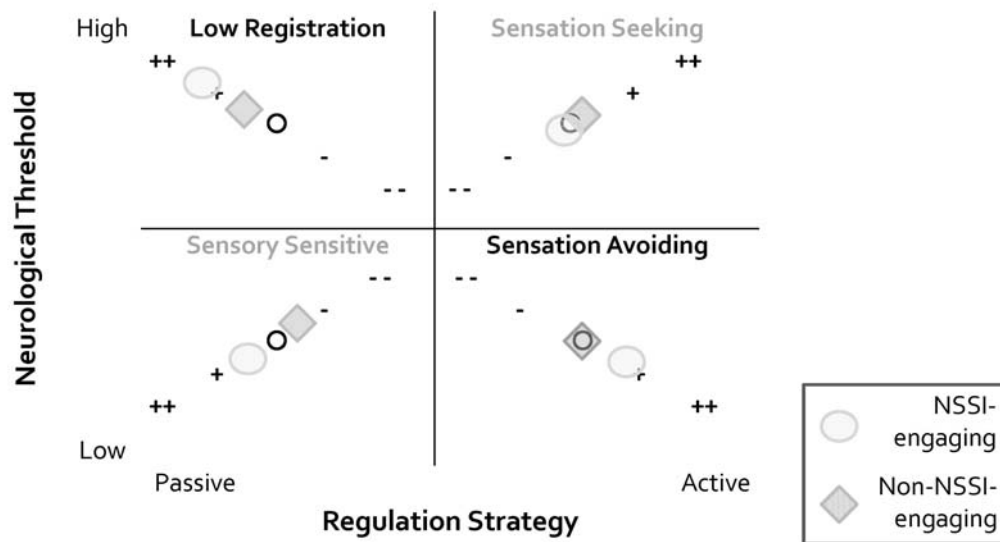
Logistic regression analysis revealed that youth mean sensation avoiding quadrant scores significantly predicted NSSI engagement after controlling for youth age,  $\chi^2 = 7.239$ ,  $df = 1$ ,  $p = .007$ . The Wald criterion demonstrated that higher sensation avoiding scores predicted more likely engagement of NSSI,  $B = .114$ ,  $SE = .044$ ,  $Wald = 6.54$ ,  $df = 1$ ,  $p = .011$ ,  $Exp(B) = 1.120$ , 95% CI for  $Exp(B)$  [1.03, 1.22]. The low registration quadrant score was a statistically significant predictor of NSSI engagement after controlling for youth age,  $\chi^2 = 4.255$ ,  $df = 1$ ,  $p =$

.039. The Wald criterion demonstrated that higher low registration scores also predicted more likely NSSI engagement,  $B = .073$ ,  $SE = .037$ ,  $Wald = 3.87$ ,  $df = 1$ ,  $p = .049$ ,  $Exp(B) = 1.076$ , 95%CI for  $Exp(B)$  [1.00, 1.16].

To explore how the sensory quadrant score differences compared to other possible grouping categories of youth who reported NSSI, post hoc means comparisons were conducted to examine group differences regarding youth report of NSSI (as measured by SH#4- question regarding engagement in self-harm) and youth report of severe/moderate NSSI on the FASM. Youth who answered “yes” to SH#4 ( $n = 15$ ,  $M = 38.73$ ,  $SD = 8.52$ ), as compared to youth who answered “no” to SH#4 ( $n = 88$ ,  $M = 34.21$ ,  $SD = 7.52$ ), had higher sensation avoiding quadrant scores,  $t(101) = 2.108$ ,  $p = .037$ , 95% CI mean differences [.27, 8.76] and trended toward higher sensory sensitive scores,  $M_1 = 36.73$ ,  $SD_1 = 9.17$ ,  $M_2 = 32.86$ ,  $SD_2 = 7.18$ ,  $t(101) = 1.851$ ,  $p = .067$ ; however, results did not support findings regarding differences in low registration scores. Similarly, FASM responses revealed that youth who reported engaging in at least one moderate/severe NSSI behavior ( $n = 28$ ), as compared to youth who did not engage in moderate/severe NSSI ( $n = 70$ ), demonstrated significantly higher sensory avoiding scores  $M_1 = 37.67$ ,  $SD_1 = 6.60$ ,  $M_2 = 33.38$ ,  $SD_2 = 7.52$ ,  $t(96) = 2.643$ ,  $p = .010$ , 95% CI mean difference [1.07, 7.53], sensory sensitive scores,  $M_1 = 36.14$ ,  $SD_1 = 7.76$ ,  $M_2 = 32.44$ ,  $SD_2 = 7.99$ ,  $t(96) = 2.090$ ,  $p = .039$ , 95% CI mean difference [.19, 7.23], and low registration scores,  $M_1 = 40.13$ ,  $SD_1 = 8.40$ ,  $M_2 = 33.27$ ,  $SD_2 = 7.91$ ,  $t(95) = 3.811$ ,  $p < .001$ , 95% CI mean difference [3.29, 10.44]. Both sets of results support the findings regarding sensation avoiding quadrant score differences, as well as support the conservative and balanced approach in grouping the NSSI-engaging youth.

To further illustrate the differences in mean quadrant scores between the NSSI-engaging and Non-NSSI engaging groups, Figure 5 displays the mean scores for each group plotted onto Dunn’s (1997, 1999) Model of Sensory Processing. The lower portion of the figure provides the exact values for the group mean markers in the illustration.

Figure 5.  
Illustration of A/ASP quadrant means for NSSI-engaging & Non-NSSI-engaging youth



++	=	Much more than others / Definite difference	(+2SD above quadrant mean)
+	=	More than others / Probable difference	(+1SD above quadrant mean)
O	=	Similar to others / Typical performance	(quadrant mean)
-	=	Less than others / Probable difference	(-1SD below quadrant mean)
--	=	Much less than others / Definite difference	(-2SD below quadrant mean)

Adapted from Dunn, 1999 and Brown, et al., 2001. *Adolescent/Adult Sensory Profile*. Copyright © 2002 NCS Pearson, Inc. Reproduced with permission. All rights reserved.

A/ASP Quadrant	NSSI (n = 14)	Non-NSSI (n = 85)	Standardized Mean	Standardized Range
	○	◇	○	- ○ +
LR	39.8	34.3	29.5	24-35
SK	44.5	46.8	50.5	43-56
SS	36.2	32.9	33.5	26-41
SA	39.6	33.7	34.0	27-41

Note: NSSI- non-suicidal self-injury; A/ASP- Adult / Adolescent Sensory Profile; LR- low registration; SK- sensation seeking; SS- sensory sensitive; SA- sensation avoiding

Note that Sensory Profile (SP) scores fall along a continuum opposite in direction from Adolescent / Adult Sensory Processing (A/ASP) scores. Correlational analyses of quadrant scores for all youth demonstrated a negative correlation between youth’s A/ASP low registration scores and parent-reported SP low registration, sensory sensitive, and sensation avoiding quadrant scores, as well as between A/ASP sensory sensitive scores and SP sensation avoiding scores (see Table 3). SP scores demonstrated high correlation between all quadrants. Means testing analysis revealed no significant differences between NSSI-engaging youth and Non-NSSI-engaging youth for mean SP quadrant scores, mean SP categorical factor scores (sensation seeking, emotionally reactive, etc.), or for the mean SP sensory domain sub-category scores (auditory processing, visual processing, vestibular processing, etc.), including *modulation of sensory input affecting emotional responses*.

Table 3.  
Correlations between A/ASP and SP quadrant scores ( $n = 106$ )

Quadrant	1	2	3	4	5	6	7	8
1. A/ASP Q1	-							
2. A/ASP Q2	-.018	-						
3. A/ASP Q3	.621**	.066	-					
4. A/ASP Q4	.528**	-.069	.659**	-				
5. SP Q1	-.310**	.163	-.145	-.098	-			
6. SP Q2	-.137	-.094	-.021	.035	.309**	-		
7. SP Q3	-.237*	.149	-.168	-.049	.603**	.610**	-	
8. SP Q4	-.232*	.156	-.202*	-.094	.690**	.488**	.800**	-

Note: A/ASP- Adult/Adolescent Sensory Profile, SP- Sensory Profile, Q1- low registration, Q2- sensation seeking, Q3- sensory sensitive, Q4- sensation avoiding  
\*  $p < .05$ , \*\*  $p < .001$

**A/ASP domain sub-scores and NSSI.** Examination of A/ASP sensory domain sub-scores reveals no between-groups differences in touch processing and modulation; however, NSSI-engaging youth demonstrate higher auditory sensitivity ( $n = 14$ ;  $M = 34.00$ ,  $SD = 7.17$ ) than Non-NSSI-engaging youth ( $n = 85$ ;  $M = 28.21$ ,  $SD = 6.33$ ),  $t(97) = 3.111$ ,  $p = .002$ , 95% CI

[2.09, 9.49], *Cohen's d* = .91. Note that auditory sensitivity is defined here as lower threshold preferences for auditory input. Logistic regression analysis revealed that auditory sensitivity was a statistically significant predictor of NSSI engagement after controlling for youth age,  $\chi^2 = 10.79$ ,  $df = 1$ ,  $p = .001$ . Wald criterion demonstrated that auditory sensitivity contributes significantly to engagement in NSSI,  $B = .174$ ,  $SE = .059$ ,  $Wald = 8.66$ ,  $df = 1$ ,  $p = .003$ ,  $Exp(B) = 1.190$ , 95% CI for  $Exp(B)$  [1.06, 1.34]. These results are further supported through examination of neurological threshold and regulation strategy scores. Cumulative threshold scores indicate that NSSI-engaging youth scores have lower neurological thresholds for sensory stimuli than Non-NSSI-engaging youth (see Table 4). Specifically, NSSI-engaging youth's categorical threshold scores indicate lower visual and auditory threshold capacity, as indicated by higher scores. Cumulative regulation strategy scores indicate that NSSI-engaging youth have more passive visual and auditory regulation strategies than Non-NSSI-engaging youth. As seen in Table 5, regulation scores also revealed active regulation strategy in auditory processing.

Table 4.  
*A/ASP neurological threshold scores for NSSI groups (n = 99)*

Threshold	NSSI (n = 14)		Non-NSSI (n = 85)		<i>t</i> (97)	<i>p</i>	95% CI of difference		Cohen's <i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			<i>LL</i>	<i>UL</i>	
Low Total	75.93	13.26	66.52	14.18	2.321	<b>.022</b>	1.36	17.46	.68
L Visual	16.07	2.81	13.23	3.61	2.797	<b>.006</b>	.82	4.84	.82
L Auditory	18.07	3.97	14.00	4.49	3.191	<b>.002</b>	1.28	6.61	.93
High Total	81.76	18.13	78.02	10.34	1.109	.270	-2.95	10.43	.32

Note: NSSI- non-suicidal self-injury; L- Low; P- Passive; A- Active; CI = confidence interval; LL = lower limit; UL = upper limit

Table 5.  
*A/ASP regulation strategy scores for NSSI groups (n = 99)*

Regulation	NSSI (n = 14)		Non-NSSI (n = 85)		<i>t</i> (97)	<i>p</i>	95% CI of difference		Cohen's <i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			<i>LL</i>	<i>UL</i>	
Passive Total	75.98	15.89	66.84	14.80	2.120	<b>.037</b>	.58	17.70	.62
P Visual	13.48	3.29	10.24	3.51	3.228	<b>.002</b>	1.24	5.23	.94
P Auditory	17.28	4.56	14.66	4.49	2.026	<b>.046</b>	.05	5.20	.59
Active Total	84.17	14.31	80.33	10.58	1.194	.235	-2.54	10.23	.35
A Auditory	16.71	3.65	13.54	3.31	3.279	<b>.001</b>	1.25	5.09	.95

Note: NSSI- non-suicidal self-injury; L- Low; P- Passive; A- Active; CI = confidence interval; LL = lower limit; UL = upper limit

**Relationship between sensory preferences and NSSI functions.** Functional Assessment of Self-Mutilation (FASM) items related to why youth engage in NSSI were categorized into four functions. As previously noted, a shortened version of the FASM was administered due to researcher oversight, so results are interpreted cautiously. NSSI-engaging youth most frequently indicated social-positive reinforcement (SPR) (68%) as a function of NSSI, followed by automatic-positive reinforcement (APR) (47%), social-negative reinforcement (SNR) (47%), and automatic-negative reinforcement (ANR) (42%). Boys who engaged in NSSI were significantly more likely to report SNR functions of NSSI (6 of 8) than girls (0 of 6),  $p = .019$  (*Fisher's Exact Test, one-tailed*). No gender differences were found for the other functional categories. Correlational analyses indicated no relationship between A/ASP or SP quadrant scores and NSSI function scores.

**Relationship between trauma history, PTSD symptomology, NSSI, and sensory preferences.** Per parent report on the PTSD-RI, 39% of total youth sample (n = 99) experienced at least one traumatic event in their lifetime, with 43% of NSSI-engaging youth and 39% of Non-NSSI-engaging youth having experienced at least one trauma (n = 99; see Table 6). No



significant differences in trauma history or responses to trauma were found between the two groups. No differences in mean scores or correlational relationships were found between PTSD symptomology scores or PTSD criterion sub-scores (re-experiencing, arousal, avoiding) and the two groups.

Table 6.  
*Percent reporting trauma incidents by group (n = 98)*

	NSSI (n = 14)	Non-NSSI (n = 84)
	%	
Experienced at least one traumatic event	43	39
Been in an earthquake	-	-
Been in another disaster	-	2
Been in a bad accident	7	8
Been around war	-	-
Punched, hit or kicked at home	-	5
Witness someone else punched, hit or kicked at home	14	11
Beaten up, shot at, or threatened to be hurt badly	7	1
Witness someone beaten, shot at, or hurt badly	-	4
See dead body (not including funerals)	-	2
Adult touch child's sexual body parts	-	-
Hear about violent death or serious injury of loved one	7	6
Receive painful or scary medical treatment in hospital	-	6
Other scary/dangerous/violent incidents	17	19

Note: NSSI- non-suicidal self-injury; - = 0

***Relationship between sensory preferences and trauma.*** No correlations or mean differences were found between history of traumatic events and A/ASP scores or SP quadrant scores; however, SP subcategory score means comparisons revealed that youth with reported history of traumatic event (n = 42) had slightly lower auditory processing score ( $M = 29.38$ ,  $SD = 4.75$ ), indicating significantly more auditory sensitivity than those without traumatic events (n = 66,  $M = 31.56$ ,  $SD = 5.31$ ),  $t(105) = 2.159$ ,  $p = .033$ , 95% CI mean differences [.18, 4.18 ],

*Cohen's d* = .44. Additionally, in youth with at least one reported traumatic event, post hoc analysis revealed that total PTSD score was significantly correlated with the following SP quadrant scores: low registration,  $r(42) = -.451, p = .003$ , sensory sensitive,  $r(42) = -.411, p = .007$ , and sensation avoiding,  $r(42) = -.552, p < .001$ . Linear regression was employed to test the predictive value of total PTSD scores on SP quadrant scores, while accounting for any age or gender differences. As further detailed in Table 7, significant regression models emerged for SP low registration,  $R^2 = .221$ , Adjusted  $R^2 = .160$ ,  $\Delta R^2 = .207$ ,  $F(1,38) = 10.12, p = .003$ , sensory sensitive,  $R^2 = .226$ , Adjusted  $R^2 = .165$ ,  $\Delta R^2 = .178$ ,  $F(1,38) = 8.76, p = .005$ , and sensation avoiding,  $R^2 = .315$ , Adjusted  $R^2 = .260$ ,  $\Delta R^2 = .292$ ,  $F(1,36) = 16.20, p < .001$ . Missing values within youth age variable were replaced with mean.

Table 7.  
*Total PTSD score as a predictor of SP quadrant scores in youth with trauma history (n = 42)*

SP Quadrant	B	SE B	$\beta$	$R^2$	95% CI for B
<i>Predicting low registration</i>					
Youth sex	.86	2.30	.057		
Youth age	.62	.92	.105		
Total PTSD Score	-.39	.12	-.472*	.221	[-.63, -.14]
<i>Predicting sensation seeking</i>					
Youth sex	4.71	4.40	.178		
Youth age	-.18	1.76	-.017		
Total PTSD Score	-.31	.23	-.216	.082	[-.78, .16]
<i>Predicting sensory sensitive</i>					
Youth sex	2.96	3.13	.144		
Youth age	1.22	1.25	.152		
Total PTSD Score	-.49	.17	-.438*	.226	[-.82, -.15]
<i>Predicting sensation. avoiding</i>					
Youth sex	2.15	4.46	.069		
Youth age	.62	1.79	.051		
Total PTSD Score	-.95	.24	-.560**	.315	[-1.42, -.47]

Note: SP- Sensory Profile; CI = confidence interval; LL = lower limit; UL = upper limit

\*  $p < .005$ , \*\*  $p < .001$

## CHAPTER FIVE

### DISCUSSION

This dissertation research explored non-suicidal self-injury (NSSI) in pre-adolescence, including the source of NSSI knowledge and the role of sensory preferences in relation to pre-adolescents' engagement in NSSI. Additionally, I sought to connect these findings to the functions of NSSI and examine the relationship of trauma to NSSI and sensory preferences. Overall, data demonstrated mixed findings, as only portions of the hypotheses were supported.

**Knowledge and prevalence of NSSI.** Over half of youth in the sample reported knowledge of NSSI, suggesting that awareness of NSSI is prevalent in late childhood and early adolescence. Youth reported social sources of NSSI knowledge, including family members, friends, and media, a finding which aligns with previous research (Nock, 2009; Yates, 2004). The findings that one-third of youth reported peer/family sources and 12% of youth reported media sources are also consistent with the literature. Alternatively, very few youth in the current sample reported internal discovery or uncertainty about the source of their knowledge which contradicts findings by Deliberto and Nock (2008), who found that one-fifth of youth reported that NSSI was self-taught and one-third of youth indicated no recollection of where they learned about NSSI. The results of this dissertation provide insight into pre-adolescents' awareness of NSSI, and fit reasonably with previous literature, especially given that most youth surveyed in the community-based studies are adolescents (Bjarehed & Lundh, 2008; Laye-Ghindu & Schonert-Reichl, 2005; Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007).

Few studies have examined the sources of NSSI knowledge in pre-adolescents. From a developmental perspective, studying the onset of NSSI and the conditions under which it occurs

prior to adolescence can inform prevention approaches and our understanding of how NSSI develops as a regular behavior in certain youth. Closer qualitative review of the responses demonstrates that peers play a key role in youth's awareness of NSSI, in that youth reported knowing someone or hearing of someone their age engaging in NSSI. Additionally, media content, such as that found in medical based television shows, leaves a lasting impression on youth as evidenced by references to shows, news, or websites. Responses reveal an awareness of stereotyped subculture (e.g., kids who are "Emo") or associated symptomology (e.g., depression, suicidality, bullying). No youth referenced their own self-injurious behavior in revealing the source of their NSSI knowledge, which may indicate that youth view their own NSSI engagement as separate from where they learned about it. Youth may have also been reluctant to discuss NSSI in regard to their own behavior, or perhaps they view themselves as different from "others" who engage in NSSI. These findings are useful in better understanding the social learning element of NSSI, and can inform the types of education and awareness necessary in working with pre-adolescent youth. Emphasis in training for middle school teachers, along with increased awareness among school counselors, can help in reducing false information that often spreads quickly among youth and in identifying youth who may be in need of support. Additionally, encouraging parents to discuss NSSI with children earlier in development may assist in buffering against peer or media influence.

Approximately 14% of the sample reported moderate/severe NSSI, indicating that prevalence of NSSI engagement in the present study is consistent with other findings using community, non-clinical samples that have reported prevalence of moderate/severe NSSI in 7-22% of similar-aged samples (Hilt, Cha, & Nolen-Hoeksema, 2008; Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007; Nock & Prinstein, 2005; Ross & Heath, 2002). Current findings

contribute to the conceptualization of NSSI as not only an adolescent behavior, but as a behavior and notion that is alive within the collective awareness of pre-adolescents. Reframing our understanding of NSSI as rooted in late childhood and early adolescence and peaking in mid- to late-adolescence will assist researchers and clinicians in redirecting efforts to address this challenging behavior earlier in development.

**Sensory preferences and NSSI.** Analysis of Adolescent / Adult Sensory Profile (A/ASP) results support the hypothesis that youth who engage in moderate/severe NSSI have different sensory preferences than youth who do not engage in NSSI or who engage in mild NSSI. As expected, NSSI-engaging youth are slightly more sensitive to their environment and are more likely to reject and avoid stimuli that impress upon their threshold than Non-NSSI-engaging youth, as measured by higher A/ASP sensation avoiding scores. Interestingly, youth who reported NSSI also habituate more quickly to certain stimuli and may be less sensitive to or aware of certain types of sensory input than Non-NSSI-engaging peers, as measured by higher low registration scores. NSSI-engaging youth demonstrated more low threshold preferences than an average person, as the mean low registration scores for NSSI-engaging youth fell above the cut-off scores of 1 standard deviation above the measure mean. Sensation avoiding preference results should be interpreted cautiously in that both the NSSI-engaging and Non-NSSI-engaging youth had mean sensation avoiding scores within the typical range (less than 1 standard deviation from mean), indicating that NSSI-engaging youth do not have extreme sensory avoiding tendencies as compared to an average person. Still, NSSI-engaging youth scored substantially higher in sensation avoiding preferences than Non-NSSI-engaging peers as evidenced by a large effect size (*Cohen's d* = .83). No differences were found between groups in sensation seeking or sensory sensitive quadrant scores. Though differences were not significant, the finding that

sensation seeking scores differed in an opposite direction in both A/ASP and SP results, with Non-NSSI-engaging youth showing a trend toward more sensation seeking preferences, suggests that youth who engage in NSSI may have less tendencies to seek out stimuli than youth who do not engage in NSSI. It is critical to keep in mind that all individuals fall along a spectrum of preferences within each quadrant, with individuals occasionally displaying stronger or weaker preferences in certain domains (Dunn, 1999). Specifically, individuals can demonstrate more or less need for sensory input in different domains, which will result in specific placement in each quadrant as compared to an average, typically developing individual. Consistent with Brown, et al. (2001), it is quite possible for NSSI-engaging youth to show stronger preferences in these opposing quadrants, such that higher processing scores in each of these areas demonstrates greater levels of habituation to stimuli. Simultaneously, the opposite quadrants suggest differences in responsivity, such that youth who report NSSI are highly sensitive to certain types of sensory input, such as sound or noise, while they are also less aware of or less sensitive to other types of sensory input.

As hypothesized, NSSI-engaging youth demonstrated greater auditory sensitivity, or lower threshold for auditory stimuli, than Non-NSSI-engaging peers, and auditory sensitivity predicted engagement in NSSI. Though findings did not support higher touch sensitivity in NSSI-engaging youth, the combined findings regarding auditory sensitivity, low visual and auditory threshold, passive visual and auditory regulation, along with active auditory regulation support the notion that NSSI- engaging youth are more sensitive and quicker to respond to auditory and some visual stimuli. The combined results align with research identifying auditory sensitivity as most common in those with lower threshold levels (Ben-Sasson, Carter, & Briggs-

Gowan, 2009) and support findings demonstrating higher levels of sensory defensiveness in those who self-injure (Moore & Henry, 2003).

Though group differences in levels of visual sensitivity was not predicted, the current findings implicate a relationship between low visual threshold and NSSI. Prior to NSSI, visual sensitivity may result in individuals feeling overwhelmed when presented with too much visual input, or may even be indicative of highly sensitive visual cues (e.g., misreading a facial expression as angry or disapproving). During and after NSSI, some individuals report that the site of blood acts as a precipitant of relief (e.g., Himber, 1994). Sensory-based intervention strategies, such as those in dialectical behavior therapy (DBT) include drawing on the intended NSSI location with a red marker to serve as a visual stimulus and placebo in place of actual NSSI (Linehan, 1993; McKay, Wood, & Brantley, 2007). Further investigation into the relationship between visual threshold and NSSI would contribute to current NSSI treatment models.

Lack of findings regarding touch sensitivity contradicts our prediction that differences in the tactile modulation of under-arousal or over-arousal as measured by touch processing sensitivity would be connected to use of NSSI as a self-regulation strategy. It is feasible that differences in tactile sensory processing and modulation may not be apparent unless the youth is under duress (real or perceived). Auditory or visual sensitivity could contribute to greater perception of stimuli as threatening and increase feelings of duress. Since individuals with sensory avoiding preferences habituate quickly, it is possible that increased auditory stimuli results in the need to take action, not only to stop or reduce the stimuli, but to decrease level of arousal caused by the stimuli. One possible solution is the use of NSSI as a self-regulation strategy, in which youth habituate quickly to the pain and possibility require increased stimulation, which fits with the low registration findings, to return to an alert processing or calm

arousal state (Lillas & Turnbull, 2009). Though such an intricate series of events cannot be conclusively extrapolated from the data collected, the findings bring us one step closer to understanding how the sensory system plays a role in the use of NSSI, often as a coping mechanism. Further research pertaining to sensory processing and sensory modulation is necessary to deconstruct this process. One possible direction for future research is to explore changes in sensory preferences, especially tactile and proprioceptive processing and modulation, when youth are stressed.

Consistent with the generally small correlations between Adolescent / Adult Sensory profile (A/ASP) scores and Sensory Profile (SP) scores, parent-report of sensory processing did not match with youth-report scores. As such, analysis using SP scores failed to demonstrate differences in sensory preferences between NSSI-engaging and Non-NSSI-engaging youth. Possible explanations for SP score differences include parents' assumed similarity between their own sensory preferences and those of their child, parents' unawareness of their child's sensory experiences, or a weak parent-child attachment relationship.

Results did not support the hypothesis that low threshold sensory preferences would predict automatic/internal functions of NSSI along Nock and Prinstein's (2004) four-function model. Youth were likely to report multiple functions of NSSI, with *social-positive reinforcement* reported as the most common function of self-injury, followed by *automatic-positive reinforcement*, *social-negative reinforcement*, and *automatic-negative reinforcement*. These results differ from those of Nock, Prinstein, and Sterba (2009), who found internal reasons for self-injury reported more frequently, and social functions reported less frequently. One possible explanation for this discrepancy is that in capturing NSSI behavior at such an early stage in the current study, youth have yet to internalize the functions of the behavior pattern.



The finding that boys were more likely to report *social-negative reinforcement* functions than girls corresponds with research by Laye-Gindhu and Schonert-Reichl (2005) who found that boys were more likely than girls to report task avoidance as a reason for engaging in NSSI. Still, overall reliability and generalizability of these results should be interpreted cautiously as only half of the FASM functional items were administered.

**NSSI, trauma, and sensory preferences.** Results failed to support part of the final hypothesis, in that youth who engaged in NSSI were not more likely to have a reported trauma history. Additionally, NSSI-engaging youth with trauma history did not display higher levels of PTSD scores than Non-NSSI-engaging youth with trauma history. While youth-reported sensory preference scores were not correlated with or predictive of trauma, higher PTSD scores were predictive of SP quadrant scores in youth who experienced at least one trauma, which supports the hypothesized relationship between trauma and sensory preferences. Results also demonstrated that youth with a history of trauma are more sensitive to how they process auditory input, as they displayed significantly higher levels of parent-reported auditory sensitivity (*Cohen's d* = .44), and their mean scores fell just barely below the cut-off score in the “probable difference” range for more sensitivity than others. These findings further contribute to developmental regulatory theory regarding the impact of trauma on the sensory system (e.g., Lillas & Turnbull, 2009; Shore, 2001b).

While the combined results fail to support a seamless connection between trauma, sensory processing, and NSSI, the conceptual elements are present. Youth-report data provide evidence for the connection between NSSI and sensory preferences, while parent-report findings provide evidence for the connection between sensory preferences and trauma (PTSD symptomology). Auditory sensitivity findings serve as a link between both sets of results,

supporting the relationship between NSSI, sensory preferences, and trauma. Youth's lower threshold for sensory input, especially visual and auditory stimulus, indicates a lower tolerance for sights and sounds that may be perceived as irritating, as well as possible heightened sensitivity in interpreting other's displays of emotions, such as misperceiving a stern tone of voice as yelling. These youth may have more difficulty habituating to sounds around them. Once dysregulated, these youth are active in their efforts to change the stimulus, however low registration scores reveal higher threshold as well, which may be where the tolerance for NSSI as a regulation strategy comes into play.

### **Limitations**

Key limitations for the current study include methodological issues, such as measures and sample characteristics. As subsequently described, the shortened FASM, limitations of the SP, and reliance on parent report of youth trauma outcomes limited our ability to fully test the relationship between NSSI behavior, NSSI functions, sensory preferences, and trauma.

The use of both SH#4 (item regarding whether youth had ever engaged in self-harming behavior) and the FASM as measures of NSSI engagement yielded inconsistent results. As described within the results section, a multi-faceted approach was used in determining which youth actually reported NSSI as an impulsive behavior, as opposed to solely compulsive or accidental behavior. Prefacing the FASM with the self-injury knowledge, thoughts, and engagement questions was intended to reduce youth's misinterpretation of FASM items. Despite this, some youth may have misunderstood items, as evidenced by participants occasionally asking research staff whether the FASM items were asking about behaviors done on purpose. Few youth clarified specific NSSI instances as accidental, even in instances where youth reported never engaging in NSSI but responded positively to specific behaviors (e.g., cutting,

biting lip, burning self). Such inconsistencies resulted in careful analysis of which youth were categorized as NSSI, and may have potentially limited the generalizability of NSSI engagement findings. Increased qualitative or descriptive elements should be included to assist in better differentiating youth who actively engage in impulsive NSSI. To better assess NSSI functionality, the full 22-item FASM should be used. Added qualitative components would also contribute to deeper functional understanding of the regulatory role of NSSI.

Sensory Profile (SP) low registration and sensation seeking mean scores were slightly high for the sample overall, with each quadrant mean just beyond 1 standard deviation above the SP measure standardized mean (see Appendix D, Figure D2). Since the calculation of quadrant scores was not part of the original structure of the SP, SP quadrant score data do not distribute as evenly as A/ASP quadrant score data (Dunn, 2006). Continuation of the current study will include the A/ASP to track stability of sensory preferences over time. Developmental literature on temperament suggests that sensory preferences would be fairly stable throughout life (Zentner & Bates, 2008). While certain aspects, such as taste preferences, might change naturally over time, it is predicted that general responsivity and self-regulation strategies would remain constant through adolescence and adulthood. It is also predicted, however, that changes in sensory processing or modulation could occur following incidents of trauma.

In regards to measuring trauma history and long-term impact of trauma, results revealed fairly low incidents of youth trauma history. It should be noted that parents' who previously indicated incidents of child abuse during a former study were reported per mandated protocol and were not contacted to participate in the current study, which could be related to the low incidence of reported abuse. Additionally, as the informed consent form stated that reportable incidents would be disclosed to legal authorities, parents may have been less inclined to report

potentially incriminating information, which limits the generalizability of the findings. The low rates of trauma suggest that parents potentially under-reported youth's traumatic experiences, especially sexual abuse history. Research indicates that history of sexual abuse is a strong predictor of NSSI (Gratz, 2006; Harned, Najavitis, & Weiss, 2006; van der Kolk, Perry, & Herman, 1991; Yates, 2009). Data from the present sample indicated no reported incidents of sexual trauma, despite national averages indicating that 21% of children have experienced some form of sexual trauma before age 18 (Center for Disease Control, 2010). Though national data reveal that incidents of reported sexual abuse decreased significantly over the past 20 years, sexual abuse remains dramatically underreported (Finkelhor & Jones, 2006). Additionally, the types of items included in the PTSD-RI do not account for other types of sexual abuse that can result in maladjustment, including youth-on-youth molestation, inappropriate exposure of perpetrator to youth, or inappropriate requests made of the youth by the perpetrator- all of which have the potential for long term negative impact on youth's emotional and regulatory well-being (e.g., Maker, Kemmelmeier, & Peterson, 2001). Other types of trauma, such as violence witnessed or physical abuse, are also potentially underreported. Research also indicates that children and parents may perceive events differently, they may not demonstrate agreement regarding what children experience and recall as traumatic, and parents may be biased by their own levels of trauma (Shemesh, et al., 2005; Valentino, Berkowitz, & Stover, 2010). In fact, Stover, Hahn, Im, and Berkowitz (2010) found no agreement between parent and child reports on the PTSD-RI regarding reporting certain types of traumatic incidents (e.g., physical assaults, serious accidents) or long-term impact of trauma, and no correlation in avoidance or hyperarousal PTSD symptoms. Continuations of this study will obtain a child report of traumatic events, as parents may not be privy to all of the youths' experiences or may be afraid

to recount due to fear of mandating reporting. While youth will likely underreport traumatic experiences such as sexual abuse, their perspective will assist in gaining a clearer understanding of youth's trauma history and possible long-term impacts of traumatic experiences.

Final limitations exist within the sample characteristics of the current study. Due to the cross-sectional nature of the sample, causal interpretation of data is impossible. Longitudinal research is necessary to further explore the stability of sensory preferences, PTSD symptomology, and NSSI functionality. Though the age range of the current sample yielded informative results, the inclusion of slightly older youth may ameliorate the potential impact of misunderstanding of the items by younger youth. To gain a deeper understanding of the relationship between sensory preferences, NSSI, and trauma, other future research should include a matched sample with youth who demonstrate habitual NSSI, such as those in treatment or who are selected for participation based on such criteria.

### **Directions for Future Research**

Further, in-depth studies exploring differences in frequency, duration, and intensity of sensory stimuli- preceding, during, and following NSSI- will contribute to better understanding this complex, functional behavior that haunts many youth. Moore and Henry (2003) illustrated that stimulating tactile and proprioceptive senses in a regular way eliminated NSSI in women with sensory defensiveness. To further explore sensory processing and begin exploring differences in sensory modulation, qualitative indicators could be obtained through individual interviews or focus groups. Activity preferences or biological measures (e.g., auditory sensitivity, skin conductance) could be included to support this study's findings. In line with Berntson and Cacioppo's (2000, 2007) research, it is also crucial to study disruptions in sensory processing and modulation when individuals are under stress, as changes in physiological arousal

indicate interaction between higher-level executive functions and lower-level regulatory functions in an effort to recover back to baseline arousal levels. A combination of self-report regarding sensory preferences in various emotional states (e.g., the desire to squeeze an object when anger elicits a sensory need for proprioceptive input) and physical test of sensory preferences would be useful in better understanding the connection between our bodies, our emotions, our thoughts, and our actions. Only through continued exploration can we find new ways to treat and prevent youth from a self-destructive cycle, while also assisting them with developing healthy self-regulation strategies that account for their individual environmental, cognitive, emotional, regulatory, and sensory differences.

Demonstrating a relationship between sensory processing and NSSI will contribute to the design and implementation of evidence-based prevention and intervention strategies, as well as support treatments that focus on adolescents' sensory preferences and self-regulation as opposed to primarily complex cognitive-behavioral approaches. Future clinical research should use a transdisciplinary approach in creating treatment protocols that emphasize and utilize the role of the sensory system, as well as support prevention efforts that include a sensory component to meet individual sensory needs before negative behaviors are entrenched. Positive findings would assist in recognizing the connection and help researchers work backwards to better understand the varying sensory needs of youth who self-injure.

## **Conclusion**

Non-suicidal self-injury is a complex, multifaceted phenomenon that is impacted by numerous internal and external risk factors. Current explanatory models take a complex approach in linking trauma, emotion regulation, social cognition, impulsivity, and neurophysiological arousal (Nock, 2010; Yates, 2009). Using the neurorelational framework

(NRF) (Lillas & Turnbull, 2010) as a guide for understanding the various puzzle pieces that build the complexity of NSSI, researchers can continue to further dissect and explore why individuals adopt NSSI as a regular behavior. The theoretical underpinnings previously detailed in the literature review require multiple studies to deeply illustrate the complex relationship between NSSI, sensory preferences, and trauma. The current dissertation provides a starting point for future research that seeks to further link sensory processing and modulation with NSSI. It is my intention to continue data collection with this sample as to gain a longitudinal perspective of the measured constructs.

Results from this dissertation demonstrate partial support for the role of the sensory system in the onset and maintenance of NSSI. While little evidence was found to support the tactile sensory interaction with NSSI, results offered support for differences in sensory processing and modulation that possibly precede NSSI. These findings contribute to the assertion that youth who engage in NSSI perceive their environment differently than peers who do not self-injure, even if those differences are subtle. By integrating the current findings with established explanatory models of NSSI, results from this research begin to answer not just why youth choose to self-injure, but provides a link from NSSI to how they process information through their sensory system and perceive the world around them. Most importantly, this research contributes to the field of developmental psychology by further opening the gateway to utilizing an applied, interdisciplinary approach in studying, preventing, and treating NSSI in adolescence. Bringing together emotional and behavioral knowledge from developmental and social psychology, sensory knowledge from occupational therapy, arousal state and regulatory knowledge from psychobiology, and neurochemical knowledge from neuroscience will be the most productive way to continue addressing the complexity of NSSI.

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## Appendix A

### **Statement to Youth Introducing Sensory Preferences**

Next you will be answering questions about your sensory preferences. Sensory preferences have to do with how you take in different sensations using your different sense.

Can you name some different senses?

Touch, taste, smell, movement.

Everyone has a specific set of sensory preferences. Some like to be warm, some like to be cold. Some people like the feeling of sand in-between their toes, while others dislike that feeling.

I have a question about your sensory preferences. When you wake up in the morning, would you rather the light be turned on quickly or would you rather there be just a little bit of light?

For a person who prefers bright light, then low lighting might just make that person feel sleepy. If someone prefers less light or no light, then sudden light may make that person anxious, angry, or startled.

Either way, people usually have preferences for certain sensations- bright or dim light, salty or sweet food, slow or fast rides, lots of noise or quiet surroundings. Everyone is unique in what they prefer.

## Appendix B

### **Statement to Parents Introducing Sensory Preferences**

Today you will be answering questions about sensory preferences for you and your child. Sensory preferences have to do with how you take in different sensations using your different senses...such as touch, taste, smell, movement, etc. Everyone has a specific set of sensory preferences. Some like to be warm, some like to be cold. Some people like the feeling of sand in-between their toes, while others dislike that feeling.

For example, when you wake up in the morning, do you prefer bright light as soon as you get out of bed, or do you prefer a slow/gradual transition into soft lighting?

You probably have a preference. Now, what would you do if the opposite happened?

For a person who prefers bright light, then low lighting might just make that person feel sleepy. If someone prefers less light or no light, then sudden light may make that person anxious, angry, or startled. Either way, people usually have preferences for certain sensations- bright or dim light, salty or sweet food, slow or fast rides, lots of noise or quiet surroundings.

You are going to complete two questionnaires. To get you started, you will complete one about your own sensory preferences. When you are finished, you will complete one about your child- who also has unique sensory preferences.



## Appendix C

### **Brief Questionnaire Regarding Knowledge and Thoughts about Self-Harm**

Please answer the following questions.

Circle “yes” or “no” for items 1 and 3

Write in your own answer for item 2.

#### **Knowledge of Self-harm**

1. Have you ever heard of people (kids, teens) who hurt themselves on purpose without wanting to die?

0) no

1) yes

2. If so, describe a little bit about where you learned about this behavior or if you know people your age who do it?

#### **Thoughts of Self-harm**

3. Have you ever had thoughts of purposely hurting yourself without wanting to die? (e.g., cutting or burning?)<sup>a</sup>

0) no

1) yes

a. Item adapted from Self-injurious Thoughts and Behaviors Questionnaire (STBI) (Nock., Holmberg, Photos, & Michel, 2007)

## Appendix D

Chart 1.

*Scoring matrix for Adolescent / Adult Sensory Profile (A/ASP)*

Quadrant	Quadrant Raw Score Total	Much Less than Most People	Less Than Most People	Similar to Most People	More Than Most People	Much More than Most People
		-2SD	-1SD	$\bar{x}$	+1SD	+2SD
Low Registration	/75	15-18	19-23	24-35	36-44	45-75
Sensation Seeking	/75	15-35	36-42	43-56	57-62	63-75
Sensory Sensitivity	/75	15-18	19-25	26-41	42-48	49-75
Sensation Avoiding	/75	15-19	20-26	27-41	42-49	50-75

Note: Each category represents a range based on measure mean. For example, “Similar to Most People” includes the measure mean and score one standard deviation above and one standard deviation below the mean.

Adapted from Brown, C. E., & Dunn, W. (2002). *Adolescent/Adult Sensory Profile: User’s manual*. San Antonio, TX: Therapy Skill Builders. *Adolescent/Adult Sensory Profile*. Copyright © 2002 NCS Pearson, Inc. Reproduced with permission. All rights reserved. “*Sensory Profile*” and “*Adolescent/Adult Sensory Profile*” are trademarks, in the US and/or other countries, of Pearson Education, Inc. or its affiliates(s).

Chart 2.

*Scoring matrix for Sensory Profile (SP)*

Quadrant	Quadrant Raw Score Total	Less Than Others		Typical Performance	More Than Others	
		Definite Difference	Probable Difference		Probable Difference	Definite Difference
		-2SD	-1SD	$\bar{x}$	+1SD	+2SD
Low Registration	/75	**	75-73	72-64	63-59	58-15
Sensation Seeking	/130	**	130-124	130-124	102-92	91-26
Sensory Sensitivity	/100	**	100-95	94-81	80-73	72-20
Sensation Avoiding	/145	145-141	140-134	133-113	112-103	102-29

Note: \*\* There is no Definite Difference/Less Than Others possible score for this section

Adapted from Dunn, W. (2006). *Sensory Profile Supplement: User’s Manual*. San Antonio, TX: Pearson. *Sensory Profile Supplement*. Copyright © 2006 NCS Pearson, Inc. Reproduced with permission. All rights reserved. “*Sensory Profile*” “*Sensory Profile Supplement*” and “*Adolescent/Adult Sensory Profile*” are trademarks, in the US and/or other countries, of Pearson Education, Inc. or its affiliates(s).

## Appendix E

### Qualitative responses regarding knowledge of NSSI

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#### **Learned from Peers / Family**

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1. My friends and my parents have told me about it.
2. I have learned about this from my sister and my parents, and I don't know anyone who does it.
3. Mom and dad taught me how to behave in fancy restaurants and the library and other place where there is a lot of people and strangers I never meet before in my life only my family, family and relatives.
4. My sister use to cut herself. I don't know why. This girl that is my age. I don't know her name and I don't know why she cut herself either.
5. In the sixth grade, there was a girl named [omitted] who lied a lot and stole things from people. Nobody really liked her. Then my sister told me that she used to cut herself.
6. I know one of my friends did that and she is only 12 told me about why she did that and I learned it from school and people always talking about it.
7. My friend was depressed and she used to cut herself.
8. I know people who cut themselves, and make themselves throw up because they are really sad and depressed, and think they are fat.
9. Well my friend heard that someone she knows wanted to kill herself and she did two days later.
10. I heard a boy did not want to kill his self but he wanted to hurt his self.
11. Yes, I've heard of it many times with teenage kids and have several friends who've tried or wanted or still are doing it.
12. My friend, [peer's name] use to tell me how she felt & why she'd do it.
13. Some of the people at school one person named [peer's name] hurts himself all the time.
14. Two of my friends. One used a razor to cut their wrists and the other used a tiny knife to cut their wrists. They don't do it anymore. They just did it like 3 or 4 times.
15. A kid in my class was because her dad was being mean to her she says.
16. I know a kid in my class said he's an Emo person so he cuts himself and he is very bipolar.
17. Some kids who were in my class would staple their fingers together or would poke themselves with pens and try to make "tattoos" on themselves.
18. I learned these things at school, emotionally, physically, and bully problems.
19. One of my friends tried killing herself because nobody liked her.
20. Some of my friends knew of some kids who did that.
21. I've learned about this at school and I knew a few people who were like this.
22. There wasn't a specific place I learned it. Over the years i found out about it from people.
23. Just from my friends' stories about kids in their school who do that.
24. My friend. [x2]
25. Kids talk 'round school; I hear what they say.
26. This one teen wanted to stab himself and to whack himself with a bat.
27. [peer's name] and [peer's name] they do it a lot after school.
28. Yes, I learned from school. [x 4]
29. Kids talk 'round school; I hear what they say.
30. Middle school, from our counselors.
31. I learned about it when researching model rockets in a kit & people hurting themselves.

### **Learned from media**

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32. I first heard about people doing this kind of stuff a while back on medical shows that were aired on TV. Then I started hearing more about it as I got older & was also more aware of how dangerous it could be. I am sad to admit that i used to have a friend who had a lot of problems & sometimes did this to "punish himself for his wrongs." I then proceeded to warn him of the dangers that it had.
33. I watch a medical based show called ER.
34. I don't know anybody who does it, I heard of it from the news about Demi Levato [celebrity]. Also there was a article about it in a magazine.
35. I don't know people my age who do it but I've heard on TV of a celebrity that went to professional help because she was hurting herself.
36. I have heard it on the internet or in magazines.
37. Newspaper, stories, newspaper website.
38. I've heard it on the news.
39. I saw it on the news.
40. From the local news.
41. I don't know anybody, but I've heard about it on the news and from other people.
42. I've seen it on TV because something was wrong with their life and they didn't want to deal with it anymore.
43. On the TV [x2]
44. Movies. No, no people my age.

### **Learned from self**

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45. I think I taught myself my behavior.

### **Unsure about knowledge source**

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46. I do not know anyone who did it and I am not sure where I learned about the behavior.
47. I don't remember how I found out.
48. I just heard about it.
49. I've only heard about it.
50. Well I really don't know I heard about suicidal teenagers and young adults.

### **Reasons for NSSI**

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51. I know that Emo people cut themselves and I guess they don't want to die, but I think kids my age do hurt themselves.
52. People who usually hurt themselves are the people that are sad or don't like their lives.
53. When they're angry.