AN EXAMINATION OF THE RELATIONSHIP BETWEEN CHARACTERISTICS ASSOCIATED WITH SELF-HARM AND BRAIN FUNCTION

by

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A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master of Arts in Clinical Psychology

Middle Tennessee State University
August 2017

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ABSTRACT

Researchers have identified characteristics in individuals associated with the likelihood of engaging in self-harm. These characteristics have been linked to increased levels of activity within the left frontal lobe of the brain. The purpose of the current study was to investigate how characteristics associated with self-harm relate to brain activation/deactivation within the frontal and parietal lobes and how this pattern differs between groups. Sixty-five male and female students completed assessments that assessed functioning in four regions of the brain. The results indicated that the performance between groups on the Line Bisection Test, which taps into right parietal functioning, was significant. However, a supplementary analysis did not indicate significance. There were no significant differences in performance between groups on other measures. The results may suggest a potential relationship between self-harm and spatial cognition that future researchers should continue to clarify.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

CHAPTER I

LITERATURE REVIEW

Deliberate self-harm (DSH) is described as "the deliberate, direct destruction or alteration of body tissue without conscious suicidal intent, but resulting in injury severe enough for tissue damage to occur" (Gratz, 2001, p. 253). Skin-cutting is considered to be the most common self-harming behavior (Briere & Gil, 1998; Klonsky, Oltmanns, & Turkheimer, 2003); however, individuals who self-harm typically engage in multiple methods (Gratz, 2001; Herpertz, 1995). The average age at onset of these behaviors is between 14 and 24 years old (Favazza & Conterio, 1989; Herpertz, 1995; White, Trepal-Wollenzier, & Nolan, 2002). Adult studies have indicated that DSH is equally prevalent among men and women in non-clinical samples (Bebbington et al., 2010; Briere & Gil, 1998; Gollust, Eisenberg, & Golberstein, 2008; Gratz, 2001; Swannell, Martin, Page, Hasking, & St John, 2014). Research suggests that the prevalence of self-harm is gradually increasing (Gratz, 2001; Lion, 1990). Briere and Gil's (1998) study showed a lifetime prevalence of self-harm in adult non-clinical populations of approximately 4% and a prevalence of 21% in the clinical population. de Klerk et al. (2011) reported a prevalence of approximately 54% within the adult clinical population. Favazza (1992) found that 14% of college students had engaged in self-harm at some point in their lives; similarly, Whitlock (2006) found that approximately 17% of college students had engaged in self-harm. However, Gratz (2001) found that approximately 35% of college

students had reported engaging in at least one self-harm incident in their lifetime, and 15% reported engaging in at least 10 incidents throughout their lifetimes.

Characteristics Associated with Self-Harm

Impulsivity. Researchers have identified several characteristics that increase the risk of engaging in self-harm. "The DSM-IV disorders of impulse-control are characterized by a failure to resist an impulse, drive, or temptation to perform a harmful act; there is increasing tension or arousal before the act, and pleasure, relief, or gratification when the act is performed" (Herpertz, Sass, & Favazza, 1997, p. 451). Higher levels of impulsivity were found in female college students who self-harmed as compared to female college students who did not self-harm (Glenn & Klonsky, 2010; Ogle & Clements, 2008). Castille et al. (2007) conducted a study utilizing adult males and females in clinical and nonclinical populations. They reported that the participants who self-harmed expressed a lack of self-control and the inability to adapt appropriately. These participants scored higher on the Insufficient Self-Control/Self-Discipline schema of the Early Maladaptive Schemas questionnaire. Favazza and Conterio (1989) conducted a study detailing the behaviors and characteristics of adult females who frequently self-harmed within the non-clinical population. They discovered that approximately 78% of the participants who engaged in DSH described it as being spontaneous.

Researchers have localized motor and response inhibition to the right prefrontal cortex. Luria's (1966) research involving the prefrontal lobe was related to the inhibition of instantaneous responses and reconditioning behaviors. The right hemisphere has

frequently been linked to the suppression of inappropriate movements and behaviors (Asahi, Okamoto, Okada, Yamawaki, & Yokota, 2004). Garavan, Ross, and Stein (1999) assessed adult male and female participants using fMRI scans. They reported that activation of the right prefrontal cortex positively corresponded with inhibition. Through the utilization of Go/No-Go tasks, researchers have shown that response and motor inhibition activate the right prefrontal cortex (Asahi et al., 2004; Kawashima et al., 1996; Konishi, Nakajima, Uchida, Sekihara, & Miyashita,1998; Liddle, Kiehl, & Smith, 2001). Kawashima et al. (1996) reported that healthy adults displayed greater cerebral flood blow and brain activation within the right frontal lobe during No-Go trials.

Emotion dysregulation. Emotion dysregulation is a common aspect of DSH and indicates an abnormal strategy of reacting to emotions (Armey, Crowther, & Miller, 2011; Haines & Williams, 1997; Klonsky, 2007). Emotion dysregulation is a result of difficulty regulating behaviors when faced with emotional anguish (Gratz & Roemer, 2008). Researchers conclude that individuals engage in self-harm as an adverse emotion regulation strategy when they feel that they do not have access to more effective methods of regulating their emotions (Gratz, 2003; Haines & Williams, 1997). Emotion dysregulation occurs as a result of fluctuations in emotions in response to stressors (Herpertz et al., 1997). Commonly reported stressors include problems in interpersonal functioning (Briere & Gil, 1998; Favazza & Conterio 1989; Haines & Williams, 1997; Kakhnovets, Young, Purnell, Huebner, & Bishop, 2010). In young adulthood, self-harm often occurs as a result of difficult interactions with significant others (Harkess-Murphy, MacDonald & Ramsay, 2013; Hawton et al., 2003).

Gratz and Chapman (2007) conducted a study with male undergraduate students. Their results indicated that emotion dysregulation positively correlated with the repetition of DSH. Gratz and Roemer's (2008) results indicated that female undergraduate participants who exhibited high levels of emotion dysregulation engaged in self-harm more frequently than those who did not. Individuals engage in DSH to relieve overpowering emotions and decrease tension (Gratz, 2001; Klonsky, 2007; Laye-Gindhu & Schonert-Reichl, 2005; Nock & Prinstein, 2004; Nock, Prinstein, & Sterba, 2009). In a sample of non-clinical adults, Davis et al. (2014) found that individuals who engaged in DSH reacted negatively to stressful situations and lacked the ability to appropriately manage their emotions. Kemperman, Russ, and Shearin (1997) conducted a study with a population of inpatient females who had been clinically diagnosed with borderline personality disorder. The researchers evaluated emotions experienced by patients directly after they engaged in DSH. The results indicated that engaging in DSH increased positive emotionality and decreased negative emotionality. Impulsivity is an aspect of emotion dysregulation because it provokes irritability and creates swift changes in attitude (Glenn & Klonsky, 2010; Lynam, Miller, Miller, Bornovalova, & Lejuez, 2011; Taylor, Peterson, & Fischer, 2012). Anestis et al. (2012) reported that, in an adult outpatient population, participants were inclined to react impulsively and engage in DSH to overcome negative affective attitudes.

Feuchtwanger (1923) was one of the first neurologists to localize functions associated with the frontal lobe by studying the effects of frontal lobe damage. He discovered that frontal lobe pathology often increased the likelihood of personality

changes, including emotion dysregulation. Since then, the prefrontal cortex has consistently been found to be instrumental in the ability to express and control emotions (Fuster, 2002). Beer, John, Scabini, and Knight (2006) conducted a study with adult patients with brain lesions and a healthy control group. They reported that the prefrontal cortex regulates emotional impulses and is involved in selecting socially acceptable responses when confronted with emotional stimuli. Emotion regulation has been found to be lateralized within the right hemisphere (Schore, 2009).

Aggression. Similar to impulsivity and emotion dysregulation, higher levels of anger and aggression have been found among individuals who self-harm (Favazza & Conterio, 1989; Herpertz et al., 1997; Klonsky et al., 2003). Klonsky et al. (2003) included military recruits as participants in a study of personality traits. The researchers found that higher levels of aggression were revealed in individuals who engaged in DSH as opposed to those who did not. Researchers conclude that anger and aggression are linked to impulsivity (Herpertz et al., 1997). These characteristics are also associated with emotion dysregulation and incite responses of anger to low-level stimuli (Herpertz et al., 1997). Herpertz et al. (1997) reported that a sample of adult inpatients, diagnosed with personality disorders, expressed their aggression through DSH due to their inability to appropriately express emotions.

The prefrontal cortex has been associated with dispositional anger and aggressive behaviors (Raine, Meloy, Bihrle, Stoddard, LaCasse, & Buchsbaum, 1998; Peterson, Shackman, & Harmon-Jones, 2008). d'Alfonso, van Honk, Hermans, Postma, and de Haan (2000) reported that non-clinical, adult, female participants with greater left frontal

brain activation attended to angry faces, while participants with greater right frontal brain activation withdrew from angry faces. Harmon-Jones and Allen's (1998) study included male and female participants from middle schools and an inpatient unit. The results indicated that individuals who scored higher on measures of dispositional anger exhibited greater left frontal activity as assessed by an EEG. Oder, Goldenberg, Spatt, Podreka, Binder, and Deecke (1993) conducted a study with adult patients who had closed head injuries. The authors reported that lower blood flow in the right frontal lobe was significantly correlated with aggression.

Social isolation. Individuals who self-harm score higher on measures of social isolation, alienation, and detachment than individuals who do not (Castille et al., 2007; Klonsky et al., 2003). High levels of loneliness are predictors of self-harm and increase the odds of engaging in DSH (Castille et al., 2007). Often, individuals who self-harm describe themselves as being "outsiders, strangers, and lone wolves" (Castille et al., 2007, p. 59). Individuals who self-harm score highly on Social Isolation/Alienation and Emotional Deprivation of the Early Maladaptive Schemas (EMS) (Castille et al., 2007). Higher scores on the Social Isolation/Alienation schema show that individuals who self-harm feel as if they do not belong to a social group and may believe that they are different from others. Higher scores on the Emotional Deprivation schema show that individuals who self-harm feel as if they have no emotional support (Castille et al., 2007); these feelings are often precipitated by rejection or separation (Herpertz, 1995). Social Isolation and emotional deprivation lead to feelings of loneliness, isolation, and rejection which trigger self-harm urges for a feeling of immediate, short-term relief (Castille et al.,

2007). Haw and Hawton (2011) reported that individuals who live alone and are more socially isolated are more likely to report higher rates of DSH and suicidal ideation.

Oddy, Humphrey, and Uttley (1978) conducted a study with older adolescent and adult patients who had suffered from closed head injuries. They discovered that frontal lobe injuries led to personality changes in the participants, who became more socially isolated, aggressive, impatient, and irritable. The study conducted by Oder et al. (1993), indicated that greater cerebral blood flow in the left frontal lobe was associated with social isolation.

Theories of Balance and Inhibition

The aforementioned literature review associated characteristics with individuals who self-harm. These characteristics are associated with regional dysfunction in the brain. The regional dysfunction associated with these characteristics may have a cascade of effects within other regions of the brain. The specific effects of the brain dysfunction associated with each characteristic may vary along a longitudinal line.

Donald Tucker proposed a model of hemispheric balance through which contralateral activation results in ipsilateral deactivation (Tyler & Tucker, 1982). This theory posits that deactivation of the right frontal region of the brain would cause an increase in activation in the left frontal region. Diminished inhibition, impulsivity, and emotion dysregulation are associated with reduced levels of activity within the right frontal region. Based on Tucker's theory, impulsivity and emotion dysregulation should result in increased activation within the left frontal region. Therefore, all characteristics associated with self-harm should be localized within the left frontal region of the brain.

Derek Denny-Brown and Chambers (1958) proposed a model of mutual inhibition between the frontal and parietal lobes. They theorized that the frontal lobes are inhibitory in nature, and the parietal lobes are exploratory. Therefore, increased activity and functioning within the frontal lobe would result in decreased activity and functioning within the parietal lobe. Based on the theory of mutual inhibition, increased activity within the left frontal lobe would result in decreased activity within the left parietal lobe.

Through a combination of the theory of hemispheric balance and the theory of mutual inhibition, activation of the left frontal region should result in deactivation of the right frontal region, activation of the right parietal region, and deactivation of the left parietal region.

Relating Characteristics to the Assessments

Given that each of the characteristics related to self-harm have been localized within a specific region of the brain, they should directly relate to brain functioning as measured by assessments that have been shown to tap into functioning associated with this region. The specified characteristics have been localized to the left frontal region of the brain. The purpose of measuring all regions of the brain is to confirm the localizations of the characteristics to the left frontal region through the utilization of Denny-Brown and Chambers theory of mutual inhibition, and Tucker's theory of hemispheric balance.

Brain Functioning

Right frontal. Working memory is known as the ability to hold and manipulate information over a short period of time (Baddeley, 1992). Many researchers have

localized working memory to the lateral prefrontal cortex through lesion studies and electrophysiological recordings (Awh et al., 1996; Bor, Duncan, Lee, Parr, & Owen, 2006; Owen, Evans & Petrides, 1996). Spatial Span is a verbal test of working memory that measures the ability to hold and process a numerical sequence and formulate a response. Spatial Span has been consistently linked to the right prefrontal cortex (Bor et al., 2006; Owen et al., 1996). Bor et al. (2006) conducted a study with adult male patients with brain lesions and a healthy adult control group. They reported that individuals with damage to the right prefrontal cortex were significantly impaired on Spatial Span. Owen et al. (1996) conducted a study with adult healthy participants. They used PET scans to show that blood flow increased in the right prefrontal region throughout the participant's performance on Spatial Span.

Fluency is known as the ability to produce a large number of responses while minimizing repetitive responses (Ruff, Allen, Farrow, Niemann, & Wylie, 1994). Jones-Gotman, and Milner (1977) conducted a study with adult patients with brain lesions and a healthy control group. The results indicated that patients with right frontal lesions were more impaired on tasks measuring figural fluency. The Ruff Figural Fluency Test (RFFT) is a test of figural fluency that requires the ability to shift set, plan, and coordinate. Ruff et al. (1994) reported that patients with right frontal lesions produced the fewest number of designs and were within the impaired range on the task.

Left frontal. The left frontal region of the brain is associated with executive functioning and verbal fluency (Benton, Hamsher, Sivan, 1994). Cantor-Graae, Warkentin, Franzen, and Risberg (1993) reported that regional cerebral blood flow was

increased in the left frontal region during tasks measuring verbal fluency and executive functioning in healthy adult participants. Cuenod et al. (1995) reported that greater word generation was associated with higher levels of brain activity within the left frontal region in healthy adult participants. Patients with left frontal lesions produce lower word generation and are commonly impaired on phonemic tasks (Janowsky, Shimamura, Kritchevsky, & Squire, 1989; Milner, 1982). Baldo, Schwartz, Wilkins, and Dronkers (2006) mapped lesions in stroke patients and discovered that poor word generation during category fluency tasks was associated with lesions in the left temporal region. The Controlled Oral Word Association Test (COWAT) is one of the most commonly used measures of phonemic fluency. Stuss et. al (1998) reported that adult patients with brain lesions in the left frontal region were impaired on the COWAT in comparison to a healthy control group. Further, they reported that damage to the right frontal region of the brain did not hinder performance on the COWAT. Wood, Saling, Abbott, and Jackson (2001) found that greater word generation during the COWAT correlated with greater activation of the left frontal region of the brain.

The Trail Making Test (TMT) is a measure of executive functioning associated with the left frontal region of the brain (Reitan, 1971). The TMT requires cognitive flexibility and the ability to shift attention (Jacobson, Blanchard, Connolly, Cannon, & Garavan, 2011). Researchers have used fMRI scans to observe activation within the left prefrontal cortex during the set-shifting task on the TMT (Jacobson et al., 2011; Moll, de Oliveira-Souza, Moll, Bramati, & Andreiuolo, 2002; Zakzanis, Mraz, & Graham, 2005)

Left posterior. The left posterior region of the brain is associated with semantic fluency. Mummery, Patterson, Hodges, and Wise (1996) and Gourovitch, Kirkby, Goldberg, and Weinberger (2000) used PET scans to measure cerebral blood flow. They reported that greater blood flow in the left temporal lobe correlated with higher scores on semantic fluency tasks.

Additionally, the left posterior region of the brain has been associated with object naming. Warrington (1995) reported that adult patients with left posterior lesions performed poorly on object-naming tasks. Benson et. al (1999) conducted functional MRI and Wada testing on healthy adults to assess brain activation during verbal tasks. They observed that there was greater activation in the left hemisphere during the Boston Naming Test (BNT). Ojemann and Whitaker (1978) utilized cortical stimulation to measure brain activation during a variety of verbal tasks, including object naming. They reported that the left temporal region was associated with naming images of objects.

Right posterior. The right posterior region of the brain is associated with spatial cognition (Heilman, Watson, & Valenstein, 1993; Ng et al., 2000). Researchers have indicated that patients with right hemisphere damage were more impaired on tasks involving the visual perception of a line in comparison to patients with left hemisphere damage (Benton, Hannay, & Varney, 1975; Benton, Varney, & Hamsher, 1978; Treccani, Torri, & Cubelli, 2005). The Benton Judgement of Line Orientation Test (JLO; Benton, Hamsher, Varney, & Spreen, 1983) is a test that assesses visual-spatial processing. Benton et al. (1978) and Hamsher, Capruso, and Benton (1992) reported that patients with right parietal lesions were impaired on the JLO. Deutsch, Bourbon, Papanicolaou,

and Eisenberg (1988) utilized adult, healthy participants to measure cerebral blood flow during the JLO. They reported that the right parietal region was significantly activated throughout this test.

Right posterior damage has been linked to left spatial neglect (Ferber & Karnath, 2001; Suchan, Rorden, & Karnath, 2012; Treccani et al., 2005). Spatial neglect refers to individuals who are unable to attend to stimuli in space that is contralateral to a brain lesion (Ferber & Karnath, 2001). Left spatial neglect is a visual-spatial impairment that has been linked to right posterior damage in several studies (Ferber & Karnath, 2001; Treccani et al., 2005). A commonly administered test to assess spatial neglect is the line bisection test (Heilman & Valenstein, 1979). Patients with right posterior lesions were significantly more likely to displace the bisection toward the right portion of a line (Heilman & Valenstein, 1979; Mark, Barton & Black, 1999).

Summary and Purpose of the Current Study

Researchers have been able to identify multiple characteristics in individuals that are associated with the likelihood of engaging in self-harm. Higher levels of impulsivity have been identified in individuals who self-harmed throughout many studies (Favazza & Conterio, 1989; Glenn & Klonsky, 2010; Ogle & Clements, 2008). Utilization of tasks to assess inhibition have revealed that poor performance is associated with right prefrontal dysfunction (Asahi, et al., 2004; Kawashima et al., 1996; Konishi et al.,1998; Liddle et al., 2001). Based on Donald Tucker's theory, impulsivity should be associated with increases in activity in the left frontal region of the brain.

Emotion dysregulation is a common aspect of DSH (Armey, Crowther, & Miller, 2011; Haines & Williams, 1997; Klonsky, 2007). Regulation of emotions has been found to be lateralized within the right prefrontal region of the brain (Schore, 2009). Therefore, emotion dysregulation should be associated with the left frontal region. Higher levels of anger and aggression have been found among participants who self-harmed (Favazza & Conterio, 1989; Herpertz et al., 1997; Klonsky et al., 2003). These characteristics have been localized in the left frontal region of the brain (d'Alfonso et al., 2000; Harmon-Jones & Allen, 1998).

Individuals who self-harm score higher on measures of social isolation, alienation, and detachment (Castille et al., 2007; Klonsky et al., 2003). Oder et al. (1993) reported that greater cerebral blood flow in the left frontal region was associated with social withdrawal.

Based on the theories of hemispheric balance and mutual inhibition, the left frontal and right parietal regions of the brain should show the most activation and result in higher levels of functioning in participants who have self-harmed within the past three years; the right frontal and left parietal regions should show less activity and result in lower levels of functioning in participants who have self-harmed within the past three years. Levels of functioning will be measured with the use of assessments that have been shown to tap into skills associated with specific areas of the brain.

The purpose of the current study was to investigate how characteristics associated with self-harm related to brain activation/deactivation within the frontal and parietal lobes and how this pattern differed between groups of individuals who self-harmed

within the past three years (Within Group), individuals who self-harmed over three years ago (Over Group), and individuals who never self-harmed (Never Group). Based on previous research identifying characteristics and their localization within the left frontal region of the brain, it is likely that individuals who exhibited self-harming behaviors within the past three years experienced increased levels of activation within this region.

Therefore, it was predicted that participants in the Within Group would not perform as well as individuals in the Over and Never Groups on tasks that tapped into right frontal functioning (i.e., Spatial Span and the RFFT) and left parietal functioning (i.e., Animal Naming and the BNT). It was also predicted that participants in the Within Group would perform better than individuals in the Over and Never Groups on tasks that tapped into left frontal functioning (i.e., the COWAT and the TMT) and right parietal functioning (i.e., the JLO and the Line Bisection test).

CHAPTER II

METHOD

Participants

The total sample consisted of 45 female and 20 male students enrolled at Middle Tennessee State University. This sample of participants was gathered from undergraduate psychology courses and the Research Pool. The ages of the participants in the total sample ranged from 18 to 36 (*M* = 21.95, *SD* = 3.38). The Never Group was composed of 27 females and 11 males with an average age of 21.74 (*SD* = 2.33). The Over Group was composed of 8 females and 4 males with an average age of 22.33 (*SD* = 4.68). The Within Group was composed of 10 females and 5 males with an average age of 22.20 (*SD* = 4.52). Individuals who reported hearing or visual impairments diagnosed by a medical professional were excluded from participation. Individuals with a history of concussions and loss of consciousness also were excluded.

Measures

Demographics. A brief demographics questionnaire was completed by each participant, assessing gender, ethnicity, grade, etc. (see Appendix A).

Beck Depression Inventory. The Beck Depression Inventory- Second Edition (BDI-II; Beck, Steer & Brown, 1996) was developed to assess the severity of self-reported depression in adolescents and adults. The inventory is composed of 21 self-report questions. Each item has four response options that are scored from 0 to 3. The score from each item is added to create a total score. The maximum total score is 63 with higher scores reflecting greater severity of depressive symptoms. Raw scores that range

from 0 to 13 reflect minimal depression, 14 to 19 reflect mild depression, 20 to 28 reflect moderate depression, and 29 to 63 reflect severe depression (Beck et al., 1996). The BDI-II is normed on individuals aged 13 years and older. It has an internal consistency reliability score ranging of .93 (Beck et al., 1996). The BDI-II is correlated with other depression-related measures, such as the Structured Clinical Interview for DSM-IV Axis I Disorders (.83; Sprinkle et al., 2002). The dependent variable was the total raw score.

Beck Anxiety Inventory. The Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988) was developed to assess the severity of self-reported anxiety in adolescents and adults. The inventory is composed of 21 self-report questions with a required duration of 2 weeks. Each item has four response options that are scored from 0-3. The highest score from each item is added up to create a total score. The maximum total score is 63 and higher scores reflect greater severity of anxiety symptoms. Raw scores that range from 8-15 reflect mild anxiety, 16-25 reflect moderate anxiety, and 26-63 reflect severe anxiety (Beck et al., 1988). The BAI is normed on individuals aged 12-80. It has an internal consistency reliability score of .92 and a test-retest reliability score of .75 (Beck et al., 1988). The BAI is moderately correlated with the Hamilton Anxiety Rating Scale (.51; Beck et al., 1988). The dependent variable of the BAI was the total score.

Deliberate Self-Harm Inventory. The Deliberate Self-Harm Inventory (DSHI; Gratz, 2001) was developed to assess the frequency, severity, duration, and type of behaviors associated with self-harm. This inventory is composed of 17 behaviorally-based self-report questions established on the definition of self-harm as the "deliberate,

direct destruction or alteration of body tissue without conscious suicidal intent, but resulting in injury severe enough for tissue damage to occur" (Gratz, 2001, p. 253). The types of self-harm being assessed were chosen as a result of clinical observations, self-reports by individuals, and literature review. The DSHI has an internal consistency reliability coefficient of .82. (Gratz, 2001, p. 253).

The participants were placed into one of three groups based on their responses on the Deliberate Self-Harm Inventory: individuals who have self-harmed within the past three years (Within Group), individuals who self-harmed over three years ago (Over Group), and individuals who have never self-harmed (Never Group). Affirmative answers on any of the 17 questions determined if participants were placed into the group of individuals who self-harmed within the past three years or over three years ago. Negative answers on all 17 questions determined placement in the never having self-harmed group. The DSHI has an internal consistency reliability coefficient of .82. (Gratz, 2001, p. 253).

Spatial Span. Spatial Span was developed as part of the Wechsler Memory Scale-3rd Edition (SS; Wechsler, 1997). This task involves the ability to hold and process a numerical sequence in working memory and formulate a response. The sequence becomes more difficult with subsequent trials and has a forward and backward component which are combined to form the total score. Spatial Span is normed on individuals aged 16-89. It has an internal consistency reliability coefficient of .79 (Tulsky, Zhu, & Ledbetter, 1997). The dependent variables were the raw scores of the

forward and backward trials, and the total raw score of the combined sum of the forward and backward raw scores.

Ruff Figural Fluency Test. The Ruff Figural Fluency Test (RFFT; Ruff, 1996) was developed to assesses the non-verbal ability to shift set, plan, and coordinate. The RFFT involves five parts consisting of 60-second intervals. The participants were required to draw as many unique designs as possible by connecting a series of dots. The dots are presented in 35 five-dot matrices that are arranged in a five by seven square grid. The participant's score was calculated by summing the total number of unique designs that are created. A perseverative error score represents the number of created patterns that are repeated. The RFFT is normed on individuals from ages 7 to 70 years old. It has a test-retest reliability of .76 (Ruff, Light, & Evans, 1987). The dependent variables were the total number of unique designs, the total number of errors, and the error ratio.

Controlled Oral Word Association Test. The Controlled Oral Word Association Test (COWAT; Benton et al., 1994) assesses phonemic fluency. The COWAT required participants to spontaneously produce words verbally in a limited amount of time for three different letters. The participants were given 60 seconds per trial and were prohibited from saying proper names or numbers and from using the same word with different endings. The total score was based on the number of spontaneously given words that do not violate the rules. Words that were repetitions or intrusions were not counted toward the total score but are noted for reference. The COWAT is normed on individuals ages 7 to 95 for the letters "F", "A", and "S". The COWAT has an internal reliability score of .83 and a test-retest reliability score of .70 (Strauss, Sherman, &

Spreen, 2006). The dependent variable was the total number of spontaneously given words.

Trail Making Test. The Trail Making Test (TMT; Reitan, 1955) assesses attention, speed, and mental flexibility. It is composed of two parts during which participants were required to connect encircled numbers in Part A and encircled numbers and letters in alternating order in Part B. Part B is typically given a time limit of 300 seconds in order to avoid frustration. The adult version of the TMT is normed on individuals ages 15 to 89. The TMT has a test-retest reliability of .46-.79 for Part A and .44-.89 for Part B in non-clinical settings. Inter-rater reliability is reported to be .94 for Part A and .90 for Part B (Strauss et al., 2006). The dependent variables were the amount of time (in seconds) taken to complete each part (A and B).

Animal Naming. Animal Naming (AN; Benton et al., 1994) assesses semantic fluency. The participants were asked to spontaneously produce as many animal names as possible in a 60 second time period. The total score was based on the number of spontaneously given names that are not proper names, repetitions, or intrusions. Animal Naming is normed on individuals ages 7 to 95. It has a test-retest reliability of .70 (Strauss et al., 2006). The dependent variable was the total number of spontaneously given animals.

Boston Naming Test. The Boston Naming Test - 2 (BNT-2; Kaplan, Goodglass, & Weintraub, 2001) assesses the ability to visually name common objects. The BNT is composed of 60 items which include increasingly difficult line drawings of common objects. For non-aphasic adults, the starting point on the BNT is item 30. An individual

must produce 8 correct responses on the first eight items, and if not, the administrator reverses until the participant receives a consecutive score of 8. If the participant misperceived the item, they were provided with a stimulus cue. If the participant was unable to name the object, a phonemic cue was given. The total score included the number of spontaneously correct responses and the number of correct responses given after a stimulus cue. The BNT is normed on individuals ages 18 years and older. Internal consistency has been reported to be between .78-.96 (Strauss et al., 2006). The dependent variable was the total number of correctly named objects.

Judgement of Line Orientation Test. The Judgement of Line Orientation Test (JLO; Benton, Hamsher, Varney, & Spreen, 1994) is used to measure spatial perception and orientation. Stimuli appear in the bottom half of a bound booklet and multiple choice appear in the top half. The participants were required to identify two lines from the multiple choice portion that match the lines from the stimulus portion. The total score included the total number of correct responses. The JLO is normed on individuals ages 7 to 96. Split-half reliability ranges from .84-.91 (Strauss et al., 2006). The dependent variable was the total raw score.

Line Bisection Test. The Line Bisection Test (LBT, Albert, 1973) is administered to assess spatial neglect. The participants were required to divide a horizontal line at its perceived center point. The participants were given 5 sheets of paper with 1 line per page. The total score included the average length by which the participant's perceived center deviated from the actual center. Spatial neglect presents as marks consistently displaced to the contralateral side of a damaged hemisphere (Strauss et al., 2006). The

dependent variable was the number in millimeters that the perceived center deviated from the actual center.

Procedure

Informed consent was gathered from all participants involved in the study (see Appendix C). The participants were placed into one of three groups based on their responses on the Deliberate Self-Harm Inventory (see Appendix B): individuals who have self-harmed within the past three years (Within Group), individuals who have self-harmed over three years ago (Over Group), and individuals who have never self-harmed (Never Group). All tests were administered in counterbalanced order and in adherence to standardized procedures.

CHAPTER III

RESULTS

Descriptive Statistics

Table 1 provides information regarding the descriptive statistics for the percentage of participants who engaged in each method of self-harm as defined by the DSHI.

Preliminary Analyses

Initial analyses using ANOVA were conducted to ensure groups were equivalent in terms of levels of anxiety and depression, as measured by the BAI and BDI-II, and age. The results indicated that the level of anxiety did not differ between groups, $F(2,62) = 1.85$, $p = .167$, nor did age $F(2,62) = 0.19$, $p = .829$. A Chi-square test was conducted to ensure that the groups were equivalent in terms of gender. The results indicated that gender did not significantly differ between groups, $\chi 2(2, N = 65) = 0.14$, $p = .931$. The level of depression significantly differed between groups, $F(2,62) = 8.73$, $p < .01$. Given the significant differences in depression between the groups, the scores from the BDI-II were entered as a covariate in all subsequent analyses to control for any potentially confounding influence of depression. See Table 2 for the descriptive statistics for the BDI-II and BAI scores for each of the three groups.

Primary Analyses

To examine the hypothesis that the Within Group would perform worse than the Over and Never Groups on measures of right frontal lobe functioning and left parietal

functioning, a series of One Way Between-Groups ANCOVAs were conducted based on the measures of right frontal and left parietal functioning. The results indicated that no significant differences existed between the groups on measures of right frontal lobe functioning. Specifically, no significant difference was noted between the Within, Over, and Never groups on SS, $F(2,61) = 1.91$, $p = .157$, $R^2 = .092$ or the RFFT, $F(2,61) = 0.54$, $p = .584$, $R^2 = .039$. Analyses did not indicate significant differences between the groups on measures of left parietal functioning. Specifically, no significant differences were noted between the groups on AN, $F(2,61) = 1.28$, $p = .284$, $R^2 = .043$ or the BNT, $F(2,61) = 0.76$, $p = .470$, $R^2 = .024$. Consult Table 2 for the means and standard deviations.

To examine the hypothesis that the Within Group would perform better than the Over and Never Groups on measures of left frontal lobe functioning and right parietal functioning, a series of One Way Between-Groups ANCOVAs were conducted based on the measures of left frontal and right parietal functioning. The results indicated that no significant differences existed between the groups on any measure of left frontal lobe functioning. Specifically, no significant difference was noted between the Within, Over, and Never groups on the COWAT, $F(2,61) = 1.64$, $p = .203$, $R^2 = .053$ or the TMT, $F(2,61) = 0.78$, $p = .462$, $R^2 = .031$. Analyses did not indicate significant differences between the groups on one measure of right parietal functioning. Specifically, no significant differences were noted between the groups on the JLO, $F(2,61) = 0.99$, $p = .377$, $R^2 = .052$. However, the results indicated that there was a significant difference between groups on the Line Bisection Test, $F(2,61) = 3.21$, $p = .047$, $R^2 = .096$. Further analyses indicated that participants in the Within Group bisected the line significantly

further to the left than individuals in the Never Group, $F(1,50) = 6.01$, $p = .018$, $R^2 = .109$. Analyses did not indicate significant differences between the Within and Over Groups, $F(1,47) = 0.24$, $p = .624$, $R^2 = .021$, or between the Over and Never Groups, $F(1,24) = 2.76$, $p = .110$, $R^2 = .105$. Consult Table 2 for the means and standard deviations.

Supplementary Analyses

An ANOVA was conducted to assess potential differences in scores on Part A and Part B of the TMT. The results did not indicate significant differences between these scores for each group, $F(2,61) = 1.95$, $p = .151$, $R^2 = .094$.

Due to the small number of participants in the Within and Over Groups, there exists a high likelihood that the data were not normally distributed and would therefore have violated the assumption of normality for the ANCOVA. Hence, a Kruskal-Wallis test was conducted to examine for group differences.

The results indicated that no significant differences existed between the groups on measures of right frontal lobe functioning. Specifically, no significant difference was noted between the Within, Over, and Never groups on SS, $\chi2(2, N = 65) = 2.09$, $p = .352$, or the RFFT, $\chi2(2, N = 65) = 0.95$, $p = .623$. Analyses did not indicate significant differences between the groups on measures of left parietal functioning. Specifically, no significant differences were noted between the groups on AN, $\chi2(2, N = 65) = 2.50$, $p = .287$, or on the BNT, $\chi2(2, N = 65) = 2.61$, $p = .272$. Consult Table 3 for the mean rank.

The results indicated that no significant differences existed between the groups on any measure of left frontal lobe functioning. Specifically, no significant difference was noted between the Within, Over, and Never groups on the COWAT, $\chi 2(2, N = 65) = 2.07$, $p = .355$ or the TMT, $\chi 2(2, N = 65) = 0.85$, $p = .653$. Analyses did not indicate significant differences between the groups on one measure of right parietal functioning. Specifically, no significant differences were noted between the groups on the JLO, $\chi 2(2, N = 65) = 3.48$, $p = .176$ or the Line Bisection Test, $\chi 2(2, N = 65) = 3.50$, $p = .174$. Consult Table 3 for the mean ranks by tool.

CHAPTER IV

DISCUSSION

The purpose of the current study was to investigate how characteristics associated with self-harm related to brain activation/deactivation within the frontal and parietal lobes and how this pattern differed between three groups of participants who were grouped according to if and when they had engaged in self-harm.

Research has indicated that certain personality characteristics, including impulsivity (Favazza, 1992; Favazza & Conterio, 1989; Klonsky et al., 2003), emotion dysregulation (Haines & Williams, 1997), higher levels of anger and aggression (Favazza & Conterio, 1989; Herpertz et al., 1997; Klonsky et al., 2003), and social isolation, alienation, and detachment (Castille et al., 2007; Klonsky et al., 2014) are associated with the likelihood of engaging in self-harm. These characteristics have been linked to greater levels of activation within the left frontal region of the brain (Garavan et al., 1999; Harmon-Jones & Allen, 1998; Kawashima et al., 1996; Oder et al., 2009; Schore, 2009).

Based on the theories proposed by Donald Tucker (Tyler & Tucker, 1982) and Derek Denny-Brown and Chambers (1958), it was predicted that individuals who reported engaging in self-harm within the past three years (Within Group) would perform better on tasks that tap into the left frontal region and right parietal region of the brain and not perform as well on tasks that tap into the right frontal region and left parietal region of the brain, as compared to individuals who reported engaging in self-harm more than three years ago (Over Group) or who have never engaged in self-harm (Never Group).

Contrary to the hypotheses, the results indicated no significant difference between the groups regarding performance on tests of left and right frontal lobe functioning and left parietal lobe functioning. Nonsignificant results may suggest that these tasks are not related to characteristics associated with self-harm, and there may not be an association between self-harm and brain functioning in these areas.

A significant difference did emerge on one of the measures of right parietal lobe functioning. Specifically, a significant difference between groups on the Line Bisection Test was found. Participants in the Within Group bisected the line further to the left than individuals in the Never Group. Typically, individuals indicate a leftward spatial bias in global attention on visuospatial tasks that tap into right parietal functioning (Zago et al., 2017). Therefore, the Within Group may be exhibiting relative right parietal activation as their attention is pushed more to the left than the Never Group on the Line Bisection Test. However, this finding is tempered by the fact that a supplementary analysis using the Kruskal-Wallis test did not indicate significant differences between groups. A Kruskal-Wallis test was used to analyze the data due to concerns about the low sample size and a possible violation of the normality assumption of the ANOVA. A larger sample size may help to clarify these findings.

There are some limitations to this study that should be considered. Although the DSHI contained questions regarding the frequency of self-harming behaviors, frequency was not considered in assigning participants to groups. Participants were grouped based on the timing of the last occurrence of self-harm. This study utilized a three year cut-off to determine the groups of participants; however, the three year cut-off was due to time

constraints and the low number of participants who had recently engaged in self-harm. The frontal lobe of the brain develops over time and is typically the last region to reach maturation (Casey, Giedd, & Thomas, 2000). Therefore, changes in brain development and activity may have occurred since the last instance of self-harm. Perhaps a stronger relationship would have emerged if groups were assigned based on frequency and more recent occurrences of self-harming behaviors.

Additionally, one of the functions of self-harm listed in the DSHI is head-banging to the point of forming a bruise. Head trauma to this extent could be enough to damage brain tissue and affect brain functioning. Therefore, in a future study, researchers may want to exclude participants who engaged in head banging for more valid results.

Further, this study defined DSH as "the deliberate, direct destruction or alteration of body tissue without conscious suicidal intent, but resulting in injury severe enough for tissue damage to occur" (Gratz, 2001, p. 253). Hawton, Zahl, and Weatherall (2003) conducted a study to determine the risk of suicide following self-harm. Their results indicated that individuals aged 10-24, who had previously engaged in self-harm, were significantly more likely to commit suicide. Therefore, suicidal intent could have been present at the time that participants engaged in self-harm, prohibiting them from endorsing some items on the DSHI. The DSHI relied on the student's accuracy and truthfulness regarding the type, frequency, and duration of self-harming behaviors. Although students were given extra credit for their participation, they had no extrinsic motivation to put forth their best effort on assessments or be truthful on self-reports.

Finally, participants were recruited from individuals enrolled in psychology courses at Middle Tennessee State University. The participants were over the ages of 18 years old, which limits the scope of this study to an adult population. Two of the composed groups had small sample sizes, which may have decreased the reliability and validity of results. Future researchers may wish to gather participants from an adolescent population, since the average age at onset of these behaviors is between 14 and 24 years old (Favazza & Conterio, 1989; Herpertz, 1995; White et al., 2002).

In conclusion, the purpose of the current study was to investigate how certain personality characteristics linked to self-harm related to brain activation/deactivation within the frontal and parietal lobes. The results were non-significant, with the exception of one assessment tool pertaining to the right parietal lobe. Participants in the Within Group bisected their lines further to the left than participants in the Never Group. These results could indicate that individuals who have recently self-harmed may perform better on tasks requiring them to quickly orient their attention, process global information, and mentally manipulate spatially oriented objects.

Future research regarding self-harm and brain functioning is necessary to determine the potential risks of self-harm and to aid in treatment planning. A larger study with a younger population may help to increase the reliability and validity of results. It is important that research is gathered on participants who self-harmed more recently than three years as the brain pathways are likely to change with time, especially in a younger population. This study included characteristics previously identified by researchers as being associated with the likelihood of engaging in self-harm. However, further research

into the characteristics specified by this study and other potential characteristics may make a difference in a future study. Different methodologies may also impact the effectiveness of a future study.

Greater activation of the right parietal lobe has been linked to multiple functions throughout fMRI and PET studies. Research has shown that the right parietal lobe is associated with the orientation of attention, global perceptual processing, and the mental manipulation of spatially oriented objects. Corbetta, Kincade, Ollinger, McAvoy, and Shulman (2000) conducted an fMRI study with a non-clinical adult sample. They observed greater activation within the right parietal lobe when participants reoriented their attention to a stimulus. Additionally, Fink et al. (1997) conducted a study with healthy adult male volunteers. Using PET scans, the examiners observed regional cerebral blood flow in response to focal and global features of stimuli. With the use of complex figures, they determined that the discrimination of global features resulted in greater right parietal activation. Finally, right parietal activation was associated with better performance on tasks requiring individuals to mentally manipulate objects in space (Harris et al., 2000). Assessments that measure these functions may prove useful in establishing a future link between self-harm and brain function.

Researchers have identified hemispheric differences in propositional speech and affective speech. Nagae and Moscovitch (2002) conducted a visual field study utilizing adult undergraduate students. Their research indicated that emotional words, whether negative or positive, presented to the left visual field were more accurately recognized. Further, emotional words were better recalled subsequent to being presented to the left

visual field, which projects to the right hemisphere of the brain. The right temporoparietal region of the brain has been associated with perceiving and processing emotional prosody, or intonation. Heilman, Scholes, and Watson (1975) compared the functioning of patients with left temporoparietal lesions and patients with right temporoparietal lesions. Their results indicated that the patients with right temporoparietal lesions were unable to identify the emotional mood of a speaker. Therefore, greater activation of the right temporoparietal region should result in an enhanced ability to comprehend emotion in speech. Individuals who self-harm may be reacting to the emotional speech of others in a detrimental manner. Future researchers may wish to investigate these connections given the findings of the current study.

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APPENDICES

APPENDIX A

DEMOGRAPHIC FORM

Subject History and Demographics

Participant Number: _____

Date of Birth: _____

Date of Study: _____

Sex: _____

Age: _____

Height: _____

Weight: _____

Handedness: _____

Level of Education: _____

History of significant head injury (meaning loss of consciousness)? Y / N

If yes, then explain. How long was the loss of consciousness?

History of neurological or psychological / psychiatric illness? Y / N

If yes, then explain.

Currently taking psychotropic medications? Such as medication for depression or anxiety?

Y / N

If yes, then explain. What medication?

APPENDIX B

DELIBERATE SELF-HARM INVENTORY

This questionnaire asks about a number of different things that people sometimes do to hurt themselves. Please be sure to read each question carefully and respond honestly. Often, people who do these kinds of things to themselves keep it a secret, for a variety of reasons. However, honest responses to these questions will provide us with greater understanding and knowledge about these behaviors and the best way to help people. Please answer yes to a question only if you did the behavior intentionally, or on purpose, to hurt yourself. Do not respond yes if you did something accidentally (e.g., you tripped and banged you head on accident). Also, please be assured that your responses are completely confidential.

1. Have you ever intentionally (i.e., on purpose) cut your wrist, arms, or other area(s) of your body (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

2. Have you ever intentionally (i.e., on purpose) burned yourself with a cigarette (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

3. Have you ever intentionally (i.e., on purpose) burned yourself with a lighter or a match (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

4. Have you ever intentionally (i.e., on purpose) carved words into your skin (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

5. Have you ever intentionally (i.e., on purpose) carved pictures, designs, or other marks into your skin (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

6. Have you ever intentionally (i.e., on purpose) severely scratched yourself, to the extent that scarring or bleeding occurred (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

7. Have you ever intentionally (i.e., on purpose) bit yourself, to the extent that you broke the skin (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

8. Have you ever intentionally (i.e., on purpose) rubbed sandpaper on your body (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

9. Have you ever intentionally (i.e., on purpose) dripped acid onto your skin (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

10. Have you ever intentionally (i.e., on purpose) used bleach, comet, or oven cleaner to scrub your skin (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

11. Have you ever intentionally (i.e., on purpose) stuck sharp objects such as needles, pins, staples, etc. into your skin, not including tattoos, ear piercing, needles used for drug use, or body piercing (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

12. Have you ever intentionally (i.e., on purpose) rubbed glass into your skin (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

13. Have you ever intentionally (i.e., on purpose) broken your own bones (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

14. Have you ever intentionally (i.e., on purpose) banged your head against something, to the extent that you caused a bruise to appear (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

15. Have you ever intentionally (i.e., on purpose) punched yourself, to the extent that you caused a bruise to appear (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

16. Have you ever intentionally (i.e., on purpose) prevented wounds from healing (without intending to kill yourself)? (circle one):

Yes No

If yes,

How many times have you done this? _____

When was the last time you did this? _____

17. Have you ever intentionally (i.e., on purpose) done anything else to hurt yourself that was not asked about in this questionnaire (without intending to kill yourself)? (circle one):

Yes No

How many times have you done this? _____

When was the last time you did this? _____

APPENDIX C

INFORMED CONSENT SCRIPT

Principal Investigator: Victoria Fox
Study Title: An Examination of the Relationship Between Characteristics Associated with Self-Harm and Brain Function
Institution: Middle Tennessee State University

Name of participant: _____Age: _____

The following information is provided to inform you about the research project that you are participating in. Please read this form carefully and feel free to ask any questions you may have about this study and the information given below. You will be given an opportunity to ask questions, and your questions will be answered. Also, you will be given a copy of this consent form.

Your participation in this research study is voluntary. You are free to withdraw from this study at any time. In the event new information becomes available that may affect the risks or benefits associated with this research study or your willingness to participate in it, you will be notified so that you can make an informed decision whether or not to continue your participation in this study.

For additional information about giving consent or your rights as a participant in this study, please feel free to contact the MTSU Office of Compliance at (615) 494-8918.

1. **Purpose of the study:** The purpose of the current study is to investigate how characteristics associated with self-harm influence brain activation/deactivation within the frontal and parietal lobes and how this differs between groups (individuals who have self-harmed within the past year, individuals who have self-harmed over one year ago, individuals who have never self-harmed).

2. **Description of procedures to be followed and approximate duration of the study:** The study we are doing will take you approximately 60-90 minutes to participate. During that time, you will be answering questions about some behaviors that people might engage in to purposefully hurt themselves. Afterwards, you will fill out a couple of inventories detailing what your mood has been like for the past couple of weeks. You will also be asked to perform some tasks that assess memory, visuospatial functioning, and verbal functioning.

3. **Expected costs:** There are no costs to you for your participation**.**

4. **Description of the discomforts, inconveniences, and/or possible risks that can be reasonably expected as a result of participation in this study:** The risk of participation in this study is minimal. Some individuals may be uncomfortable answering questions or talking about their thoughts and feelings regarding self-harming behaviors. If you do not wish to continue, there will be no negative consequences.

5. **Compensation in case of study-related injury:** MTSU will not provide any compensation in the case of study-related injury.

6. **Anticipated benefits from this study:**

a) The potential benefits to science and humankind that may result from this study are that we may gain an increasing understanding of how characteristics related to self-harm may affect cognitive functioning. This kind of information could help identify early risk factors for intervention that could prevent the development of self-harming behaviors.
b) The potential benefits to you from this study are that you will gain a better understanding of how research is conducted and you will earn extra-credit points for your course.

7. Alternative treatments available: Not Applicable.

8. Compensation for participation: None.

9. **Circumstances under which the Principal Investigator may withdraw you from study participation:** Non-compliance with the study procedures and failure to comply with instructions. Also, you may be withdrawn if you have any history of significant head injury, neurological illness, or are taking a psychotropic medication.

10. **What happens if you choose to withdraw from study participation:** Participation in this study is strictly voluntary and there are no penalties for refusing to participate. There are no consequences from withdrawing from the study. The paticipants may choose to withdraw from the study at any point.

11. **Contact Information.** If you should have any questions about this research study or possible injury, please feel free to contact Paul S. Foster at 898-2007.

12. Confidentiality. All efforts, within reason, will be made to keep the personal information in your research record private but total privacy cannot be promised. Your information may be shared with MTSU or the government, such as the Middle Tennessee State University Institutional Review Board, Federal Government Office for Human Research Protections, *if* you or someone else is in danger or if we are required to do so by law.

14. **STATEMENT BY PERSON AGREEING TO PARTICIPATE IN THIS STUDY**

I have read this informed consent document and the material contained in it has been explained to me verbally. I understand each part of the document, all my questions have been answered, and I give permission for my child to participate in the study.

Date	Signature of patient/volunteer
Date	Signature of student researcher
Date	Signature of faculty researcher

APPENDIX D

DEBRIEFING LETTER

Thank you for participating in our study about self-harm and brain functioning. We hope to learn some interesting things about how characteristics associated with self-harm may affect brain functioning. The kinds of questions and activities you participated in will help us to figure out this potential relationship. If you have any questions or concerns about the study, please contact me (Victoria Fox) by email vef2b@mtmail.mtsu.edu.

If after participating in the study you have concerns about self-harming behaviors, the following resources have professionals who might be able to help you. Feel free to contact any of these service providers directly should you want help with self-harming behaviors or suicidal ideation.

National Suicide Prevention Lifeline:
1-(800)273-8255

The Guidance Center/Volunteer Behavioral
118 North Church Street
Murfreesboro TN 37130
Phone: (615) 893-0771 or 890-4622

APPENDIX E

TABLES

Table 1
Descriptive statistics for the method of self-harm by group

	Total Sample*	Never*	Over Three Years*	Within Three Years *
	%	*%*	*%*	*%*
Cutting	70.4	0	83.3	60.0
Burned with a Cigarette	3.70	0	0	6.67
Burned with a Lighter/Match	11.1	0	0	20.0
Carved Words	25.9	0	16.7	33.3
Carved Pictures	18.5	0	25.0	13.3
Scratched	33.3	0	50.0	20.0
Bit	11.1	0	0	20.0
Rubbed Sandpaper	0	0	0	0
Dripped Acid	3.70	0	0	6.67
Used Bleach/Comet/Oven Cleaner	0	0	0	0
Stuck Sharp Objects	7.41	0	0	13.3
Rubbed Glass	0	0	0	0
Broken Bones	0	0	0	0
Banged Head	18.5	0	16.7	20.0
Punched Self	29.6	0	25.0	26.7
Prevented Wound Healing	14.8	0	0	26.7
Other	37.0	0	8.33	53.3

*Total Sample: $n = 65$; Never: $n = 38$; Over Three Years: $n = 12$; Within Three Years: $n = 15$

Table 2
Descriptive statistics for assessments by group

	Total Sample*		Never*		Over Three Years*		Within Three Years *	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
BDI-II	9.95	7.69	7.32	5.84	10.7	6.56	16.1	9.32
BAI	8.80	8.60	7.32	6.89	9.17	8.52	12.3	11.7
SS Total	15.9	3.51	15.7	3.56	17.6	4.12	15.1	2.49
SS Forward	9.54	1.80	9.37	1.84	10.4	1.83	9.27	1.58
SS Backward	6.37	2.30	6.34	2.34	7.17	2.66	5.80	1.82
RFFT	85.0	26.0	84.2	28.5	91.3	24.9	82.2	20.7
RFFT Error	6.35	14.6	6.79	18.3	5.17	4.75	6.20	8.75
RFFT Ratio	0.09	0.27	0.10	0.34	0.06	0.07	0.08	0.14
COWAT	35.0	9.90	33.4	9.44	38.3	10.5	36.1	10.5
AN	21.4	4.73	21.1	4.85	20.8	4.37	22.7	4.76
TMT A	25.6	8.69	24.0	7.75	28.8	10.4	26.9	9.21
TMT B	60.2	22.0	63.3	24.8	53.9	10.6	57.5	20.7
BNT	48.8	7.10	48.0	6.79	50.5	6.36	49.6	8.47
JLO	24.2	4.38	23.5	4.25	25.8	4.35	24.9	4.58
LBT	-2.30	3.84	-1.62	3.84	-1.96	3.14	-4.29	3.91

*Total Sample: $n = 65$; Never: $n = 38$; Over Three Years: $n = 12$; Within Three Years: $n = 15$

Table 3
Mean rank of assessments by group

	Never*	Over Three Years*	Within Three Years *
	Mean rank	*Mean rank*	*Mean rank*
BDI	26.7	36.1	46.4
BAI	30.2	34.3	39.2
SS Total	32.5	39.5	29.2
SS Forward	31.7	41.1	29.8
SS Backward	32.7	37.5	30.2
RFFT	32.2	37.7	31.2
RFFT Error	30.7	36.9	35.7
RFFT Ratio	30.9	35.5	36.3
COWAT	30.1	38.0	36.0
AN	31.1	30.5	39.7
TMT A	29.8	39.1	36.2
TMT B	34.8	30.1	30.7
BNT	29.8	37.5	37.4
JLO	29.5	40.3	36.0
LBT	35.5	35.0	25.0

*Never: n = 38; Over Three Years: n = 12; Within Three Years: n = 15

APPENDIX F

MTSU IRB APPROVAL LETTER

IRBN001 - EXPEDITED PROTOCOL APPROVAL NOTICE

Principal Investigator	**Victoria Fox** (Student)
Faculty Advisor	Paul Foster
Co-Investigators	NONE
Investigator Email(s)	*vef2b@mtmail.mtsu.edu; paul.foster@mtsu.edu*
Department	Psychology
Protocol Title	***An examination of the relationship between characteristics associated with self-harm and brain function***
Protocol ID	**16-2286**

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXPEDITED** mechanism under 45 CFR 46.110 and 21 CFR 56.110 within the category *(7) Research on individual or group characteristics or behavior* A summary of the IRB action and other particulars in regard to this protocol application is tabulated as shown below:

IRB Action	APPROVED for one year
Date of expiration	**8/31/2017**
Participant Size	75 (SEVENTY FIVE)
Participant Pool	Adult MTSU students (18 and older)
Exceptions	NONE
Restrictions	1. **Mandatory signed informed consent.** **2. NO Identifiable information must be collected or recorded.**
Comments	Approval was originally granted on 08/31/2016 (MP 07/12/2017)

This protocol can be continued for up to THREE years (**8/31/2019**) by obtaining a continuation approval prior to **8/31/2017** . Refer to the following schedule to plan your annual project reports and be aware that you may not receive a separate reminder to complete your continuing reviews. Failure in obtaining an approval for continuation will automatically result in cancellation of this protocol. Moreover, the completion of this study MUST be notified to the Office of Compliance by filing a final report in order to close-out the protocol.

Continuing Review Schedule:

Reporting Period	Requisition Deadline	IRB Comments
First year report	7/31/2017	TO BE COMPLETED
Second year report	7/31/2018	TO BE COMPLETED
Final report	7/31/2019	TO BE COMPLETED

Post-approval Protocol Amendments:

Date	Amendment(s)	IRB Comments
NONE	NONE	NONE

The investigator(s) indicated in this notification should read and abide by all of the post-approval conditions imposed with this approval. Refer to the post- approval guidelines posted in the MTSU IRB's website. Any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918 within 48 hours of the incident. Amendments to this protocol must be approved by the IRB. Inclusion of new researchers must also be approved by the Office of Compliance before they begin to work on the project.

All of the research-related records, which include signed consent forms, investigator information and other documents related to the study, must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application. The data storage must be maintained for at least three (3) years after study completion. Subsequently, the researcher may destroy the data in a manner that maintains confidentiality and anonymity. IRB reserves the right to modify, change or cancel the terms of this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University