

NON-SUICIDAL SELF-INJURY AND SUICIDAL SELF-INJURY:
A TAXOMETRIC INVESTIGATION

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FOREWORD

This thesis is written in accordance with the style of the *Publication Manual of the American Psychological Association (Sixth Edition)* as required by the Department of Psychology at Appalachian State University.

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Non-Suicidal Self-Injury and Suicidal Self-Injury: A Taxometric Investigation

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Abstract

Debate exists within the literature regarding whether self-injurious behavior (SIB) is most accurately conceptualized as a dimensional or categorical construct. Some researchers have proposed that two distinct forms of SIB s exist, suicidal self-injury (SSI) and non-suicidal self-injury (NSSI), with the forms being distinguished by the intent of the individual to die. However, others conceptualize SIB as occurring along a continuum, with SSI representing the extreme on a continuum of SIB. The aim of the present study was to investigate the latent structure of SIB using taxometrics, a series of statistical procedures designed to elucidate the latent structure (i.e., categorical or dimensional) of phenomena. Participants consisted of undergraduates who completed the Survey of College Mental Health and Well Being. Three mathematically independent taxometric procedures, Maximun Eigenvalue (MAXEIG), Mean Above Minus Below a Cut (MAMBAC), and latent-mode (L-mode) factor analysis---were used to analyze the latent structure of SIB. Although the comparison curve fit index scores did not clearly support a dimensional or categorical construct, the plot shapes were generally consistent with a latent dimensional construct, suggesting that SIB, including NSSI and SSI, occurs on a continuum.

Keywords: taxometric method, non-suicidal self-injury, suicidal-self injury, self-injurious behavior

Non-Suicidal Self-Injury and Suicidal Self-Injury: A Taxometric Investigation

A central controversy within the psychological community revolves around the appropriateness of the classification system utilized in the psychological field. The Diagnostic and Statistical Manual of Mental Disorders (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association, 2000), for example, utilizes a classification system for psychological disorders that is developed largely by committee consensus instead of empirical data regarding the latent structure of each psychological disorder. Cronbach and Meehl (1955) argue that psychological constructs are not accurately represented when constrained into rigid categorical structures, as they often lack clear boundaries and defining indicators of the disorder. The fuzzy boundaries and unclear indicators suggest that most psychological disorders are open, dimensionally distributed constructs (Cronbach & Meehl, 1955). These arguments raise questions pertaining to the existence of concrete boundaries that discriminate between individuals with a particular psychological condition from those who do not have it. It is possible that at least some psychological maladies are more accurately described as occurring along a spectrum, with individuals differing in symptom severity rather than whether a disorder exists or not.

The dimensional-categorical debate can be extended beyond the scope of the *DSM-IV-TR* (2000) to scrutinize how varying psychological constructs and behaviors are conceptualized (Schmidt, Kotov, & Joiner, 2004). Taking this debate into consideration, the current study sought to empirically test whether individuals who engage in deliberate self-injurious behavior (SIB) can be sorted into categorically distinct groups based on key defining features, such as frequency and severity of the acts, the number of methods used,

and whether or not the individual intended to die as a result of his or her self-inflicted injuries.

SIB is described as repetitive actions that cause harm to or damage the body and are not socially sanctioned (Whitlock, Eckenrode, & Silverman, 2006). Researchers have found that the most frequently utilized forms of SIB are cutting, banging one's head or hitting oneself, sticking sharp objects into one's skin, carving, scratching, burning, and preventing wounds from healing (Gratz, 2001; Lundh, Karim, & Quilisch, 2007; Ross & Heath, 2002; Swannell, Martin, Scott, Gibbons, & Gifford, 2008; Whitlock et al., 2006). Often, those who engage in SIB do not feel pain after engaging in SIB behaviors. For example, in a study of 105 adolescents who self-injure, half reported no pain afterwards, and 35% reported that they experienced a feeling of relief after the self-injury (Csorba, Dinya, Plener, Nagy, & Pali, 2009). The prevalence of SIB is difficult to determine concretely, as it varies depending on the population being assessed. Approximately 4% of the general adult population engages in SIB, whereas a 21% prevalence rate exists within clinical populations (Briere & Gil, 1998). For high school populations, a German study found that 14.9% of high schoolers engaged in occasional SIB and 4% engaged in repetitive SIB (Brunner et al., 2007), and a Swedish study found that a staggering 41.5% of adolescents had engaged in SIB more than once and 13.8% reported engaging in one type of SIB many times (Lundh et al., 2007). For college populations, one study found that the prevalence rate of engaging in one or more self-injurious behaviors to be 17% (Whitlock et al., 2006).

SIB is often engaged in when the individual is experiencing negative emotions. In the development of the Self-Injury Motivation Scale, Swannell et al. (2008) found that 92% of surveyed adolescents who self-injured reported that they utilized the physical pain in SIB

to distract themselves from emotional pain, and 87% reported that they engaged in SIB to lessen a feeling of emptiness. Other motivations frequently endorsed (by greater than 70% of responders) were to create a feeling of numbness, to rid oneself of negative memories, to alleviate a feeling of being alone, and to show others how angry or hurt the individual felt.

It is traditionally thought that females are more likely to engage in SIB than males. While some studies indicate that females are both more likely to self injure (Ross & Heath, 2002) and typically self-injure at a higher frequency than males (Patton et al., 1997; Swannell et al. 2008; Whitlock et al., 2006), results from other studies (Lundh et al., 2007) did not find gender differences in overall likelihood to self-harm. A gender difference seems to exist in the realm of self-injurious methods, as females more frequently utilize cutting behaviors than males (Csorba et al., 2009; Lundh et al., 2007; Whitlock et al., 2006). The area of injury differs between genders as well, with males being more likely to injure their hands and fingers, while females are more likely to injure their lower arms, wrists, and thighs (Csorba et al., 2009; Whitlock et al., 2006). On average, SIB has also been found to begin at a slightly younger age for females than males. In addition, females are more likely to utilize multiple methods of self-injury (Swannell et al., 2008) than males.

Self-injury is a complex phenomenon that occurs alongside a multitude of disorders, symptoms, and experiences. SIB is noted in the *DSM-IV-TR* (2000) as a symptom of several psychological disorders including borderline personality disorder, behaviors associated with autism spectrum disorders (e.g., autistic disorder, asperger's disorder), and factitious disorders. SIB is also strongly associated with internalizing disorders involving anxiety and depression (Nock, Joiner, Gordon, Lloyd-Richardson, & Prinstein, 2006; Ross & Heath, 2002), conduct or oppositional defiant disorders, Axis II personality disorders, and substance

abuse disorders (Nock et al., 2006). In addition, over half of the young adults who engaged in SIB reported a history of physical, sexual, or emotional abuse (Whitlock et al., 2006).

A review of the self-injury literature reveals that some researchers propose that two distinct forms of SIB exist: non-suicidal self injury (NSSI) and suicidal self injury (SSI; e.g., Csorba et al., 2009). NSSI, also described as parasuicide, refers to deliberate, self-inflicted destruction of the body that is made without intent to die, whereas SSI refers to SIBs that are engaged in with the intent to end one's life. Those who believe that NSSI and SSI are two distinct entities note several differences between the two behaviors including intent of the act (suicidal or non-suicidal intent), severity of damage or lethality, chronic pattern, and number of methods of self injury (Walsh, 2006).

At the forefront of the theoretical distinction between NSSI and SSI is suicidal intent. Researchers who make a categorical distinction between NSSI and SSI contend that lethal intent conveys increased risk for death by self-injury and, thus, should be assessed and used to classify SIB (Csorba et al., 2009). As the name implies, it is believed that the motivation behind NSSI is not the intent to die. Individuals who engage in SIB report that the primary reason for injuring is to remove distress or to regulate negative emotions or produce a sense of relief and satisfaction; most individuals do not report that these behaviors are meant to terminate life, which is the intent behind suicidal behaviors (Muehlenkamp, 2005). In one study consisting of 86 participants who engaged in deliberate self-harm, only 6% believed that death was a probable result of their behaviors and reported serious intent to die (Patton et al., 1997). Another study found that individuals engaging in NSSI did not report significantly different levels of suicidal ideation than individuals who did not self-injure at all (Jacobson, Muehlenkamp, Miller, & Turner, 2008), while another study estimated that about

59%-72% of individuals who engage in SIB do not report suicidal thoughts at the time of self-injury (Muehlenkamp, 2005). Similarly, an interview of individuals hospitalized for a suicide or self-injury attempt found that nearly half of these individuals did not have suicidal intent (Linehan, Comtois, Brown, Heard, & Wagner, 2006).

In addition to intent to die, research has found that the severity of the SIB can differ between NSSI and SSI. Individuals who engage in moderate to severe types of NSSI (defined as more clinically severe forms of NSSI, such as cutting or burning) report a longer history of suicide attempts and a higher level of suicide ideation than those who engage in minor NSSI (defined as less clinically severe forms of NSSI, such as hitting or biting oneself). In addition, those who engage in moderate to severe NSSI were more likely to engage in other types of NSSI and experience more incidents of NSSI (Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007). In an examination of the latent classes of NSSI, Whitlock, Muehlenkamp, & Eckenrode (2008) found that individuals in a “high severity NSSI” class demonstrated higher levels of suicidality than those in lower severity classes. In a comparison of individuals who engaged in NSSI and those who engaged in SSI, those who practiced SSI had a more serious recent history of SIB than those who practiced NSSI and also experienced significantly higher severity and intensity of SIB than NSSI adolescents (Csorba et al., 2009).

The number of types of SIB an individual has engaged in has been shown to have a strong relationship with suicide attempts, with those who have attempted suicide engaging in a greater number of different types of SIB than those who have not (Zlotnick, Donaldson, Spirito, & Pearlstein, 1997). Individuals who utilize more than three forms of SIB have been shown to demonstrate a higher level of suicidality than individuals who engage in one to

three forms (Whitlock et al., 2008). In addition, the number of lifetime suicide attempts in a sample of adolescents who engaged in NSSI was associated with the number of the different methods used to self-injure (Nock et al., 2006).

The chronic pattern, or frequency, of SIB is also thought to distinguish NSSI from SSI. Adolescents who engaged in a repetitive form of SIB (four or more times per year) reported a significantly higher rate of suicidal thoughts than those who engaged in occasional or no SIB (Brunner et al., 2007). In a comparison of adolescents who engaged in NSSI with those who engaged in SSI, the latter reported experiencing more self-injurious ideas and actions than the former (Csorba et al., 2009).

In addition to the aforementioned variables, there are several other differences between individuals who engage in NSSI and those who engage in SSI that support the categorical separation of the two types of SIB. Csorba et al. (2009) assessed the differences between NSSI and SSI in a group of 105 adolescent self-injurers. Results revealed that major depression was significantly more prevalent in the SSI group than the NSSI group. Adolescents who participated in SSI were more likely to injure their lower legs, engage in severe nail-injury (e.g., severe nail biting, inserting objects under the nail), and overdose on drugs as methods of self injury; SSI adolescents reported more fearfulness, emptiness, and abandonment than NSSI adolescents. Other comparisons between NSSI, SSI (defined here as suicidal behavior with engagement in self-injury as well), and suicidal behavior (with no history of self-injury) revealed that individuals engaging in any type of self-harm were more likely to have symptoms of borderline personality disorder than those who did not engage in self-harm, and individuals who attempted suicide (both with and without SIB) were more likely to have major depressive disorder (or significantly higher depression scores) or

posttraumatic stress disorder than those engaging in NSSI (Jacobson et al., 2008). In addition, individuals who engaged in SIB to regulate emotions or self-punish reported higher rates of suicidal thoughts and behaviors (Glenn & Klonsky, 2008). Finally, in an effort to determine whether NSSI and suicide attempts shared similar characteristics, Wichstrom (2009) discovered that while NSSI and suicide attempts shared some risk factors (young age, early sexual intercourse, and non-heterosexuality), many other risk factors were indicative of either NSSI (previous NSSI, dissatisfaction with social support) or suicide attempts (suicidal ideation, poor attachment with parents) exclusively, suggesting that NSSI and suicide attempts share some characteristic overlap but should not be considered as varying degrees of suicidality (Wichstrom, 2009).

Taking the plethora of differences between NSSI and SSI into consideration, it is possible that considering the two behaviors as similar entities could be dangerous. If the two behaviors are considered as similar or varying degrees of a single phenomenon, the vast differences between the two phenomena could be overlooked. An incorrect conceptualization of NSSI and SSI could lead to the ineffective treatment and reduction of both self-injury and suicide, respectively (Muehlenkamp, 2005).

While there is evidence of differences between NSSI and SSI, there is also evidence that the two concepts may not represent distinct categories, but rather exist on a continuum, with NSSI serving as a less severe form of SIB than SSI. Although NSSI is conceptualized as self-injurious behaviors *without* the intent to die, there is a strong correlation between NSSI and suicidal behaviors. Some authors have found that the strongest risk for engaging in SIB was the occurrence of suicidal behavior and ideation. A history of more than one suicide attempt increased the risk of repetitive self-harm in adolescents by six-fold. Occasional

suicidal ideation increased the risk of repetitive self-harm by seven-fold, while frequent ideation increased the risk by 18-fold (Brunner et al., 2007). While it was found that individuals who engaged in a higher severity of NSSI demonstrate more suicidality than individuals engaging in a lower severity of NSSI, individuals who engaged in NSSI (regardless of level of severity) exhibited significantly more suicidality than individuals who had never engaged in NSSI (Whitlock et al., 2008). In an analysis of interviews with 89 adolescents, 70% of those who endorsed engaging in NSSI behaviors reported a suicide attempt in their lifetimes and 55% of those adolescents engaging in NSSI behaviors reported multiple suicide attempts (Nock et al., 2006). In a national survey of self-injurious behavior in college students, Whitlock and Knox (2007) found that 40.3% of students who reported self-injurious behavior also reported suicidality. When comparing self-injurers and adolescents who attempted suicide, the only difference between the groups was that the individuals who attempted suicide reported higher repulsion by life than the individuals who engaged in SIB. The groups showed relatively similar levels of suicidal ideation and depression (Muehlenkamp & Gutierrez, 2004). Thus, the clarity of the distinction between of the proposed forms of SIB is questionable.

It can be argued that SIB exists on a continuum, with absence of SIB or suicidal behaviors existing on one end of the spectrum and SIB with suicide attempts existing on the other. Individuals who engage in SIB with suicide attempts show significantly higher levels of psychopathology, more depressive reaction patterns, lower levels of adaptive personality traits, and poorer coping skills than those who engage in neither SIB nor suicidal behaviors. The scores of those who engage in only NSSI or suicide attempts were nestled in the middle of the spectrum, demonstrating more adaptive traits than those engaging in NSSI and suicidal

attempts, but less adaptive traits than those who engage in neither. This indicates that, although possessing less severe psychological disturbances than those who engage in SSI, as pathologies of individuals who engage in only NSSI increase in severity, the likelihood of a suicide attempt also increases (Claes et al., 2010).

It is clear that there exists some disagreement as to whether SIB can best be conceptualized as being comprised of two distinct groups (NSSI and SSI) or as a dimensional model. While there are several differences between NSSI and SSI in SIB frequency (Brunner et al., 2007; Csorba et al., 2009), severity (Csorba et al., 2009; Lloyd-Richardson et al., 2007; Whitlock et al., 2008), and comorbid psychological conditions (Csorba et al., 2009; Jacobson et al., 2008), a high suicide rate remains among individuals engaging in NSSI (Muehlenkamp & Gutierrez, 2004; Nock et al., 2006; Whitlock & Knox, 2007), suggesting that NSSI and SSI may not be categorically distinct based on suicidal intent as presumed by some researchers. To work toward a solution to this disagreement, the current study sought to examine NSSI and SSI using the taxometric method.

The taxometric method is a series of statistical procedures formulated to uncover the true latent structure of phenomena. Concerned specifically with the classification of entities, the method seeks to determine whether constructs exist in a dimensional (continuous) or categorical (taxonic) nature. In other words, the taxometric method seeks to test whether a phenomena is comprised of multiple, naturally occurring classes or exists in a graded form, with some individuals experiencing more or less of the phenomena than others. Meehl (1995) illustrates the distinction between latent categories and dimensions, stating “There are gophers, there are chipmunks, but there are no gophmunks” (Meehl, 1995, p. 268). Naturally occurring, non-arbitrary groups, will be referred to hereafter as *taxons*. Taxons can be

distinguished from a complement class based on observable or measurable features, referred to as *indicators*.

The procedures comprising the taxometric method were developed by Meehl and colleagues (Meehl, 1995; Meehl & Golden, 1982; Meehl & Yonce, 1994, 1996; Waller & Meehl, 1998). The taxometric method does not consist of one specific analysis but rather several varying analyses applied to the same data set (Meehl & Golden, 1982). Multiple consistency tests are applied to a single data set to provide researchers with greater validity compared to a single statistical test, which may be fallible (such as an analysis of variance or a single correlation). The purpose of the method is to expose patterns in the dataset that already exist, which differentiates it from other methods of classification (such as cluster analysis) that force structure upon data that might not occur naturally (Cleland, Rothschild, & Haslam, 2000; Grove & Meehl, 1993; Waller & Meehl, 1998).

Taxometric procedures have a long history in the literature (e.g., Meehl, 1973). These procedures have been shown to consistently produce reliable and valid results, and plots can be sorted by both trained and untrained raters with greater than 95 % accuracy (e.g., Meehl & Yonce, 1994, 1996) when applied to variables whose latent structure is already known, such as biological sex (Meehl & Golden, 1982). In addition, Monte Carlo studies have demonstrated the superiority of the taxometric method over other analyses, specifically cluster analysis, in uncovering naturally occurring categories within a dataset (Cleland et al., 2000; Grove & Meehl, 1993; Waller & Meehl, 1998). The method has also been applied to discovering the latent structure of many areas of psychopathology, including bulimia nervosa (Gleaves, Lowe, Snow, Green, & Murphy-Eberenz, 2000), depression (Beach & Amir, 2003; Ruscio & Ruscio, 2000), dissociation (Waller, Putnam, & Carlson, 1996; Waller

& Ross, 1997), and posttraumatic stress disorder (Broman-Fulks et al., 2006; Forbes, Haslam, Williams, & Creamer, 2005; Ruscio, Ruscio, & Keane, 2002).

In the present study, the taxometric method was utilized to uncover the latent structure of SIB—specifically, to test if NSSI and SSI exist as two distinctly separate groups or on a continuum of SIB, with NSSI representing a less severe degree of SIB and SSI representing a more severe degree of SIB. Understanding the latent structure of SIB is of critical importance for clinicians, as an incorrect view of SIB can negatively impact how clinicians assess for and treat SIB. If the latent structure of SIB is dimensional, with NSSI and SSI representing different points on the same continuum, the previously held assumption that NSSI can be classified by an absence of suicidal intent is incorrect. As clinicians base the classification of NSSI on the presumed absence of suicidal intent, the discovery of a continuum would mean that SIB is not being accurately assessed or is being considered potentially less serious than it actually is. However, the presence of a taxon, with NSSI and SSI being two differing phenomena, would lend support to the current conceptualization of NSSI and SSI and would allow clinicians to continue and build upon the current methods of assessment and treatment.

A correct conceptualization of SIB is vital for developing appropriate treatments and clinical understanding of the severity of the symptoms. Accurate knowledge of the latent structure of SIB would also help to inform the development and selection of assessment measures. If NSSI and SSI exist on a continuum, measures that assess the full spectrum of SIB would be optimal, with the goal of identifying SIB in individuals in various positions on the spectrum. In addition, artificially dichotomizing a dimensional phenomenon can result in the loss of potentially important information in assessment. Conversely, if NSSI and SSI are

distinctly separate phenomena, assessment measures that can accurately identify individuals with NSSI versus SSI would be most useful. In this case, knowledge of the factors and symptoms that separate the two phenomena would be vital to accurately assess for and possibly diagnose NSSI or SSI.

Knowledge of the true structure of SIB can impact the clinical treatment of NSSI and SSI, as well as the therapy goals for the phenomena. For example, if the latent structure of SIB is dimensional in nature, a clinician must make suicide risk assessment a priority throughout treatment and keep the potential for suicide in the forefront of his or her mind. However, if the latent structure of SIB is categorical, the clinician may be able to focus less on suicide risk assessment and more on the function the SIB serves for the individual (e.g., a coping mechanism). The results of this study will serve to elucidate the characteristics of SIB, which can inform more accurate and appropriate assessments and treatments for SIB.

In addition, the American Psychiatric Association (2010) has proposed that NSSI be included in the upcoming fifth edition of the DSM, scheduled for publication in May of 2013. Criteria A for NSSI indicates, “the absence of suicidal intent is either reported by the patient or can be inferred by frequent use of methods that the patient knows, by experience, not to have lethal potential” (American Psychiatric Association, 2010, para. 1). In addition, Criteria A specifies that the SIB will lead to only minor to moderate physical harm. The intent to commit suicide, as indicated expressly by the patient, is classified as Non-Suicidal Self-Injury Disorder, Not Otherwise Specified, Type 2, Intent Uncertain. The rationale for the inclusion of this disorder in the DSM-V largely includes the intent to assuage the problematic assumption that SIB is equivalent to a suicide attempt. While the distinctiveness of NSSI from a suicide attempt is supported by some research, individuals who engage in

NSSI are not immune to suicidal behavior, and in fact can exhibit elevated rates of suicidality (American Psychiatric Association, 2010). The American Psychiatric Association has supported the proposed inclusion of NSSI in the DSM-V as a diagnosable disorder with an ample supply of research (e.g., Lloyd-Richardson et al., 2007; Muehlenkamp & Gutierrez, 2004; Nock et al., 2006), but an investigation of the underlying structure of the disorder could serve to further support, possibly contradict, or better inform the inclusion of this disorder and the criteria that constitute a diagnosis.

A taxometric investigation of SIB both informs and aids the assessment, diagnosis, and treatment of NSSI and SSI. The current conceptualization of SIB is that NSSI and SSI are two separate phenomena, and there exists much research to support this (Brunner et al., 2007; Csorba et al., 2009; Jacobson et al., 2008; Linehan et al., 2006; Lloyd-Richardson et al., 2007; Muehlenkamp, 2005; Nock et al., 2006; Patton et al., 1997; Whitlock et al., 2008; Zlotnick et al., 1997). Although the elevated suicide attempt rate found in some studies suggests that SIB may possess a dimensional rather than a categorical latent structure (Brunner et al., 2007; Nock et al., 2006; Whitlock & Knox, 2007; Whitlock et al., 2008), there are numerous factors besides intent to suicide that support a differentiation between NSSI and SSI. In addition to intent to die (Csorba et al., 2009; Jacobson et al., 2008; Linehan et al., 2006; Muehlenkamp, 2005; Patton et al., 1997), these factors include severity of the SIB (Csorba et al., 2009; Lloyd-Richardson et al., 2007; Whitlock et al., 2008), frequency of SIB (Brunner et al., 2007; Csorba et al., 2009), and number of methods used to self-injure (Nock et al., 2006; Whitlock et al., 2008; Zlotnick et al., 1997). Because of the plethora of evidence available that supports the differentiation of NSSI from SSI, it was

hypothesized that the latent structure of the NSSI and SSI components of SIB would be found to be categorical.

Method

Participants

Participant data were drawn from the Survey of College Mental Health and Well Being database, a vast national web-based survey administered by researchers at Cornell University in 2005 to 3,069 students at eight major universities across the country. No participation restrictions were set for gender or race, although only individuals over the age of 18 were eligible to participate. As this study involved no direct data collection or access to identifying participant information, the current study was deemed to be exempt by the Appalachian State University Institutional Review Board (see Appendix A). For the present research, participants were required to endorse a positive history of SIB. Of the 3,069 individuals who were administered measures, 1,525 met study criteria and completed all study requirements. The final sample was 70.7 % female ($n = 1,078$) and 28% male ($n = 427$), with 0.9% identifying as transgendered or nongendered ($n = 13$) and 0.5% electing not to identify their gender ($n = 7$). The mean age for the sample was 21.41 years ($SD = 4.18$). The sample was largely Caucasian (75.9%), followed by Asian (8.9%), Hispanic (7.7%), Asian-American (6.1%), African-American (4.3%), Other (3.4%), Middle Eastern or East Indian (2.4%), American Indian (1.8%), and Pacific Islander or Native Hawaiian (0.1%).

Regarding reasons endorsed for the intent behind engaging in SIB, the majority of participants reported that they engaged in SIB to cope with some sort of unpleasant emotion (55.1%), stress/pressure (48.7%) or frustration (40.3%). It should be noted that 27 participants (1.8%) reported that they self-injured as a way to practice suicide and 36 (2.4%)

reported that they self-injured as an attempt to commit suicide. More detailed information regarding endorsed intent behind SIB can be found in Table 1.

Comorbid psychological conditions reported by the participants were also examined. Of the participants who responded, 369 (24.2%) reported that they had not experienced any of the psychological disorders assessed, and 231 (15.1%) reported that they were unsure if they had experienced a psychological disorder. Depression was the most prevalent disorder reported, with almost half (47.1%) of participants reporting they had experienced depression and 28.8% having been diagnosed with depression. More detailed information regarding participant reports of disorders can be found in Table 2.

Materials

The Survey of College Mental Health and Well Being is an online survey assessing several facets of SIB including lifetime frequency, current SIB status, age of onset, specific behaviors, severity, body parts affected, and help-seeking behaviors. Access to the Survey of College Mental Health and Well Being database was granted by the study's primary investigator, Dr. Janis Whitlock. The researcher was only granted access to survey items applicable to the purpose of the study, which included items pertaining to basic demographic information (e.g., age, ethnicity), SIB, suicide history, and comorbid psychological disorders. The survey was sent to prospective participants via e-mail containing a link to the online survey (Whitlock et al., 2006). Upon receiving items pertaining to SIB, participants were informed of the content and overall purpose of the upcoming questions. They were provided with a distraction button allowing them breaks if the content was upsetting as well as contact information for someone to whom they could talk, if needed.

The specific items chosen for use in this study were taken from the Non-Suicidal Self-Injury Assessment Tool (NSSI-AT) of the Survey of Student Well-Being, included as a part of the Survey of College Mental Health and Well Being. The NSSI-AT was developed through a review of existing literature, interviews with individuals who engaged in SIB, and interviews with individuals in the field of mental health. A recent examination of the validity and reliability of the NSSI-AT revealed that the measure possesses strong psychometric properties, with test-retest reliability between .65 and .84, insignificant correlations between unrelated constructs, and strong correlations ($p < .001$) between related constructs and similar measures--indicating that this measure provides an accurate, stable assessment of NSSI, particularly in a college population (Whitlock & Purington, 2011). Items used the subscales of the Form (e.g., "Have you ever: cut wrists, arms, legs, torso or other areas of the body?"), Frequency (e.g., "Approximately on how many total occasions have you intentionally hurt yourself?"), Function (measuring intent items, i.e., "I intentionally hurt myself [please check all that apply]: As a way to practice suicide; as a way to commit suicide"), and Unintentional Severity (e.g., "Have you ever intentionally hurt yourself more severely than you expected?") portions of the Survey of Student Well-Being. Items chosen to assess for suicide history (e.g., "Have you ever seriously considered suicide or attempted suicide?") were created for the Survey of College Mental Health and Well Being and were not a part of any standardized measure. Item presentation used in the survey included yes or no questions and statements, questions with multiple-choice answers (e.g., presenting a range of total self-injury instances), and checklists with multiple answer options (Whitlock et al., 2006). A full list of items included in this study and the measure from which each item was pulled is included in Appendix B.

Procedure

Indicator selection. To conduct a taxometric analysis, potential indicators of the proposed taxon must first be identified. Indicators are specific signs or symptoms that would be indicative of the conjectured taxon (if one was present). Based on the results of previous research, five indicators were created for distinguishing SSI from NSSI: suicidal intent and history of suicidal behavior (Csorba et al., 2009; Jacobson et al., 2008; Linehan et al., 2006; Muehlenkamp, 2005; Patton et al., 1997), frequency of self-injurious behavior (Brunner et al., 2007; Csorba et al., 2009), number of methods used to self-injure (Nock et al., 2006; Whitlock et al., 2008; Zlotnick et al., 1997), and severity of the SIB (Csorba et al., 2009; Lloyd-Richardson et al., 2007; Whitlock et al., 2008). Each indicator represented the summed score of two to five items gathered from the Survey of College Mental Health and Well Being (Whitlock et al., 2006) that assessed the specific domain (e.g., SIB frequency). See Table 3 for a list of indicators, the specific items assigned to each, and the range of each indicator.

The suitability of the selected indicators for taxometric analysis was examined. Previous research suggests that suitable indicators should be correlated in the full sample, but show relatively low levels of correlation within the taxon or complement groups (i.e., low nuisance covariance; Meehl & Yonce, 1994). In addition, taxometric procedures require indicators with high levels of validity (i.e., separations between conjectured taxon and complement groups of greater than 1.25 standard deviations). Thus, prior to examining taxometric results, indicator correlations and validities were examined.

Consistency testing. A crucial element of the taxometric method is consistency testing (Meehl, 1995), whereby multiple data-analytic procedures are applied to the same dataset. To this end, three mathematically independent taxometric procedures were applied to the data: Maximum Eigenvalue (MAXEIG), “Mean Above Minus Below A Cut” (MAMBAC), and Latent-mode (L-mode) factor analysis. Each procedure produced several graphs, which were independently analyzed and interpreted by the researchers. Following is a brief description of each procedure.

MAXEIG (Waller & Meehl, 1998) is a multivariate taxometric procedure that functions by calculating and plotting the first (largest) eigenvalue of all remaining indicators across successive overlapping windows of an input indicator. If the specific construct being examined is categorical, then the resulting graphs will convex upward in the areas with the greatest mixture of taxon and non-taxon members. If the construct is dimensional, then the covariation will be minimal along successive overlapping regions of the input indicator, resulting in a relatively flat graph. MAXEIG analyses were conducted using 500 windows with a 90% overlap and three replications.

MAMBAC (Meehl & Yonce, 1994) is based on the premise that if two groups exist then mean differences will occur on valid measures of group membership. Two indicators are extracted, and cases are sorted in ascending order on one indicator. A “cut” is made near the end of the sorted indicator, and the mean difference score of the second indicator above and below the cut is plotted. If the construct being analyzed is dimensional, the resulting plot will be concave in shape, with the difference between the means of the two groups being the greatest at the high and low ends of the indicator spectrum. If the construct is categorical, then the resulting plot should convex upward at the cut that most effectively discriminates

between the two groups. MAMBAC analyses were performed using 50 evenly-spaced cuts beginning 25 cases from either extreme.

L-Mode factor analysis (Waller & Meehl, 1998) is a multivariate taxometric procedure that functions by performing an exploratory factor analysis on all indicators. Factor score estimates for the first, unrotated principal factor are calculated and plotted. If a construct is taxonic, scores typically display a bimodal distribution (a distribution with two distinct peaks). If a construct is dimensional, scores tend to be unimodal or normally distributed, with only one distinct peak.

Simulated comparison plots. To assist in the interpretation of the graphs generated by the taxometric procedures, simulated taxonic and dimensional plots were generated based on the distributional characteristics (e.g., skew, kurtosis) of the research data. Simulated plots provide examples of how the research data plots would be expected to appear if they were taxonic or dimensional. To derive parameter estimates and generate categorical comparison data, cases were assigned to groups using an iterative method wherein analyses were initially run to obtain the mean base rate. Analyses were then repeated a second time using the mean base rate to classify cases into conjectured taxon and complement groups. The raters used the simulated plots to aid in the interpretation of the data plots. Before plots were visually examined for taxonicity or dimensionality, the suitability of the research data for taxometric analyses was evaluated by examining whether simulated taxonic and dimensional plots conformed to typical taxonic and dimensional plot shapes and were clearly distinguishable from one another. To ensure the accurate interpretation of these plots, the primary author and an additional rater independently visually examined each data plot generated by the taxometric procedures to judge whether the data were taxonic, dimensional,

or ambiguous based on their similarities to the simulated plots, and the level of agreement between the two independent raters was calculated.

In addition to the visual inspection and classification of the plots, the present study examined comparison curve fit index (CCFI) scores. The CCFI provides an objective measure of whether the data plots more closely match the simulated taxonic or dimensional plots. Specifically, the data plots generated by the various statistical procedures were compared to the simulated plots; the fit between the two was calculated and quantified on a scale from .00 to 1.00, with scores closer to .00 supporting a dimensional model and scores closer to 1.00 supporting a categorical model. Scores between .45 and .55 are generally considered ambiguous, as they do not provide clear support for either taxonic or dimensional models. (Ruscio, Walters, Marcus, & Kaczetow, 2010). Recent research has provided strong support for the utility of the CCFI in accurately interpreting taxometric output (Ruscio, 2007; Ruscio & Kaczetow, 2009; Ruscio & Marcus, 2007; Ruscio, Ruscio, & Meron, 2007; Ruscio, Walters, Marcus, & Kaczetow, 2010).

Results

Due to failure to meet minimum validity criteria, the Intent indicator was excluded from analyses. The remaining indicators (history of suicidal behavior, frequency of SIB, number of methods used to SIB, and severity of SIB) met minimum validity criteria and demonstrated low nuisance (within conjectured group) correlations (see Table 3).

Research data plots were independently rated by two experienced taxometricians. Preliminary analyses revealed that the raters agreed on 23 of the 24 generated plots (96 percent; kappa = 0.90), indicating high levels of interrater reliability. Regarding the instance in which the raters did not agree on a plot rating, one rater believed the plot to be ambiguous

while the other rater believed it to be dimensional. The raters interpreted the majority of the data plots as representing dimensional latent structure (17 out of 24 plots; 71%).

MAXEIG Analyses

The MAXEIG procedure generated four plots, none of which exhibited clear peaks that would be suggestive of a taxon. Rather, the data plots were consistent with prototypical dimensional plots and more closely resembled the simulated dimensional plots. An examination of the averaged MAXEIG plot, which was created by taking the mean of each of the original plots for each indicator, further confirmed that the plots had no clear peak and resembled a dimension more than a taxon. Generated plots can be found in Appendix C. The CCFI score for the data supported a dimension more so than a taxon (0.457), but was within the ambiguous range, suggesting that the objective fit index was not confidently able to clearly discriminate whether the data plots more closely resembled the simulated taxonic or dimensional plots. The base rates for MAXEIG were consistent (see Table 3), ranging from 0.09 to 0.16 ($M = 0.13$, $SD = 0.03$). An inchworm consistency test (ICT) was performed in an effort to improve the interpretability of results. The inchworm consistency test consists of conducting MAXEIG analyses with an increasing number of overlapping windows. In the present research, the inchworm consistency test was implemented using 100 and 300 windows in addition to the initial analysis, which used 500 windows. The MAXEIG analysis utilizing 300 windows revealed plots consistent with a dimensional construct (see Appendix D) and yielded a CCFI score suggesting a dimensional construct, although still within the ambiguous range (0.455). The analysis utilizing 100 windows provided similar results, with plots more consistent with a dimensional construct (see Appendix E), but yielded a CCFI suggesting more ambiguity than previous analyses (0.468).

MAMBAC Analyses

The MAMBAC procedure generated 12 plots. Results indicated that the plots from the research data more closely resembled traditional dimensional plots, with a slight convex upward. However, it should be noted that the simulated taxonic and dimensional comparison plots were similar in appearance, and the MAMBAC CCFI score was ambiguous (0.496).

The estimated base rates for each curve were relatively consistent, ranging from 0.00 to 0.66 ($M = 0.25$, $SD = 0.19$). Generated plots can be found in Appendix F.

L-Mode Analyses

The research data plot generated by the research data depicted a single distinct peak, suggesting the data more closely resemble a dimensional rather than a taxonic construct (see Appendix G). Unlike MAMBAC and MAXEIG results, the CCFI score was interpretable and supported the dimensional interpretation (0.34).

Discussion

The purpose of this study was to investigate the latent structure of SIB through taxometric analysis. Three taxometric procedures (MAXEIG, MAMBAC, and L-Mode) were used to analyze the data. Multiple analyses and consistency tests (e.g., multiple plot raters, CCFIs) were utilized to ensure a strong test of the latent structure of SIB. A visual inspection of the plots generated by the three taxometric procedures indicated that the research plots consistently resembled a dimensional construct. The MAXEIG inchworm consistency test provided further evidence of dimensionality, with plot shapes maintaining a consistent dimensional shape with an increasing number of windows. Although the visual inspection of the plots yielded clearly dimensional results and the MAXEIG CCFI scores suggested dimensionality (although still within the ambiguous range), only the L-Mode CCFI

score clearly supported a dimensional solution. However, the average CCFI score, suggested by Ruscio et al. (2010) to be used as a means to combine the results of multiple tests to yield a final decision, supports a dimensional construct (.43). In addition, two independent raters visually inspected the generated plots and agreed, with a high level of interrater reliability, that the majority of the plots appeared to suggest a dimensional construct. Thus, the cumulative results of this study provided preliminary evidence that SIB is a dimensional construct, with SSI and NSSI representing ranges on a single dimension rather than discrete typologies.

The dimensionality of NSSI and SSI is congruent with findings that individuals who self-injure have higher rates of suicidality and a more prominent history of suicidal behavior than those who do not self-injure (Brunner et al., 2007; Nock et al., 2006; Whitlock & Knox, 2007), particularly those who engage in more severe SIB (Whitlock et al., 2008). It is also congruent with research that has failed to find obvious distinctions between NSSI and suicide attempts (e.g., Muehlenkamp & Gutierrez, 2004). These findings suggest that an act of SIB, regardless of the presence or absence of suicidal intent, does not appear to be categorically distinct from suicidal behavior. Rather, NSSI should be considered on the same the spectrum of self-injury as SSI, with SSI representing the extreme of the continuum.

The reconceptualization of SIB as a spectrum has implications for the assessment, diagnosis, and treatment of SIB. Measures of SIB that attempt to categorize individuals as exhibiting NSSI or SSI are contraindicated as artificial dichotimization generally results in a loss of potentially important information. Rather, assessment of SIB should be focused on assessing the full continuum of SIB to maximize statistical power and minimize information loss. These findings also lend support for the proposed Intent specifier when diagnosing

NSSI in the upcoming fifth edition of the DSM (American Psychiatric Association, 2010); the presence of suicidality or suicidal history may not mean that an individual cannot be considered a self-injurer, but rather that the self-injury is more extreme or severe. This can be clarified even further by specifying severity of SIB when diagnosing; for example, providing “mild,” “moderate,” or “severe” specifiers, or numerical labels to represent a similar classification.

A client’s endorsement of suicidality when self-injuring should not be used to rule out a conceptualization of a primary problem of SIB, as a combination of suicidality and SIB may be on the more severe end of the SIB spectrum as well, especially considering findings that suicidality relates to higher severity of SIB (Csorba et al., 2009; Whitlock et al., 2008). Thus, when clinicians treat self-injurious clients, even clients who do not endorse suicidality, the spectrum of SIB must be taken into account, particularly those facets of SIB that may indicate greater severity of self-injury. Although monitoring suicidality is generally considered standard protocol when working with self-injurious clients, the results of this study provide additional support for continued monitoring of severity of SIB. Additionally, clinicians working with a self-injurious client should be aware of patterns of SIB that maintain or accelerate the risk of suicidal behavior, such as the number of methods used (Nock et al., 2006; Whitlock et al., 2008; Zlotnick et al., 1997) and the frequency of the behavior (Brunner et al., 2007; Csorba et al., 2009)--and implement behavioral procedures to shape the coping pattern in a safer direction.

The conceptualization of SIB as a dimensional phenomenon has implications for the scientific community as well. Often, individuals who report injuring themselves for suicidal purposes are excluded from studies of self-injurious behaviors (e.g., Whitlock et al., 2006),

as the current definition of SIB precludes those who injure with intent to suicide from being considered as a part of the self-injurious population. Excluding SSI from SIB studies results in the loss of potentially important information regarding SIB, especially considering the preliminary evidence garnered from this study that those who engage in SSI may represent a more severe side of the SIB population as a whole. Future research should conceptualize participants who engage in SSI as a more extreme or severe version of SIB rather than a separate population altogether.

To date, the current research represents the first taxometric investigation of the latent structure of SIB. Several strengths of the study are worth noting. First, the present study was conducted using a large, diverse sample of individuals (over 1,500) who endorsed a history of SIB. In addition, this investigation utilized a rigorous process of consistency testing that included the use of multiple taxometric procedures, the inchworm consistency test, two independent raters, and an objective fit index. Further, analyses were conducted using indicators that assess the full spectrum of SIB and have been suggested in previous research (i.e., Brunner et al., 2007; Csorba et al., 2009; Jacobson et al., 2008; Linehan et al., 2006; Lloyd-Richardson et al., 2007; Muehlenkamp, 2005; Nock et al., 2006; Patton et al., 1997; Whitlock et al., 2008; Zlotnick et al., 1997) to distinguish SSI from NSSI (severity, frequency of SIB, suicide history, and number of methods used). In addition, the measures used in the survey to assess the constructs in question are psychometrically sound, indicating that they appropriately and accurately measured SIB and suicidal behavior.

While this study has a number of strengths, there are several limitations worth noting. Although the results suggest dimensionality, objective fit indices for MAXEIG and MAMBAC analyses remained ambiguous, even after inchworm consistency tests. This issue

appeared to be predominately due to the similarities in plots shapes among the simulated taxonic and dimensional plots generated by the MAXEIG and MAMBAC procedures. Additional research using alternative indicators may provide further clarification regarding the latent structure of SSI. Another limitation of this research was the exclusion of the Intent indicator, which failed to meet minimum validity criteria. Finally, although the study included many individuals who endorsed a history of SIB, relatively few were included who reported that they engaged in SIB with the primary reason being an intent to die, which may have obscured the ability of the present study to detect an extremely low base rate taxon if it was present. Future taxometric research would benefit from the inclusion of larger samples of individuals who report that they engage in SIB with the intent to die to ensure the absence of a low base rate SSI taxon.

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Table 1

Intent Endorsed for Engaging in Self-Injurious Behavior

Intent item endorsed	<i>n</i>	%
To cope with uncomfortable feelings	840	55.1
To relieve stress or pressure	742	48.7
To deal with frustration	614	40.3
To change my emotional pain into something physical	596	39.1
To feel something	444	29.1
To deal with anger	416	27.3
To distract me from other problems or tasks	342	22.4
To get control over my life	342	22.4
As self-punishment or to atone for sins	308	20.2
In hopes that someone would notice that something is wrong or so that others will pay attention to me	307	20.1
Because I get the urge and cannot stop it	294	19.3
Because it feels good	273	17.9
Because of my self-hatred	248	16.3
To get a rush or surge of energy	190	12.5
To help me cry	150	9.8
So I do not hurt myself in other ways	116	7.6
Other reasons	114	7.5
To create an excuse to avoid something else	73	4.8
To avoid committing suicide	72	4.7
Because my friends hurt themselves	37	2.4
As an attempt to commit suicide	36	2.4
As a way to practice suicide	27	1.8
To be part of a group	13	0.9
To feel closer to God	11	0.7
Because my friends expect me to	3	0.2

Table 2

Participant Reports for Suffering From and Receiving Diagnoses of Psychological Disorders

Disorder	Suffered		Received Diagnosis	
	<i>n</i>	Percentage (%)	<i>n</i>	Percentage (%)
Attention-Deficit/Hyperactivity Disorder	132	8.7	83	5.4
Anorexia	164	10.8	53	3.5
Anxiety Disorder	268	17.6	180	11.8
Bipolar Disorder	65	4.3	39	2.6
Borderline Personality Disorder	25	1.6	7	0.5
Bulimia	124	8.1	41	2.7
Depression	718	47.1	439	28.8
Obsessive-Compulsive Disorder	143	9.4	58	3.8
Post-Traumatic Stress Disorder	55	3.6	35	2.3
Schizophrenia	7	0.5	2	0.1
Seasonal Affective Disorder	135	8.9	16	1
Substance Abuse	74	4.9	30	2
Other	54	3.5	30	2

Table 3

Descriptive Data, Psychometric Properties, and Correlation Coefficients of the Indicators

Indicator	M^a	SD^b	Range	Validity	Skew	Kurtosis	1	2	3	4
1 Methods	2.62	2.09	0 - 15	2.14	1.99	4.86	1.00	0.41	0.40	0.35
2 Frequency	7.68	3.24	2 - 14	1.44	0.35	-0.92	0.41	1.00	0.23	0.28
3 Suicide History	1.05	1.30	0 - 3	1.56	0.95	-0.05	0.40	0.23	1.00	0.26
4 Severity	0.29	0.58	0 - 2	1.83	1.85	2.28	0.35	0.28	0.26	1.00

^a M denotes the mean of each indicator

^b SD denotes standard deviation of each indicator

Appendix A

Notice of IRB Exemption

To: Carissa Orlando

CAMPUS MAIL

From: Jessica Yandow, Office of Research and Sponsored Programs

Date: 8/15/2011

RE: Notice of IRB Exemption

Study #: 12-0025

Study Title: Non-Suicidal Self-Injury and Suicidal Self-Injury: A Taxometric Investigation
Exemption Category: (4) Collection or Study of Existing Data, If Public or Unable to Identify Subjects

This submission has been reviewed by the IRB Office and was determined to be exempt from further review according to the regulatory category cited above under 45 CFR 46.101(b). Should you change any aspect of the proposal, you must contact the IRB before implementing the changes to make sure the exempt status continues to apply. Otherwise, you do not need to request an annual renewal of IRB approval. Please notify the IRB Office when you have completed the study.

Best wishes with your research!

Appendix B

Items Selected from the Survey of College Mental Health and Well Being to Serve as
Indicators of Each Lower-Order Factor

Indicator	Survey items
Indicator 1 - Suicidal intent <i>(Author note: this indicator was not included in final analyses)</i>	Was practicing or attempting suicide the primary reason you intentionally hurt yourself? Yes No I intentionally hurt myself (please check all that apply): As a way to practice suicide As a way to commit suicide
Indicator 2 - History of suicidal behavior	Have you ever seriously considered or attempted suicide? Yes No Which of the following best describe your experience? (Please check all that apply): <ul style="list-style-type: none"> • I thought seriously about it • I had a general plan but did not carry it out (e.g., a time, a place, etc. were identified) • I wrote a suicide note but did not leave it where it could be found <i>(Author note: this item was not included in final analyses)</i> • I wrote a suicide note and did leave it where it could be found <i>(Author note: this item was not included in final analyses)</i> • I had a method but did not carry it out I made a serious attempt but no medical intervention occurred • I made a serious attempt that received medical attention • Although I considered suicide I was not that serious about it How many times have you made a serious attempt in which no medical attention occurred? <i>(Author note: this item was not included in final analyses)</i>

How many times have you made a serious attempt in which medical intervention occurred? *(Author note: this item was not included in final analyses)*

Indicator 3 - Frequency of SIB

Approximately on how many total occasions have you intentionally hurt yourself? Only once | 2-3 times | 4-5 times | 6-10 times | 11-20 times | 21-50 times | More than 50 times

On average, how often do you SI while you are in your most active phases? Every day | 2-3 times a week | Once a week | 1-3 times a month | Once every few months | About once a year | Once every two years or more years

During the period(s) in which you most actively hurt yourself, what has been the longest interval of times during which you did not SI? Less than a week | Less than a month | 1-3 months | 4-6 months | 7-12 months | More than a year *(Author note: this item was not included in final analyses)*

Indicator 4 - Number of methods used to self-injure

Have you ever: Severely scratched or pinched with fingernails or other objects to the point that bleeding occurs? Yes | No

Have you ever: Cut wrists, arms, legs, torso or other areas of the body? Yes | No

Have you ever: Dripped acid onto the skin? Yes | No

Have you ever: Created salt and ice burns on the skin? Yes | No

Have you ever: Carved words or symbols into the skin? Yes | No

Have you ever: Ingested a caustic substance(s) or sharp object(s)? Yes | No

Have you ever: Bitten yourself to the point that bleeding occurs or marks remain on skin? Yes | No

Have you ever: Tried to break my own bone(s)? Yes | No

Have you ever: Ripped or torn skin? Yes | No

Have you ever: Performed self-asphyxiation (with the intention of hurting yourself)? Yes | No

Have you ever: Burned wrists, hands, arms, legs, torso, or other areas of the body? Yes | No

Have you ever: Rubbed glass into skin or stuck sharp objects into the skin? Yes | No

Have you ever: Banged or punched objects to the point of bruising or bleeding? Yes | No

Have you ever: Punched or banged oneself to the point of bruising or bleeding? Yes | No

Have you ever: Mutilated genitals / rectum? Yes | No

Have you ever: Engaged in fighting or other aggressive activities with the intention of getting hurt? Yes | No

Are there other ways that you have physically hurt or mutilated your body with the purpose of intentionally hurting yourself? Yes | No

Indicator 5 - Severity of SIB

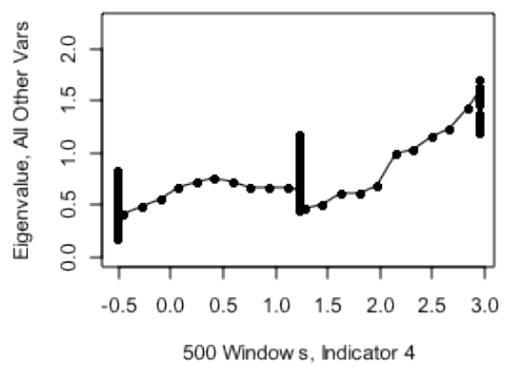
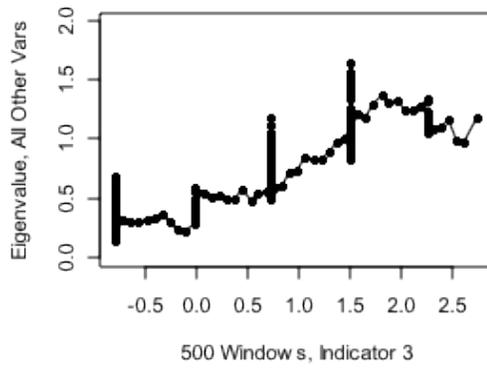
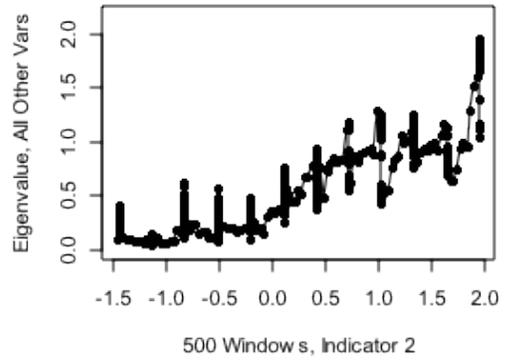
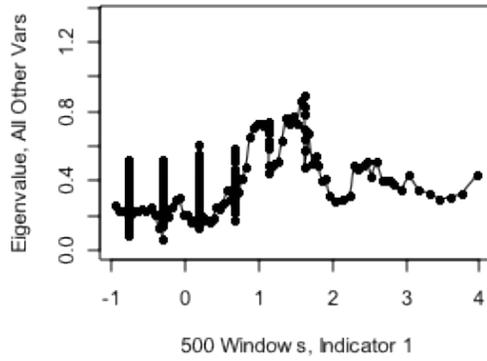
Have you ever self-injured more severely than you expected? Yes | No

Have you ever hurt yourself so badly that you should have been seen by a medical professional, even if you were not? Yes | No

How many times have you self-injured more severely than you expected? 1 | 2-3 | 4-5 | More than 5 (*Author note: this item was not included in final analyses*)

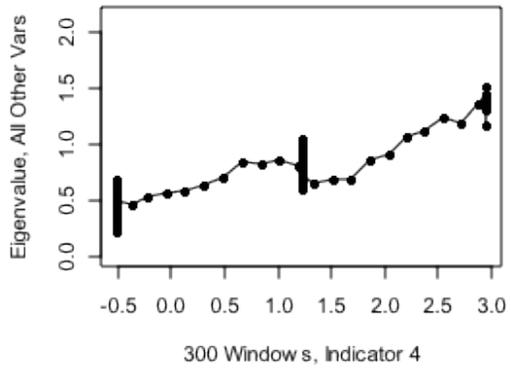
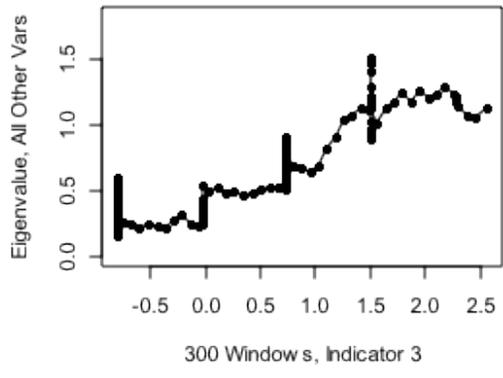
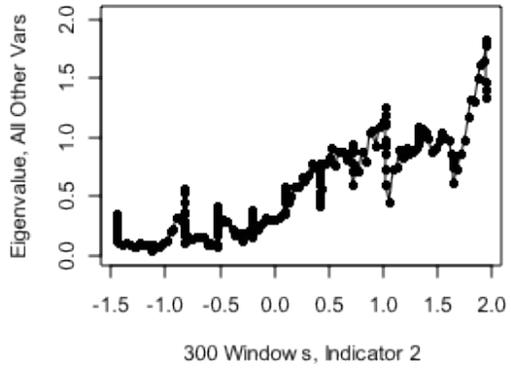
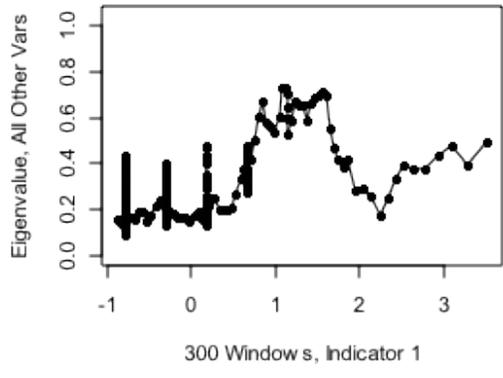
Appendix C

MAXEIG (500 windows) plots



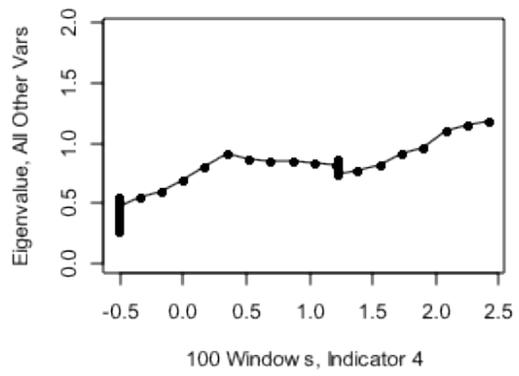
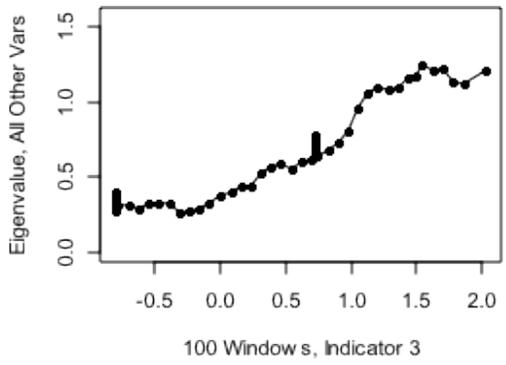
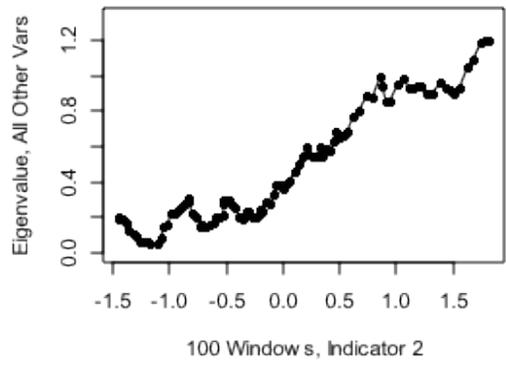
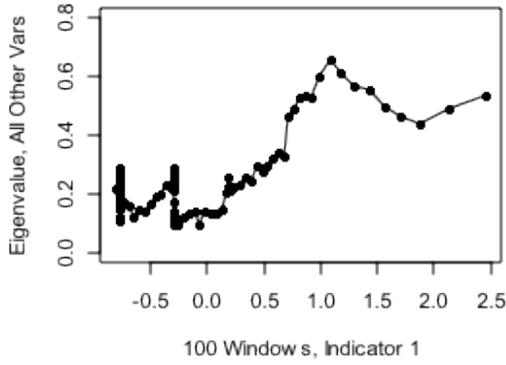
Appendix D

MAXEIG (300 windows) plots



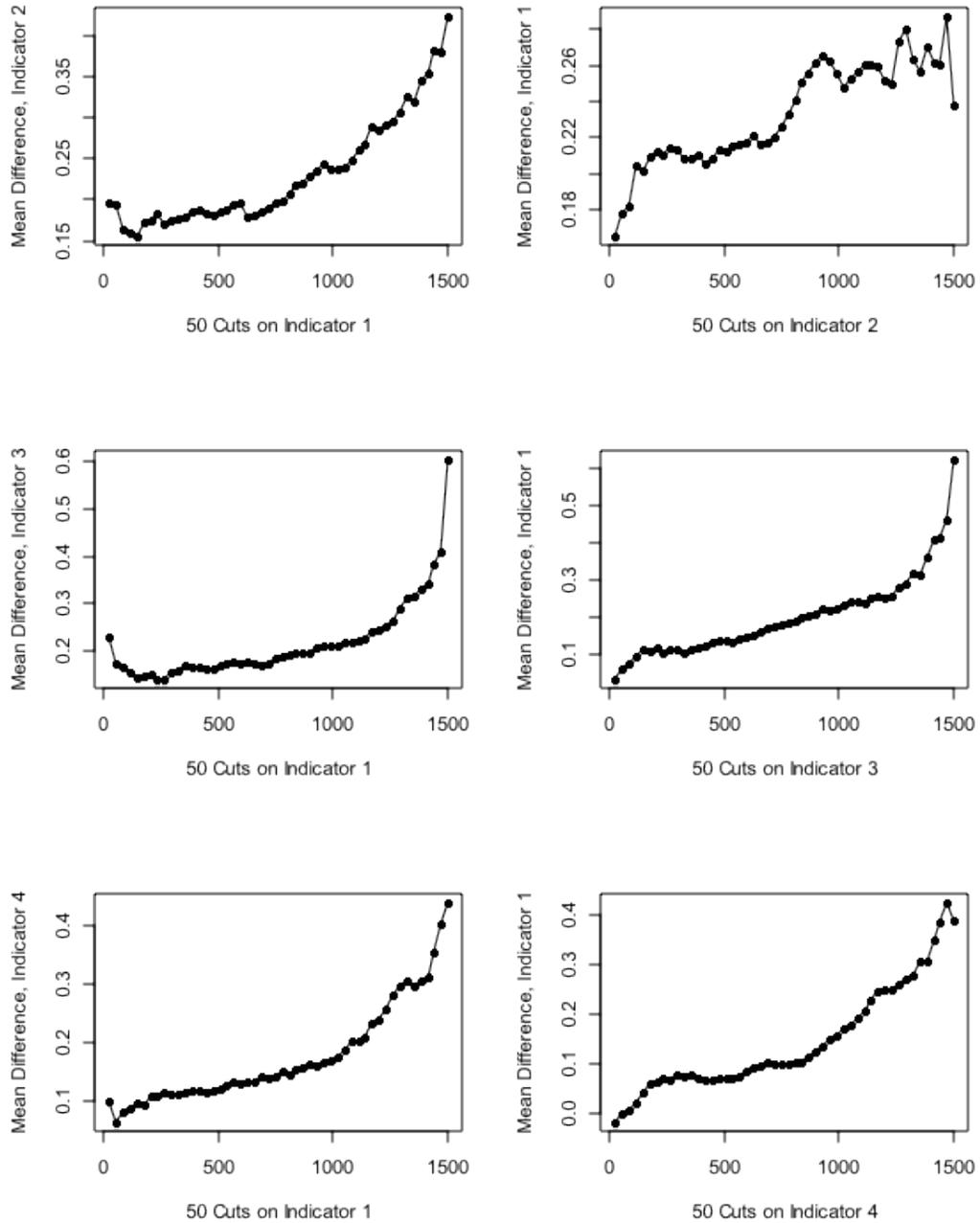
Appendix E

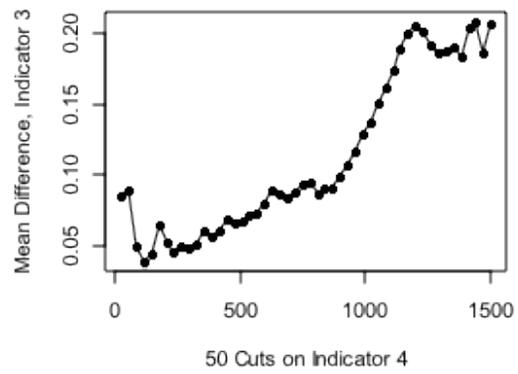
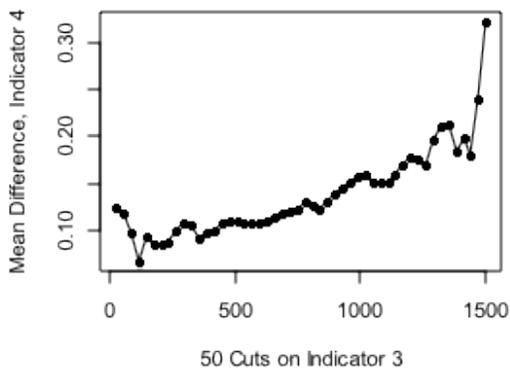
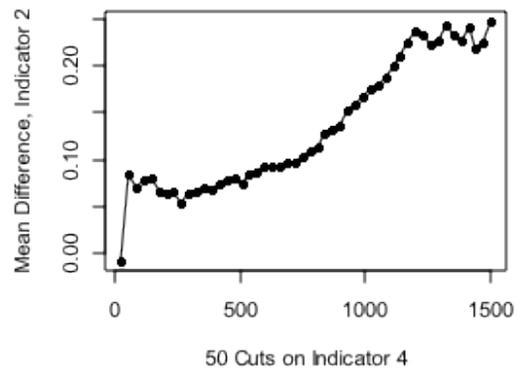
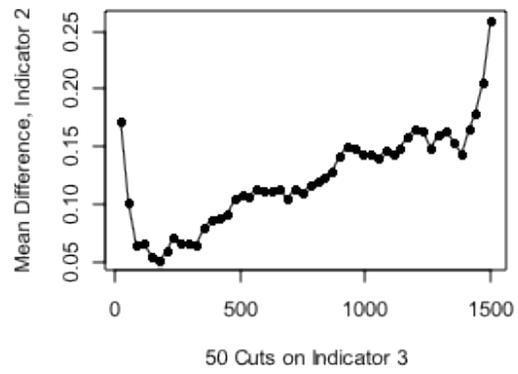
MAXEIG (100 windows) plots



Appendix F

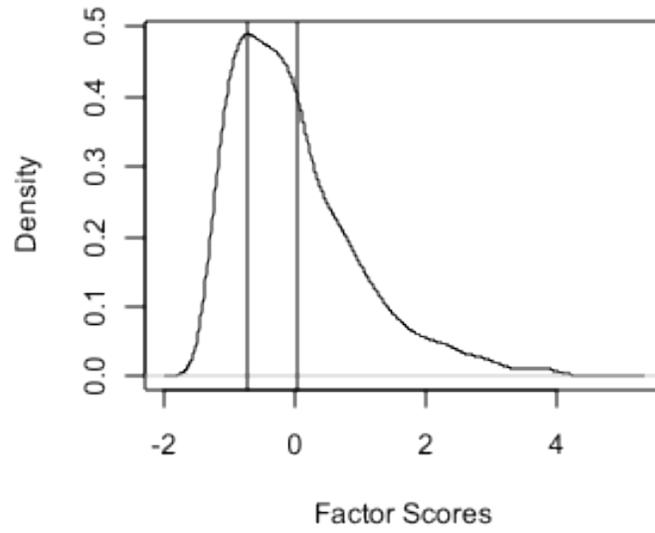
MAMBAC plots





Appendix G

L-MODE curve.



VITA

Carissa M. Orlando was born in New Haven, Connecticut. She grew up in Georgia and graduated from Dawson County High School in May 2005. She received her Bachelor of Arts degree from Queens University of Charlotte in May 2009, having majored in psychology with a concentration in creative writing. She completed work on her Master of Arts degree at Appalachian State University in May 2012. Upon graduation, Carissa relocated to Charlotte, North Carolina where she practiced as a Psychological Associate. She plans to build up the stamina to pursue her doctorate in Clinical Psychology.