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Executive Functioning Outcomes among Self-Harming Adolescents Receiving DBT-A

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by

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Each person whose signature appears below certifies that this thesis in his/her opinion is adequate, in scope and quality, as a thesis for the degree Doctor of Philosophy.

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ABBREVIATIONS

BRIEF-SR	Behavior Rating Inventory of Executive Function – Self Report Version
EF	Executive Function
DSH	Deliberate Self-Harm
DBT	Dialectical Behavior Therapy
DBT-A	Dialectical Behavior Therapy for Adolescents
GEC	Global Executive Composite
GM	Gray Matter
PFC	Prefrontal Cortex
WM	White Matter

ABSTRACT OF THE THESIS

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Changes in WM, GM, and neural activation in networks involving the PFC underlie the development of EFs during adolescence; however, adolescents with DSH have impaired EFs in the areas of inhibition,

emotion regulation, shifting, and interpersonal functioning. DBT-A has been shown to be effective in treating these youth and the skills of mindfulness, emotion regulation, distress tolerance, interpersonal effectiveness, and "walking the middle path" are suited to treat their impaired EFs. As such, this study examined EF changes in adolescents receiving DBT-A and discussed implications for treatment and brain-behavior relationships. Ninety-three adolescents from a 16-week DBT-A program for DSH were administered the BRIEF-SR at baseline and post-treatment. There was improvement from the at-risk to non-clinical range on the Emotional Control, Shift, and Monitor scales, and the GEC. Significant effects for funding type and previous history of psychiatric hospitalizations were also observed. DBT-A appears to be effective for improving the EFs of adolescents with DSH and for specific subgroups. These EF profiles will assist clinicians in implementing DBT-A skills used during this period of

neural development and inform future DBT-A outcome studies that utilize neuropsychological measures and neuroimaging techniques to examine EFs.

CHAPTER ONE

INTRODUCTION

Deliberate self-harm (DSH) is defined as the deliberate, non-fatal, intentional destruction of one's own body tissue that is not socially sanctioned or acceptable and represents a significant public health concern among adolescents (Nock & Prinstein, 2005). In terms of prevalence, 13%-45% of adolescent community samples report a history of DSH (Choate, 2012), while research with psychiatric populations have shown the rates of DSH to be two to four times greater when comparing adolescents (40% to 80%) to adults (21%) (Briere & Gill, 1998; Kerr, Muehlenkamp, & Turner, 2010). Moreover, the occurrence of DSH in adolescence has been shown to be co-morbid with internalizing disorders, externalizing disorders, eating disorders as well as personality disorders such as borderline personality disorder (Kerr et al., 2010; Nock, Joiner, Gordon, Lloyd-Richardson, & Prinstein, 2006).

Adding to the above, the onset of adolescence coincides with the development of executive functions (EFs) or higher-level processes that are involved in the regulation of cognitions, emotions, and adaptive social behaviors (Lalonde, Henry, Germain, Nolin, & Beauchamp, 2013). For example, the mastery of EFs such as inhibitory control, emotion regulation, planning, task-switching, set-shifting, interpersonal functioning, and other skills enable adolescents to make their cognitions and behaviors congruent with internal goals (Crone, 2009; Lalonde et al., 2013). In terms of brain development, important structural changes directly related to EFs occur during this period. Specifically, networks including the prefrontal cortex (PFC) experience an age-dependent, linear increase in white matter (WM) due to myelination of axons tracts as adolescents transition into

adulthood (Blakemore & Choudhury, 2006). Moreover, the development of the WM tracts involving the PFC has been associated with improved EFs such as response inhibition (Seghete, Herting, & Nagel, 2013), set-shifting (Seghete et al., 2013), and interpersonal competence (De Pisapia et al., 2014), while altered or abnormal development has been linked to deficits in planning and problem-solving (Wozniak et al., 2007) as well as depression (Huang, Fan, Williamson, & Rao, 2011).

In addition to linear WM development, prefrontal cortical gray matter (GM) follows an inverted U-shaped path of development where connections in the PFC between neurons and throughout the brain proliferate during pre-adolescence and peak or plateau at the onset of puberty (Blakemore & Choudhury, 2006). After this peak, synaptic pruning occurs where particular connections are strengthened and other connections are eliminated, which results in a sharp reduction in GM density that continues into adulthood (Blakemore & Choudhury, 2006). In terms of EFs, this cortical thinning in prefrontal regions has been linked to improved emotion regulation skills in adolescent females (Vijayakumar et al., 2014) in addition to intellectual ability in both adolescent males and females (Shaw et al., 2006). On the other hand, abnormal cortical development in prefrontal areas has been associated with inattention (Ducharme et al., 2012), hyperactivity and impulsivity (Shaw et al., 2011), early-onset psychosis (Janssen et al., 2009), and autism spectrum disorders (Zielinski et al., 2014).

The adolescent brain also experiences changes in the activation levels of neural networks involving the PFC that underlie the development of EFs such as inhibition (Marsh et al., 2006; Rubia et al., 2006; Tamm, Menon, & Reiss, 2002), emotion regulation (McRae et al., 2011; Pitskel, Bolling, Kaiser, Crowley, & Pelphrey, 2011),

interpersonal functioning (Masten et al., 2009; Moor et al., 2012), and shifting (Ezekiel, Bosma, & Morton, 2013; Morton, Bosma, & Ansari, 2009; Rubia et al., 2006). As a result, these changes in WM, GM, and activation levels reflect the dynamic nature of the growth of EFs during the period of adolescence.

With regards to adolescents who engage in DSH, studies have found that these individuals have impaired EFs in the areas of inhibition (Madge et al., 2011), emotion regulation (Mikolajczak, Petrides, & Hurry, 2009), and interpersonal functioning (You, Leung, & Fu, 2012). Furthermore, these aforementioned studies have also linked these EF deficits to DSH behaviors. Additionally, these adolescents have EF deficits with shifting in terms of mental switching and flexible problem-solving (Paris, Zelkowitz, Guzder, Joseph, & Feldman, 1999), and also with task transitioning and social problem-solving while tolerating changes in distress (Nock & Mendes, 2008). Neuroimaging studies have also identified adolescents with borderline personality disorder, a condition not only characterized by DSH and suicidal behaviors but also by impulsivity, emotion dysregulation, and impaired interpersonal functioning, as having altered neural development in terms WM (Maier-Hein et al., 2014; New et al., 2013) and GM (Brunner et al., 2010; Richter et al., 2014) in prefrontal regions as well as other areas of the brain that are important for the maturation of EFs.

In spite of these neurobiological and behavioral difficulties, various studies suggest that dialectal behavior therapy for adolescents (DBT-A) is a promising and effective intervention for individuals who engage in DSH in outpatient (Uliaszek, Wilson, Mayberry, Cox, & Maslar, 2013), inpatient (McDonell et al., 2010), and residential (Sunseri, 2004; Wasser, Tyler, McIlhaney, Taplin, & Henderson, 2008)

settings as well as in a recent randomized clinical trial (Mehlum et al., 2014). With regards to this intervention, DBT is an extension of cognitive behavioral therapy (CBT) that has been used with individuals that have a biological vulnerability for pervasive emotion dysregulation, which transacts with a consistently invalidating environment, and concomitant interpersonal, self, cognitive, and behavioral dysregulation (Katz & Cox, 2002; Lynch, Trost, Salsman, & Linehan, 2007). The fundamental DBT concepts of mindfulness, emotion regulation, distress tolerance, interpersonal effectiveness, and "walking the middle path" are taught and/or reinforced through individual therapy, group-based skills learning, telephone coaching, and therapist consultation (Linehan, 1993; Lynch et al., 2007).

As previously mentioned, adolescents with DSH have deficits in EFs such as inhibition, emotion regulation, interpersonal functioning, and shifting; however, the five treatment targets of DBT are emotional, interpersonal, intrapersonal, behavioral, and cognitive dysregulation (Linehan, 1993). Consequently, the core skills of DBT are ideally positioned to treat these areas of executive impairment. In addition, because other cognitive-based interventions have been shown to positively impact brain structure (Penades et al., 2013; Wang et al., 2013) and neural activation (Goldin et al., 2014; Kumari et al., 2011) and have been correlated with improvement in mental health functioning, DBT-A with this population should also have beneficial effect as well. For example, current DBT research has suggested that among adults with borderline personality disorder, DBT skills impact the EF of emotion dysregulation by altering hyperactivity in the amygdala (Goodman et al., 2014). More specifically, reductions in

amygdalar activity on an emotion picture task were associated with improved functioning on a self-report measure of emotion regulation (Goodman et al., 2014).

However, this is only one aspect of EFs that was examined in adults and executive dysfunction remains a serious problem in the DSH adolescent population. Moreover, this dysfunction affects multiple domains and appears to be associated with a disruption or delay in brain development and severe behavioral difficulties. On the other hand, more recent studies with cognitive-based interventions have been shown to improve neurological structure and functioning and also have resulted in improved mental health outcomes. Furthermore, there is a growing body of evidence to suggest that DBT-A is an effective treatment for adolescents with DSH. As a result, DBT-A may target some key aspects of EFs and result in positive changes in brain and behavior relationships. Also, factors such as gender, age, ethnicity, funding type, and previous history of psychiatric hospitalizations may contribute to differential EF outcomes. As such, the aims of this study were to:

(1) Examine changes in levels of EFs from baseline to post-treatment on the Inhibit, Emotional Control, Monitor, and Shift subscales and the GEC of the BRIEF-SR at the conclusion of a 16-week DBT-A program for adolescents with DSH.

(2) Examine the effect of gender, age, ethnicity, previous history of psychiatric hospitalizations, and funding type on EF change scores on the BRIEF-SR at the conclusion of a 16-week DBT-A program for adolescents with DSH.

This study will not only be useful for clinicians in providing a profile of EFs to aid in DBT-A treatment planning, but also for providing a unique clinical perspective of these adolescents' own perception of changes in their EF skills in their day-to-day environment. In addition, this study will provide a conceptual framework for future DBT-A outcome studies that examine the association between changes in EFs with the neural activation and structures of networks involving the PFC.

CHAPTER TWO

LITERATURE REVIEW

The first aspect of this literature review will define DSH, discuss the potential functions of DSH, and examine the prevalence of DSH among adolescents. Second, the term executive functions (EFs) will be defined and then the structural and functional changes in neural networks involving the PFC that underlie the development of EFs during adolescence will be reviewed. Third, the association among abnormal brain development involving prefrontal networks, impaired EFs, and DSH behaviors in adolescents will be discussed. Next, DBT will be reviewed as well the effect of cognitive-based interventions on treatment outcomes, brain structure, and neural activity. Finally, the rationale for why DBT-A will be effective in improving EFs among adolescents who engage in DSH will be presented.

Defining Deliberate Self-Harm (DSH)

Because self-harming behaviors in adolescents can encompass many different forms, it is important to operationalize what constitutes DSH for this study. For example, a variety of terms have been used to describe self-destructive behaviors on body tissue, which has contributed to a lack of consistency and clarity in describing what constitutes DSH. One of the causes of this ambiguity is due to different terms being used to describe the same behavior. Terms such as DSH by Fliege, Lee, Grimm and Klapp et al. (2009) and Gratz et al. (2012), self-mutilation by Rissanen, Kylmä, and Laukkanen (2011), self-injurious behavior by Radobuljac, Bratina, Battelino, Tomori (2009), non-suicidal self-injury by Klonsky and Glenn (2008) and Nock and Mendes (2008), and self-wounding by

Huband and Tantam (1999) have been used to describe intentional, self-destructive behaviors on body tissue without suicidal intent.

On the other hand, the term DSH has been defined as intentional self-injury or poisoning to the body regardless of motivation (Hawton & Harriss, 2007), while it has also been conceptualized as an umbrella term encompassing suicide, suicide attempts, and non-suicidal self-injury (Jacobson, Muehlenkamp, Miller, & Turner, 2008). Moreover, Latzman et al. (2010) used the term self-injurious behavior and Tournier et al. (2005) utilized the term parasuicidal behavior to describe self-destructive behaviors on body tissue that are performed irrespectively of suicidal intent. This lack of clarity is further complicated by geographical region of published research (Howat & Davidson, 2002; Nock, 2012). More specifically, published studies in the United States tend to separate self-destructive behaviors on body tissue by whether the behavior was performed with or without suicidal intent (Fliege et al., 2009; Gratz et al., 2011; Hilt, Nock, Lloyd-Richardson, & Prinstein, 2008). However, in the United Kingdom studies have been published where self-destructive behaviors on body tissue were grouped as a single self-harm construct irrespective of suicidal intent (Dickinson & Hurley, 2012; Fliege et al., 2009; Kapur et al., 2013).

Another area of importance for operationalizing DSH is in understanding the social-cultural aspect of body modification behaviors. Socially sanctioned behaviors such as piercings, tattoos, skin branding, and other behaviors such as initiation rituals and aboriginal rites passage that are emblematic of the transition from childhood to adulthood are not included as self-destructive behaviors due to the cultural acceptability and significance (Gonzales & Bergstrom, 2013; Messer & Fremouw, 2008; Nock, 2009).

Self-destructive behaviors on body tissue that are typically included in published studies are banging, hitting, burning, scratching, cutting, carving, intentional bone breaking, and self-poisoning (Andover, Primack, Gibb, & Pepper, 2010; Claes, Klonsky, Muehlenkamp, Kuppens, & Vandereycken, 2010; Klonsky & Muehlenkamp, 2007). For purposes of this study, the term deliberate self-harm will be defined as the deliberate, non-fatal, intentional destruction of one's own body tissue that occurs and is not socially sanctioned or acceptable.

Functions of Deliberate Self-Harm

Similarly to the variety terms used to describe DSH, there is also diversity in the reasons or functions of DSH for individuals that include various domains. A common function of DSH is that self-destructive behaviors on body tissue allow individuals to respond to emotional difficulties they encounter. Individuals who self-harm generally experience higher levels of negative emotionality in comparison to individuals who do not self-harm (Klonsky & Muehlenkamp, 2007). More specifically, the interaction between negative emotionality and rumination on negative emotional thoughts has been shown to be predictive of DSH (Selby, Franklin, Carson-Wong, & Rizvi, 2013).

In addition to negative emotionality, individuals who engage in DSH also have significant difficulties with emotion regulation. The affect-regulation model proposes that individuals engage in DSH as a way to help relieve their aroused affective states that are often characterized by tension, anxiety, and other negative feelings (Klonsky, 2007; Klonsky, Oltmanns, & Turkheimer, 2003). Moreover, research has demonstrated that adolescents and young adults who deliberately self-harm due to heightened physiological

levels of arousal after stressors use DSH as a way to regulate their emotional distress (Nock & Mendes, 2008). Deficits in the emotional skills of individuals with DSH also contributes to their emotion dysregulation as they struggle with emotional awareness, expression, and experience of emotion (Klonsky & Muehlenkamp, 2007). Additionally, individuals with DSH can also experience dissociation where they experience numbness or describe feeling unreal (Klonsky, 2007). As a result, individuals can utilize DSH as a way to feel emotions and physical sensations as a method to anti-dissociate and experience feeling real once again (Klonsky, 2007).

Furthermore, research has shown that first-year university students with DSH are more likely to engage in maladaptive coping behaviors in order to anti-dissociate in comparison to individuals without DSH (Hamza, Willoughby, & Good, 2013). There is also evidence to show that dissociation may also partially mediate the relationship between child maltreatment in the form of physical abuse, and the later onset of DSH among adolescent inpatients (Swannell et al., 2012). Additionally, the relationship between aversive self-awareness and DSH among young adults is also mediated by dissociation (Armey & Crowther, 2008). Moreover, because individuals with DSH have difficulty with regulating their emotions in non-maladaptive ways, various studies have emphasized the importance of understanding the role of emotion dysregulation in developing interventions for these individuals (Fleischhaker et al., 2011; James, Winmill, Anderson, & Alfoadari, 2011; Slee, Spinhoven, Garnefski, & Arensman, 2008).

Besides significant difficulties with emotion dysregulation, it has also been proposed that individuals engage in DSH as a way to express anger or derogation toward themselves as a form of punishment (Klonsky, 2007; Messer & Fremouw, 2008).

Furthermore, self-derogation has been associated with DSH in studies involving clinical and non-clinical populations (Herpetz, Henning, & Favazza, 1997; Klonsky et al., 2003). As such, research has been conducted to examine ways to effectively decrease the urge for self-punishment and DSH through emotional acceptance and suppression (Svaldi, Dorn, Matthies, & Philipsen, 2012). In addition to self-derogation or punishment, individuals with DSH may also engage in self-destructive behaviors for the purpose of reducing or preventing their drive to attempt to commit suicide (Klonsky & Muehlenkamp, 2007). Some of the reported reasons for this type of DSH behavior include prevention from acting on suicidal feelings and the discontinuation of thoughts about suicidal ideation (Klonsky, 2007).

The interpersonal boundaries view of DSH contends that individuals experience feelings independence, autonomy, and distinction from others as way of affirming their boundaries of self and assertion of control in their lives (Klonsky & Muehlenkamp, 2007; Suyemoto & MacDonald, 1995). Additionally, self-report studies demonstrate that there is modest evidence for this type of function with regards to DSH (Klonsky, 2007; Suyemoto & MacDonald, 1995). The interpersonal-influence perspective has been proposed where these individuals also use DSH to communicate needs and feelings, gain attention of others, or deflect from the dysfunction from their broken family system or other environments (Allen, 1995; Klonsky, 2007; Messer & Fremouw, 2008). Notably, research examining the functions of DSH through self-report have shown that the interpersonal-influence perspective is among some of the various reasons why individuals even utilize DSH (Brown, Comtois, & Linehan, 2002; Nock & Prinstein, 2004; Zetterqvist, Lundh, Dahlstrom, & Svedin, 2013). In summary, taking all these functions

into account, the diversity of reasons why individuals who engage in DSH reflect the complexity involved in understanding this field of research.

Epidemiology of Deliberate Self-Harm in Adolescents

DSH is important to study because of the far-reaching implications it has on various segments of society. The pervasive and damaging effects of DSH represents a significant public heath concern and is present in about 4% of the general adult population and in about 21% of the adult psychiatric population (Briere & Gill, 1998). More importantly for this study, DSH poses a significantly even greater health risk for adolescents as the onset typically occurs around the age of 14 years (Nock et al., 2006). Approximately 13% to 45% of adolescents in community populations report a history of DSH (Choate, 2012), while among psychiatric populations the rates of DSH have been shown to be two to four times greater when comparing adolescents (40% to 80%) (Kerr et al., 2010) to adults (21%) (Briere & Gill, 1998).

These rates among the general and psychiatric populations indicate that adolescents appear to be at an increased risk for DSH when compared to adults. Furthermore, more recent international prevalence research of DSH among adolescents by Muehlenkamp, Claes, Havertape, and Plener (2012) showed that the rates approximately vary between 3% and 42% in terms of lifetime prevalence. The transition from high school to college is also a dynamic period of change in life for adolescents moving into young adulthood. Moreover, analysis of the literature by Kerr et al. (2010) showed that college students also have a greater likelihood for engaging in DSH (17% to 35%) in comparison to the general population.

In terms of gender differences, Laye-Gindhu and Schonert-Reichl (2005) showed that adolescent females had a much higher rate of DSH (20.3%) in comparison to males (8.5%) in a community sample. On the other hand, another study examining DSH among a community sample adolescents did not detect overall gender differences; however, adolescent females did report engaging in more self-cutting behaviors than males (Lundh, Karim, & Quilisch, 2007). Guerreiro, Sampaio, Rihmer, Gonda, and Figueira (2013) in a more recent cross-sectional study also researched DSH among a community sample of public school students. Analysis of the data revealed that adolescent females were approximately three times more likely to self-report DSH (Guerreiro et al., 2013). With regards to prevalence, adolescent females had higher lifetime and previous year prevalence rates in comparison to males (10.5% vs. 3.3%; 5.7% vs. 1.8%) (Guerreiro et al., 2013). In addition, research by de Kloet et al. (2011) examining adolescent inpatients with DSH also showed that female gender as well as other factors significantly increased the probability of self-harming behaviors.

With regard to ethnicity, there have been mixed findings in terms of differences in rates among adolescents. In a longitudinal study with junior high school students, Hilt et al. (2008) did not detect any differences in rates of DSH between Caucasian and non-Caucasian adolescents. Nock and Mendes (2008) in a laboratory experiment examining emotional reactivity in DSH adolescents recruited participants through advertisements that were sent to psychiatric clinics and newspapers in addition to community bulletins and the Internet. Their analysis showed that there were no significant differences in terms of ethnicity in comparing adolescents with DSH to controls (Nock & Mendes, 2008). Zetterqvist et al. (2013) in a much larger European-based prevalence study examined

rates among adolescents in their first year of high school. Their findings also did not detect any significant differences in prevalence rates among groups with regards to adolescents' country of origin or parents' country of origin (Zetterqvist et al., 2013). In addition, Jacobson et al. (2008) did not find any significant differences in ethnicity and occurrence of DSH among a psychiatric adolescent population.

On the other hand, other studies have found differences in the rates of DSH among various ethnicities. Guertin, Lloyd-Richardson, Spirito, Donaldson, and Boergers (2001) investigated the rates of DSH behavior among adolescents who had a history of attempted suicide by overdose. The findings showed that adolescents who engaged in DSH were more likely to be Caucasian in comparison to adolescents without a history of DSH (Guertin et al., 2001). In addition, Gratz et al. (2012) exclusively examined prevalence rates among Caucasian and African-American students in a poor and underserved area that engaged in DSH and displayed features of borderline personality disorder. Analysis of the research showed that Caucasian adolescent females had higher self-reported levels of DSH in comparison to white adolescent males, while African-American adolescent males had higher self-reported levels of DSH relative to African-American females (Gratz et al., 2012). In examining the relationship between school and ethnicity, African-Americans had higher self-reported levels of DSH in middle school relative to Caucasians, while the pattern was reversed in high school as Caucasians had higher self-reported levels of DSH (Gratz et al., 2012). In addition, African-American males were at high risk for earlier onset and engagement in DSH in terms of various forms of DSH (Gratz et al., 2012).

In terms of co-morbidity with psychiatric diagnoses and symptoms, a review of the literature showed that about 70% to 75% of individuals with borderline personality disorder engage in DSH (Kerr et al., 2010). Furthermore, approximately 69% of individuals with dissociative disorders have a history of DSH (Kerr et al., 2010). With regards to of eating disorders, estimates for rates of DSH range from 26% to 55% for individuals with bulimia nervosa, 27% to 61% for individuals with anorexia nervosa, binge-purge subtype, and 13% to 42%, for individuals with anorexia nervosa, restricting type (Kerr et al., 2010). In examining DSH and its relationship with depression, Nock and Kessler (2006) found that 42% of individuals in a sample ranging from adolescents to middle-aged adults who engaged in DSH fit the diagnostic criteria for major depressive disorder, while 15.2% of respondents fit the diagnostic criteria for dysthymic disorder.

In another study focusing specifically on adolescent inpatients, Nock et al. (2006) examined diagnostic correlates of DSH. Analysis showed that the majority of deliberately, self-harming adolescents (87.6%) met the criteria for a DSM-IV Axis I disorder (Nock et al., 2006). Moreover, 62.9% and 51.7% of adolescents met criteria for externalizing and internalizing disorders, respectively, while 59.6% met criteria for substance use disorders (Nock et al., 2006). In addition, the majority of adolescents met criteria for DSM-IV Axis II personality disorder (67.3%) with 51.7% of female adolescents meeting the criteria for borderline personality disorder (Nock et al., 2006). Furthermore, 70% of DSH adolescents reported at least one lifetime suicide attempt with 55% of adolescents reporting a history of multiple attempts (Nock et al., 2006). Collectively, the findings in this section indicate that adolescents are at much higher risk

for DSH than adults and need interventional services to help address their self-destructive behaviors that co-occur with other disorders.

Definition and Aspects of Executive Functions (EFs)

EFs are critical for adolescents in their daily environment as they are used for goal-directed, purposeful behaviors that enable adolescents to complete everyday goals and tasks (Huizinga & Smidts, 2011). In terms of defining EFs, they are the higher-level processes that are used for the regulation of adolescents' cognitions, emotions, and adaptive social behaviors (Lalonde et al., 2013). Moreover, EFs encompass the abilities of inhibition, emotion regulation, shifting, planning and organizing, and working memory among others (Fikke, Melinder, & Landro, 2011; Oberle & Schonert-Reichl, 2013; Pnevmatikos & Trikkaliotis, 2013). In addition, the EF of interpersonal functioning in conjunction with utilizing cognitive flexibility is important for adapting behavior to changes in the environment (Lalonde et al., 2013; Oberle, Schonert-Reichl, Lawlor, & Thomson, 2011). For this study, the EFs of inhibition, emotion regulation, interpersonal functioning, and shifting will be examined as these are areas which adolescents with DSH have been shown to have difficulty with.

White Matter Changes in the Prefrontal Cortex and EFs during Adolescence

The beginning of adolescence marks significant changes in the lives of individuals as they develop from childhood to adulthood. The onset of this period which approximately begins around the age of 10 is characterized by physical, cognitive, and emotional changes that help form the skills to allow adolescents to function with

increasing levels of independence as they mature into adulthood (Blakemore & Choudhury, 2006; Crone, 2009; Oberle et al., 2011; Yurgelun-Todd, 2007). Moreover, the prefrontal cortex (PFC), which is located in the anterior portion of the frontal lobes, has been shown to undergo significant changes in adolescence and play an important role in the development EFs (Blakemore & Choudhury, 2006).

In comparison to other regions of the brain, the PFC matures much slower and later in development, which corresponds to improvements in EFs (Blakemore & Choudhury, 2006). More specifically, networks including the PFC experience an age-dependent, linear increase in white matter (WM) due to myelination of axons tracts as adolescents transition into adulthood (Blakemore & Choudhury, 2006). As children mature into adolescence, neurons develop a layer of myelin that forms around the axons that extend out from the cell bodies (Blakemore & Choudhury, 2006). This process along with the insulator-like quality of myelin in turn allows for a more faster and efficient transmission of signals between neurons throughout the brain (Blakemore & Choudhury, 2006).

With regards to EFs, the maturation of WM tracts in adolescents has been correlated with improvements in response inhibition (Seghete et al., 2013), set-shifting (Seghete et al., 2013), and interpersonal competence (De Pisapia et al., 2014); however, altered or abnormal development has been associated with deficits in planning and problem-solving (Wozniak et al., 2007) as well as depression (Huang et al., 2011). These findings indicate that structural changes in WM integrity are critical for the improvement of EFs, while disrupted development can lead to executive and psychological dysfunction.

Gray Matter Changes in the Prefrontal Cortex and EFs during Adolescence

As children develop, the gray matter (GM) of PFC also undergoes dynamic changes. In contrast to linear WM development, cortical GM follows an inverted U-shaped path of development (Blakemore & Choudhury, 2006). More specifically, synaptic connections in the PFC between neurons and throughout the brain proliferate in a process called synaptogenesis during pre-adolescence and peaks or plateaus at the onset of puberty (Blakemore & Choudhury, 2006). After this peak, synaptic pruning occurs where particular connections are strengthened and other connections are eliminated (Blakemore & Choudhury, 2006). This maturation process leads to the decline of GM through adolescence into adulthood and is considered an essential part of the fine-tuning of neural networks in the brain and EFs (Blakemore & Choudhury, 2006).

Giedd et al. (1999) longitudinally examined changes in GM and showed that frontal cortex GM volume increased through pre-adolescence and peaked at about 12 years in males and 11.0 years in females. After this peak, the volume of GM decreased in the frontal lobes throughout adolescence into young adulthood (Giedd et al., 1999). A later cross-sectional study with children, adolescents, and adults by Sowell, Thompson, Tessner, and Toga et al. (2001) also confirmed this pattern of development in frontal cortex and also demonstrated that there was a steep decrease in frontal lobe GM density during the transition from adolescence to adulthood (Sowell et al., 2001). As a result, the authors suggested the cortical thinning along with increased myelination of these frontal areas, which are important for EFs, might also subserve improved cognitive performance (Sowell et al., 2001).

Moreover, cortical thinning in prefrontal regions has been linked to improved emotion regulation skills in adolescent females (Vijayakumar et al., 2014) and to intellectual ability in both adolescent males and females (Shaw et al., 2006). However, abnormal cortical development in prefrontal areas has been associated with inattention (Ducharme et al., 2012), hyperactivity and impulsivity (Janssen et al., 2009; Shaw et al., 2011), early-onset psychosis (Janssen et al., 2009), and autism spectrum disorders (Zielinski et al., 2014). Taken together, changes in adolescent GM during this period can contribute to the growth of EFs or result in impaired psychological functioning.

Prefrontal Cortex Activity in Adolescence and Executive Functions

In addition to structural changes to prefrontal regions, research has demonstrated that networks involving the PFC also undergo dynamic changes during adolescence. More specifically, multiple neuroimaging studies have shown that the adolescent brain also experiences changes in the activation levels of neural networks involving the PFC that underlie the development of EFs such as inhibition (Marsh et al., 2006; Rubia et al., 2006; Tamm et al., 2002), emotion regulation (McRae et al., 2011; Pitskel et al., 2011), interpersonal functioning (Masten et al., 2009; Moor et al., 2012), and shifting (Ezekiel et al., 2013; Morton et al., 2009; Rubia et al., 2006). As a result, changes in neural activation, WM, and GM, all uniquely contribute to the dynamic growth of EFs during the period of adolescence. However, there is also evidence to suggest that adolescents who engage in DSH have impaired EFs in these areas as well.

Impaired Inhibition in Adolescents with DSH

The ability of adolescents to inhibit or suppress pre-potent behaviors is a skill that is essential for effectively regulating responses to changes in their daily environment and also for reducing performance errors (Schachar, Tannock, Marriot, & Logan, 1995). Adolescents with DSH have been shown to display impaired inhibition in various types of studies. In terms of self-reported impulsivity, researchers from the Child & Adolescent Self-harm (CASE) Study examined this area of functioning along with other features associated with DSH among 14-17 year olds in Belgium, England, Hungary, Ireland, the Netherlands and Norway (Madge et al., 2011).

The results of the findings showed that increased severity of DSH history directly related to greater levels of impulsivity in addition to depression, anxiety, and lower self-esteem. The findings also showed that higher impulsivity, female gender, experiencing the suicide and/or self-harm of others, abuse, and concerns over sexual orientation were factors that were associated with the differentiation of single-episode self-harming instances from only thoughts about DSH (Madge et al., 2011). Furthermore, the authors suggested the research findings were indicative of the importance of psychological factors and life events and how they are related to self-harming behaviors (Madge et al., 2011).

In addition, another self-report study by Cloutier, Martin, Kennedy, Nixon, and Muehlenkamp (2010) examined clinical features associated with DSH among 12 to 17 year olds in pediatric emergency crisis services. With regards to reported impulsivity symptoms, non-DSH adolescents and adolescents with DSH endorsed less symptoms than the suicide attempt only group and the combined suicide attempt and DSH group

(Cloutier et al., 2010). As a result, the authors suggested their results were reflective of research that indicates that suicide attempts in adolescents are related to increased impulsivity, while non-suicidal DSH behaviors are indicative of an intentional process used to regulate emotions in response to stress (Cloutier et al., 2010). Taken together, the authors asserted that increased attention to impulsivity symptoms among adolescents who engage in DSH should be viewed as a risk factor for assessing for future suicide attempts (Cloutier et al., 2010).

There is also behavioral laboratory research investigating inhibition among adolescents with DSH. Janis and Nock (2009) examined self-reported impulsiveness, behavioral disinhibition, and risky decision-making among 12-19 year olds with DSH. Their findings showed that DSH individuals had significantly higher levels of self-reported impulsivity when compared to non-self harmers; however, DSH individuals did not exhibit greater levels of behavioral disinhibition when compared to non-self-harming individuals (Janis & Nock, 2009). In addition, there were no significant differences in risky decision-making with regard to the main effect of group, time by group interaction, and overall group performance (Janis & Nock, 2009).

However, the authors noted that when age was entered at the first step into the hierarchical regression model individuals with DSH did significantly differ from non-self-harming individuals with respect to decision-making (Janis & Nock, 2009). The authors asserted that age possibly obscured the potential differences between groups on the decision making task (Janis & Nock, 2009). The authors then replicated their findings in this same study with adult participants and observed higher levels of impulsivity

among individuals with DSH and no group differences in terms of behavioral disinhibition (Janis & Nock, 2009).

In summary, the above authors stated the findings were indicative of the complexity involved DSH and suggested that impulsivity in itself may not fully explain the role of impaired decision-making in regards to self-harm (Janis & Nock, 2009). However, the authors stated that the failure to detect group differences could have been the result heterogeneity of samples in addition to the failure of laboratory-based behavioral measures to capture the impulsivity of individuals with DSH in the real-world context when participants are responding to emotional distress (Janis & Nock, 2009). Moreover, the authors contended that prospective studies needed to be conducted with different behavioral measures assessing impulsivity to determine if the lack of group differences were specific to the behavioral disinhibition task that was utilized (Janis & Nock, 2009).

Building on these recommendations for future research, Fikke, Melinder, and Landro (2011) examined behavioral inhibition with a different neuropsychological task among high and low severity adolescents that deliberately self-harm . The results revealed that the low-severity DSH group had impaired inhibitory control. The authors also contended that the nature of DSH in the low-severity group was characterized by impulsivity, while DSH in the high-severity group was more suggestive of a contemplative form of self-harm (Fikke et al., 2011). Moreover, the authors asserted that impaired inhibitory control may be involved in DSH adolescents' attempt to regulate their emotions (Fikke et al., 2011).

In a later study, Fikke, Melinder, and Landro (2013) further examined this area of research by examining the contribution of acute tryptophan depletion and its impact on levels of impulsivity (impulsive action and reflection impulsivity) and mood in female adolescents with DSH . More specifically, the results revealed that acute tryptophan depletion (which leads to decreased serotonin transmission) was associated with an impulsive response style (Fikke et al., 2013). Taken together, the authors suggested that female adolescents with DSH have a serotonin vulnerability, which creates a sensitivity for dysfunction in the regulatory processes of the serotonin system in the brain (Fikke et al., 2013). Furthermore, the authors contended that the impulsive action and low serotonin function are important factors among female adolescents when they utilize DSH behaviors to respond to emotional distress (Fikke et al., 2013).

In an earlier study, a different group of researchers examined serotonergic correlates in addition to psychological and autonomic precursors to self-harming behaviors among adolescent females (Crowell et al., 2005). More specifically, the authors analyzed psychological factors through completed questionnaires by adolescents and their parents and teachers, while psychophysiological measures such as electrodermal responding (EDR), reduced respiratory sinus arrhythmia (RSA), and cardiac pre-ejection period (PEP) were utilized at baseline, negative mood induction, and at the recovery period (Crowell et al., 2005). Moreover, EDR was used to examine anxiety while RSA was used to examine emotion regulation (Crowell et al., 2005). Additionally, PEP and peripheral serotonin were used to examine impulsivity (Crowell et al., 2005).

In comparison to non-self-harming adolescents, females with a history of DSH behaviors had attenuated levels of RSA at baseline, higher levels of RSA reactivity

during negative mood induction, and decreased levels of peripheral serotonin; however, no group differences were detected with regards to PEP or EDR measurements (Crowell et al., 2005). In summary, the authors concluded that attenuated levels of RSA and decreased peripheral serotonin levels provide evidence for the contention that self-harming adolescents are characterized by impulsivity and emotional dysregulation that are also features of borderline personality disorder in adult populations (Crowell et al., 2005).

These studies suggest that adolescents with DSH may have difficulty with impulsivity and disinhibition on self-report measures (Cloutier et al., 2010; Madge et al., 2011) and on neuropsychological tasks (Fikke et al., 2011). Moreover, these adolescents may also have a neurobiological vulnerability, which provides further support the presence of impaired inhibition in this population (Crowell et al., 2005; Fikke et al., 2013).

Impaired Emotion Regulation in Adolescents with DSH

Emotion regulation is a critical ability that is very important for successful functioning in adulthood that develops during adolescence (McRae et al., 2011) and adolescents with DSH have been shown to have problems effectively regulating their emotions. More specifically, Mikolajczak, Petrides, and Hurry (2009) examined how DSH functions as an emotion regulation strategy among DSH adolescents and how increased levels of emotional intelligence and coping styles affects this relationship. Moreover, well being, self-control, emotionality, and sociability were the dimensions of functioning that comprised emotional intelligence (Mikolajczak et al., 2009).

In terms of findings, the results showed that the type of coping strategy partly mediated the relationship between emotional intelligence and DSH (Mikolajczak et al., 2009). Furthermore, emotional coping was a strong mediator of the relationship between emotional intelligence and DSH (Mikolajczak et al., 2009). Consequently, the authors contended that DSH possibly functions as a way to reduce negative emotions which can be amplified by poor emotional coping mechanisms (Mikolajczak et al., 2009).

Additionally, the authors identified rumination, self-blame, and helplessness as maladaptive coping strategies (Mikolajczak et al., 2009). On the other hand, higher levels of emotional intelligence were associated with effective coping styles, while lower levels of emotional intelligence were inversely related to depression and poor coping styles (Mikolajczak et al., 2009). As a result, the authors asserted that instructive coping programs should be incorporated in the treatment of adolescents with DSH as way to help them effectively manage their negative emotions without utilizing self-destructive behaviors (Mikolajczak et al., 2009).

Another study by Phillips et al. (2013) sought to identify emotional and intrapersonal factors related to predicting current and future risk of DSH in a community sample of adolescents. The authors wanted to determine the utility of a brief evaluation the examined negative emotionality and self-esteem among adolescents in secondary schools in the United Kingdom (Phillips et al., 2013). More specifically, the authors employed principal components analysis and item reduction analysis and identified three internally reliable factors from The Short Mood and Feelings Questionnaire, Revised Child Anxiety and Depression Scale, Rosenberg Self-Esteem Scale, and the Children's Automatic Thought's Scale measures (Phillips et al., 2013). The factors were the

following: personal failure (3 items), physical symptoms of depression and anxiety (6 items), and self-esteem (5 items) (Phillips et al., 2013). The authors then utilized logistic regression and identified an association with these factors for predicting current and future DSH (Phillips et al., 2013).

In addition, the authors used summative score of the 14-items and were able to detect current DSH and future DSH at 6-months and 12-months for males and females with these emotional and self-esteem factors (Phillips et al., 2013). As a result, factors not only such as negative emotionality, but also self-esteem should be taken into account when providing interventions for adolescents in the community who are at risk for DSH (Phillips et al., 2013). Furthermore, this study displayed that these adolescents may have a specific pattern of emotion dysregulation that may be predictive of future DSH.

Examining emotional functioning from a neurobiological perspective, Plener, Bubalo, Fladung, Ludoph, and Lule (2012) investigated the neural underpinnings of impaired emotion regulation skills in female adolescents that engage in DSH. More specifically, the researchers evaluated the adolescents' emotional processing through their verbal responses to affective visual stimuli during functional magnetic resonance imaging (Plener et al., 2012). In comparison to the controls, adolescents in the DSH group subjectively rated pictures with themes of DSH as more arousing. In terms of emotional pictures, self-harming adolescents had significantly higher levels of neural response in the brain regions of the amygdala, hippocampus, and anterior cingulate cortex bilaterally (Plener et al., 2012). Moreover, differential activity in the limbic regions of the brain was explained by elevated depression scores in distinguishing between self-harming adolescents to the control group (Plener et al., 2012).

In addition, frontal regions such as the middle orbitofrontal, inferior frontal, and middle frontal cortices showed increased levels of activation among self-harming adolescents in comparison to controls. Furthermore, the authors asserted that the findings indicate that adolescents with DSH possibly have altered patterns of neurobiological functioning that may result in abnormal of emotion development (Plener et al., 2012). As a result, these altered neural patterns can lead to emotion regulation deficits among self-harming adolescents that need to be assessed early in development (Plener et al., 2012). Overall, these cited studies provide evidence that these adolescents have difficulties with emotional regulation characterized by poor emotional coping (Mikolajczak et al., 2009), a specific profile of negative emotionality and low self-esteem (Phillips et al., 2013), and abnormal patterns of neural activity in frontal and limbic systems for emotional processing (Plener et al., 2012) that contribute to DSH.

Impaired Interpersonal Functioning in Adolescents with DSH

Interpersonal functioning is another factor that has been shown to be important for examining DSH in adolescents. Muehlenkamp, Ertelt, Miller, Claes (2011) examined impaired interpersonal functioning along with other borderline personality symptoms among adolescents that engaged in DSH. Analysis showed that specific interpersonal and intrapersonal borderline personality disorder symptoms discriminated between types of DSH (Muehlenkamp et al., 2011). More specifically, the combination of the "interpersonal chaos" and "confusion about self" scales from the Life Problems Inventory significantly differentiated DSH group only from the DSH suicide groups (Muehlenkamp et al., 2011).

Additionally, higher levels of unstable interpersonal relationships were positively associated with greater probability of engaging in DSH and were also more predictive of DSH only group membership (Muehlenkamp et al., 2011). On the other hand, increased levels of confusion about self were positively associated with a greater probability of being in the suicide groups as well as with repeated DSH attempts (Muehlenkamp et al., 2011). Taken together, the authors suggested that awareness of borderline personality disorder criteria should be utilized when performing suicide risk assessments with adolescents who engage in DSH (Muehlenkamp et al., 2011). The authors also asserted that interventions targeting impaired interpersonal functioning and self-concept may help reduce DSH behaviors in adolescents (Muehlenkamp et al., 2011).

A longitudinal cross-lag study by You, Leung, and Fu (2012) with a community sample of Chinese adolescents investigated the relationship between interpersonal functioning and DSH. With regards to the study, the profile of intense and unstable interpersonal relationships significantly predicted DSH by the six-month follow-up period, after the initial associations between variables were controlled for (You et al., 2012). Moreover, adolescents that endorsed higher levels of impaired interpersonal functioning were more likely to engage in DSH at the Time 2 follow-up period (You et al., 2012). Furthermore, the authors asserted that because impaired interpersonal functioning was shown to be a significant predictor of future DSH in adolescents, interventions that emphasize improving interpersonal skills should be utilized to prevent or reduce future DSH over time (You et al., 2012).

Additionally, Tatnell, Kelada, Hasking, and Martin (2013) examined the effect of interpersonal and intrapersonal factors in adolescents with DSH through a longitudinal

study. The interpersonal variable of family support was significantly associated with the onset, maintenance, and cessation of DSH behaviors (Tatnell et al., 2013). Additionally, anxiety attachment related to parent-child relationships was predictive of onset of DSH (Tatnell et al., 2013). In terms of intrapersonal factors, variables such as self-esteem and self-efficacy were significantly associated with the onset of DSH behaviors (Tatnell et al., 2013). In addition, self-esteem, self-efficacy, and ability to utilize cognitive reappraisals were significant mediators in the relationship between the onset of DSH behaviors and attachment anxiety (Tatnell et al., 2013).

Furthermore, the authors suggested that the complex relationships between the previously mentioned interpersonal and intrapersonal variables were predictive of the onset, maintenance, and cessation of DSH behaviors in adolescents (Tatnell et al., 2013). Moreover, the authors asserted that increased attention on improving interpersonal functioning between family members and their adolescents can serve as a protective mechanism that can possibly reduce the number of adolescents starting DSH behaviors and also increase the cessation of these self-destructive behaviors (Tatnell et al., 2013). Given the results of these studies, the research suggests that impaired interpersonal functioning is a contributing factor to DSH in adolescents.

Relationship between Impaired Emotion Regulation and Interpersonal Functioning

Research has indicated that the relationship between emotional regulation and impaired interpersonal functioning is related to engagement in DSH behaviors among adolescents. Sim et al. (2009) investigated how emotion dysregulation and impaired interpersonal functioning impact DSH among psychiatrically hospitalized adolescents.

Analysis of the data revealed that adolescents who engaged in DSH utilized these destructive behaviors as a way to regulate their negative emotional states (Sim et al., 2009). The authors also discovered that emotional regulation partially mediated between family climate and DSH; however, this relationship was only significant for females in the study (Sim et al., 2009). More specifically, females with dysregulated emotion ability that were exposed to invalidating parental emotions had higher levels of engagement with DSH behaviors (Sim et al., 2009). Additionally, these authors suggested that because these adolescent females had an impaired ability to identify and express their negative emotionality in context of impaired interpersonal function with their parents, they were not prepared to cope with their negative emotionality in more effective ways than DSH (Sim et al., 2009).

In an extension of this previous study, Adrian, Zeman, Erdley, Lisa, and Sim (2011) further examined additional aspects of emotion dysregulation and interpersonal functioning with family and peers among inpatient adolescent females with DSH. The results from structural equation modeling indicated that the direct process of emotion dysregulation was predictive of DSH (Adrian et al., 2011). Additionally, impaired emotion regulation mediated the influence of interpersonal difficulties such as peer and family relational problems' effect on DSH (Adrian et al., 2011). Moreover, the indirect effect of interpersonal peer difficulties was significantly related to the frequency and severity of DSH among these adolescent females (Adrian et al., 2011). Furthermore, the authors suggested that the relationship between impaired interpersonal functioning and DSH is multifaceted and is influenced by impaired emotion regulation (Adrian et al., 2011). Consequently, the authors asserted that adolescent females with a history of

psychiatric hospitalizations possibly lack adaptive coping strategies and interpersonal skills and as a result utilize DSH to respond to emotional distress (Adrian et al., 2011).

In an earlier correlational study by Garisch and Wilson (2010), the authors examined emotion dysregulation, impaired interpersonal functioning with peers, and DSH with adolescents enrolled in school. More specifically, the authors investigated the associations between peer victimization and alexithymia on DSH behaviors (Garisch & Wilson, 2010). Alexithymia is characterized by difficulty identifying, regulating, and communicating emotions in addition to reflecting on feelings (Venta, Hart, & Sharp, 2013). It is also characterized by a lack of interpersonal insight with regards to interpreting others' emotions (Venta et al., 2013). In terms of results, analysis of the data showed that higher levels of victimization and alexithymic symptoms differentiated self-harming adolescents from non-self-harming adolescents (Garisch & Wilson, 2010).

Moreover, the association between peer bullying and DSH moderated and was partially mediated by alexithymia (Garisch & Wilson, 2010). Furthermore, when adolescents' levels of alexithymia were moderate to high, DSH behaviors and bullying significantly co-varied together (Garisch & Wilson, 2010). With regards to intrapersonal factors, depression was a significant mediator of alexithymic symptomatology and also was a significant moderator for the association between DSH and bullying (Garisch & Wilson, 2010).

In summary, the authors concluded that the bullying of adolescents with DSH is associated with engagement of DSH behaviors when adolescents are emotionally dysregulated, have impaired interpersonal communication skills, and significant mood problems (Garisch & Wilson, 2010). Lastly, these studies display the multifaceted and

complex relationships among emotion regulation, interpersonal functioning, and the occurrence of DSH in adolescents.

Impaired Shifting in Adolescents with DSH

Switching mental sets, using flexible problem-solving strategies, making transitions, and tolerating changes in distress, all comprise the EF of shifting. Furthermore, this ability to respond efficiently to changes in the environment is important for matured levels of cognitive functioning (Davidson, Amso, Anderson, & Diamond, 2006) More importantly, research suggests that adolescents with DSH have difficulty with this skill. Paris, Zelkowitz, Guzder, Joseph, and Feldman (2001) examined performance of children and adolescents with borderline personality disorder pathology on the Wisconsin Card Sorting Task, which requires mental set-shifting, cognitive flexibility, and planning among other neuropsychological skills. On the Wisconsin Card Sorting Task, children and adolescents with borderline pathology needed more trials to complete sets, which was indicative of greater difficulty with the task in comparison to the group with no pathology. In addition, these individuals committed more errors and failed to learn from their mistakes (Paris et al., 1999).

Moreover, this group also had greater difficulty with forming conceptual level responses to the sorting task (Paris et al., 1999). The borderline pathology group also displayed poor orientation, slow reaction times, and highly variable responding on a sustained visual attention task which was reflective of decreased level of attention (Paris et al., 1999). Furthermore, the authors asserted that the mental switching, cognitive flexibility, planning, and attention deficits among children and adolescents with

borderline pathology provide support for the idea of a biological diathesis or predisposition underlying the borderline symptomatology that is similar to adults with borderline personality disorder (Paris et al., 1999).

A later study by Zelkowitz, Paris, Guzder, and Feldman (2001) also examined to switching sets, cognitive flexibility, and planning in addition to other neuropsychological deficits among children with borderline pathology, but in the context of childhood trauma. The results of the study revealed that psychological trauma in the forms of sexual abuse and witnessing of violence accounted for significant amount of variance to the diagnosis of borderline pathology in children and adolescents (Zelkowitz et al., 2001). In addition, the neuropsychological results were consistent with Paris et al. 2001 in that deficits in switching, cognitive flexibility, planning, and attention accounted for significant amount of variance as well (Zelkowitz et al., 2001). Moreover, the authors stated that the combination of psychological and neuropsychological variables explained almost 50% of the variance in the model that examined contributions to the borderline pathology diagnosis (Zelkowitz et al., 2001).

As a result, the authors postulated that a combination of environmental factors along with neuropsychological vulnerabilities influence the development of borderline pathology in children that continues into adulthood (Zelkowitz et al., 2001). Furthermore, the authors asserted that through the diathesis-stress model predisposed impulsive, affective, and cognitive difficulties contribute to heightened sensitivity to environmental stress, which is associated with borderline pathology (Zelkowitz et al., 2001).

Another aspect of shifting DSH adolescents struggle with is the ability to tolerate transitions and changes in distress. Nock and Mendes (2008) in a psychophysiological

experiment examined social problem-solving deficits among adolescent with DSH after shifting from a distressing task. Analysis of the results demonstrated adolescents with DSH displayed greater levels of physiological reactivity on skin conductance measures during an intentionally distressing task (Nock & Mendes, 2008).

Consequently, these self-harming adolescents showed an impaired ability to effectively manage and tolerate the induce distress and displayed subsequent deficits on a social problem-solving task in comparison to non-self-harming adolescents (Nock & Mendes, 2008). Taken together, these findings provide behavioral and laboratory evidence that DSH adolescents struggle to effectively shift and adapt to stress inducing situations in the environment. Furthermore, the authors asserted that impaired shifting ability in response to distress, heightened reactivity, and deficits in social skills should be target areas for clinicians in assessing and treating adolescents with DSH (Nock & Mendes, 2008).

Dialectical Behavior Therapy (DBT)

Dialectical behavior therapy (DBT) is an extension of cognitive behavioral therapy (CBT) developed by Marsha Linehan that incorporates behaviorism, dialectical philosophy (acceptance and change), and Zen Buddhist techniques for the purpose of treating chronically suicidal and self-injuring individuals with borderline personality disorder (Koons, 2008; Linehan, 2006; Rathus & Miller, 2002). Moreover, reviews of the literature have shown that DBT has since been applied to various types of disorders and dysfunction in terms of individuals with histories substance abuse, domestic violence, eating disorders, mood disorders, as well as other psychiatric disorders (Bankoff, Karpel,

Forbes, & Pantalone, 2012; Katz & Cox, 2002; MacPherson, Cheavens, & Fristad, 2013). In addition, DBT has not only been used with adults, but also with other treatment populations such as adolescents and geriatric patients and has been implemented in outpatient, inpatient, and residential treatment settings (Lynch et al., 2007; MacPherson et al., 2013; Uliaszek et al., 2013; Wasser et al., 2008).

DBT is based on Linehan's biosocial theory where individuals with borderline personality disorder have a biological vulnerability for pervasive emotion dysregulation that transacts with a consistently invalidating environment, which contributes to dysfunction in terms of interpersonal, self, cognitive, and behavioral dysregulation (Katz & Cox, 2002; Lynch et al., 2007). DBT treats these various domains of dysfunction through four modes of therapy that are presented concurrently during treatment. Individual therapy with a DBT clinician is comprised of a treatment hierarchy being formed that first seeks to eliminate suicidal and self-harming behaviors and then therapy-interfering behaviors such as inconsistent attendance or non-completion of homework assignments (Lynch et al., 2007). The next goal is to identify and change behaviors that contribute to reduced quality of life (Lynch et al., 2007). The second mode of therapy consists of group-based skills training where the core DBT skills of mindfulness, distress tolerance, emotion regulation, interpersonal effectiveness, and "walking the middle path" are taught (Linehan, 1993; Lynch et al., 2007; Quinn, 2009).

In the third mode of therapy, patients receive brief and focused telephone coaching to help them generalize the DBT skills that they have learned outside of therapy as a way to cope with urges to engage in suicidal and self-harming behaviors (Koons, 2008; Lynch et al., 2007). Lastly, the fourth mode of DBT provides the opportunity for

therapists that are a part of the treatment team to consult and troubleshoot with each other about patients and how to better implement DBT to solve problems that come up in therapy (Koons, 2008; Lynch et al., 2007).

Dialectical Behavior Therapy for Adolescents (DBT-A)

Different types of studies have examined the potential benefits of utilizing dialectical behavior therapy adapted for adolescents (DBT-A). With regards to effectiveness research, Sunseri (2004) examined the impact of implementing DBT-A among chronically suicidal adolescents in residential care. The study showed that DBT-A was effective in reducing early terminations due to suicidality, number of psychiatric inpatient stays due to DSH, and length of physical restraints and seclusions used by the residential care staff (Sunseri, 2004). The author suggested that pretreatment commitment strategies were likely helpful in bolstering adolescents' motivation to stay in therapy, while the presentation of DBT-A skills provided more positive, alternative forms of coping as opposed to DSH (Sunseri, 2004). In addition, Sunseri (2004) asserted that utilizing DBT-A skills during restraints with adolescents were most likely beneficial in reducing the length of time spent in seclusions.

Goldstein, Axelson, Birmaher, and Brent (2007) utilized DBT-A in a year open trial for adolescents with bipolar disorder. Analysis of the results showed that DBT-A was viable treatment option for adolescents and their families (Goldstein et al., 2007). More specifically, over 90% of sessions were attended and the only occurrence of dropout was due to living relocation (Goldstein et al., 2007). In addition, post-treatment surveys indicated that adolescents as well as parents reported high levels of satisfaction

with the DBT-A program (Goldstein et al., 2007). In terms of changes in clinical functioning, at the conclusion of DBT-A, adolescents showed significant improvements in suicidality, emotional dysregulation, and depressive symptoms. In addition, adolescents showed clinically meaningful reductions in DSH behaviors and this relationship had a large effect size (d = 0.8); however, this effect was only marginally significant (Goldstein et al., 2007).

In another effectiveness study, James, Taylor, Winmill, and Alfoadari (2008) used DBT-A exclusively with a community sample of adolescent females with DSH. Their research showed that not only did female adolescents have a high treatment attendance rate, but also had marked improvement with regards to self-reported levels of depression, hopelessness, occurrence of DSH, and general functioning which continued to follow up approximately 9-months later (James et al., 2008). The authors suggested DBT-A skills that targeted improving emotional dysregulation may have helped adolescent females better manage their emotions and DSH, as these deficiencies are seen as distinguishing features in this population (James et al., 2008).

Effectiveness research by Fleischhaker et al. (2011) examined the impact DBT-A in a sample of patients with DSH behaviors and borderline symptomatology over a one year time period. Their study not only demonstrated improvements with regards to suicide attempts, other DSH behaviors, depressive symptoms, and emotion regulation, but also with interpersonal and social functioning, anxiety, attention problems, and schizoid-obsessive and aggressive behaviors (Fleischhaker et al., 2011). As a result, the authors contended that DBT-A was associated with improvements in multiple domains and was well accepted by adolescents and their parents (Fleischhaker et al., 2011). As

such, the authors asserted that these findings serve as evidence for DBT-A as an effective treatment for this severe population of adolescents (Fleischhaker et al., 2011).

James, Winmill, Anderson, and Alfoadari (2011) also implemented DBT-A into a Looked After Care System in the United Kingdom with adolescents that had emotional and behavioral disorders. Similarly to Fleischhaker et al. (2011), DBT-A was shown to be effective in reducing depressive symptomatology and DSH (James et al., 2011). In addition, DBT-A was beneficial in reducing levels of hopelessness among adolescents; however, 35% of adolescents in the sample did not engage in therapy (James et al., 2011). Consequently, the authors suggested that although DBT-A was effective for the majority of adolescents in the study, adolescents with higher initial levels of depression and hopelessness at start of DBT-A may be vulnerable to dropping out and possibly require more focused support in those areas (James et al., 2011).

In addition to the above, there have been multiple studies that examined DBT-A's effectiveness with adolescents in comparison to other interventions. Rathus and Miller (2002) compared DBT-A to treatment as usual for suicidal adolescents with borderline personality symptomatology. Over a 12-week period, the DBT-A intervention consisted of twice-weekly individual therapy with a multifamily skills training group, while the treatment as usual group that received twice weekly supportive psychodynamic therapy with weekly family therapy as well (Rathus & Miller, 2002). In terms of between group differences, the adolescents in DBT-A treatment had significantly fewer inpatient hospitalizations and significantly higher treatment completion rates (62% vs. 40%); however, due to limited amount of suicide attempters during the study (n = 8) there were

no statistically significant differences in number of suicide attempts even though DBT-A group had fewer attempts (8.6% vs. 3.4%) (Rathus & Miller, 2002).

With regards to within group differences, the DBT-A group had significant reductions in levels of suicidal ideation as well as significant decreases in psychiatric and borderline symptoms (Rathus & Miller, 2002). More specifically, adolescents experienced improvements in anxiety, depression, interpersonal sensitivity, and obsessive-compulsive symptoms. In addition, adolescents showed improvement with impulsivity, emotion dysregulation, interpersonal difficulties and confusion about self (Rathus & Miller, 2002). Moreover, the authors suggested that DBT-A appears be an effective and viable treatment for adolescents with severe psychopathology such as suicidal behaviors and borderline symptomatology (Rathus & Miller, 2002).

In another study comparing DBT-A to a psychodynamic treatment as usual intervention, Katz, Cox, Gunasekara, and Miller (2004) examined the utility of DBT-A with suicidal adolescent inpatients. Katz et al. (2004) performed assessments in various areas of clinical functioning at pre-treatment, post-treatment, and at one-year follow up for the DBT-A and treatment as usual groups. Analysis of the results showed that the DBT-A was associated with significantly decreased behavior incidents in comparison to the treatment as usual group during admission (Katz et al., 2004). On the other hand, the DBT-A and treatment as usual interventions were both shown to be strongly effective in reducing DSH behaviors in addition to levels of depressive symptoms and suicidal ideation by the one-year follow up (Katz et al., 2004). As a result, the authors concluded that DBT-A not only is effective in an adolescent psychiatric setting with severe populations, but that the skills are also generalizable to the patients' everyday

environment given the level of improvement in various areas of functioning at the one-year follow up (Katz et al., 2004).

Apsche, Bass, and Houston (2006) examined the effectiveness of mode deactivation therapy (MDT) in comparison to DBT-A among adolescent males with aggression problems, conduct problems, and personality disorders in a residential treatment center. Their study demonstrated that all of the patients were positively impacted by treatment irrespective of the therapeutic intervention; however, there were also differences in their relative effectiveness for MDT and DBT-A (Apsche et al., 2006). More specifically, both interventions decreased levels physical aggression, but MDT was shown to be more effective in reducing aggressive behaviors (Apsche et al., 2006). In addition, MDT and DBT-A were both effective in treating depressive symptoms and suicidal ideation; however, MDT was also shown to be more effective than DBT-A in reducing levels of impairment in both of these areas (Apsche et al., 2006). Moreover, the authors asserted that MDT may be more effective than DBT-A in treating physical aggression, suicidal ideation, and personality disorders or traits among adolescent males in a residential setting (Apsche et al., 2006).

Wasser, Tyler, McIlhaney, Taplin, and Henderson (2008) also performed a comparison study with adolescents in a residential treatment setting. More specifically, Wasser et al. (2008) examined the effectiveness of DBT-A used in one state in comparison to Standard Therapeutic Milieu Therapy (STM), which was used in a different state. As such, adolescents were matched on demographic characteristics and Axis I diagnoses in order to compare treatment outcomes of the two interventions (Wasser et al., 2008). The findings showed that DBT-A and STM significantly decreased

depressive symptoms; however, DBT-A was more effective in reducing depressive symptoms than STM by discharge (Wasser et al., 2008). On the other hand, STM was more effective at reducing symptoms of psychomotor excitation (Wasser et al., 2008).

, McDonell et al. (2010) conducted a pilot study examining the feasibility of utilizing DBT-A for self-harming adolescents in long-term inpatient care. However, instead of comparing the DBT-A to group to another set of participants receiving an intervention, this study used a historical control group with patients that also engaged in DSH (McDonell et al., 2010). With regards to treatment outcomes, adolescents who received DBT-A had a significant improvement in overall clinical functioning that was also accompanied by a significant decrease in amount of psychotropic medications and DSH behaviors (McDonell et al., 2010). In terms of between group differences, when the effects of age, gender, length of stay, and time were controlled for, adolescents in the DBT-A group had a decreased likelihood of DSH behaviors in comparison to the historical control group (McDonell et al., 2010). As a result, the authors asserted that the preliminary findings indicate that DBT-A may be a promising treatment for adolescents that exhibit DSH and impaired functioning in long-term psychiatric care (McDonell et al., 2010).

In a more recent randomized trial with DSH adolescents, Mehlum et al. (2014) compared DBT-A versus enhanced usual care (EUC) for DSH. EUC consisted of 19 weeks of either non-manualized psychodynamic or cognitive behavioral therapy that was delivered with psychopharmacological treatment as warranted (Mehlum et al., 2014). Moreover, data on DSH behaviors, suicidal ideation, depression, and other symptoms of

borderline personality disorder were collected at pretreatment, 9-weeks, 15-weeks, and at 16-weeks (Mehlum et al., 2014).

Although adolescents in both groups had good treatment retention and a low need for the utilization of emergency, DBT-A was shown to be more effective in treating DSH behaviors, suicidal ideation, and symptoms of depression than EUC (Mehlum et al., 2014). Together with these findings, Mehlum et al. (2014) also demonstrated that DBT-A had large treatment outcome effect sizes in comparison EUC, which had small treatment outcome effect sizes. As a result, the authors suggested that DBT-A with these adolescents might not only be a suitable treatment for reducing DSH, but also suicidal ideation, and depression (Mehlum et al., 2014).

Cognitive-Based Interventions and Treatment Outcomes, Brain Structure, and Neural Activity

The use of DBT-A for treating adolescents with DSH is also important because cognitive-based interventions have been shown to not only have a positive impact on treatment outcomes, but also affect brain functioning and/or structure. For example, Kumari et al. (2011) investigated the impact of CBT on neural activity among adults with schizophrenia in a longitudinal design. Adults receiving CBT for psychosis with treatment as usual demonstrated reduced neural responses in the inferior frontal, insula, thalamus, putamen, and occipital brain regions with regards to fearful and angry facial stimuli when assessed post-treatment and compared to pre-treatment (Kumari et al., 2011). Along with these results, Kumari et al. (2011) also found that decreased neural activity was directly associated improvements in symptoms of schizophrenia.

Furthermore, Kumari et al. (2011) suggested that their findings provides support for CBT altering neural activity for threatening expressions and mediating decreases in schizophrenia symptomatology by individuals processing angry facial expressions with a more adaptive approach.

In a later study, Penades et al. (2013) examined treatment effects in a randomized clinical trial with adults with schizophrenia and healthy controls receiving either cognitive remediation therapy (CRT) or social skills training (SST). The results showed that at the completion of treatment abnormal patterns of neural activity were reduced and mirrored healthy controls and that patients with schizophrenia also had increased WM integrity of anterior portion of the corpus callosum (Penades et al., 2013). Furthermore, these functional and structural changes were also positively associated with improvements in cognition and the authors suggested that the benefits might be reflective of better transfer of information between the PFC due to the corpus callosum (Penades et al., 2013).

In another study using the cognitive-based intervention of guided imagery therapy, Wang et al. (2013) examined outcomes among adults with major depression. The findings showed that not only did adults with major depression have significant reductions in their symptomatology, but they also had increased WM integrity in their right thalamus (Wang et al., 2013). In addition, these individuals also had elevated WM integrity in the left superior frontal gyrus, which the authors asserted was a part of a frontal emotion regulation region (Wang et al., 2013). As a result, the authors contended that cognitive technique of guided image might have a remodeling effect on frontal

connections involved with mood regulation during the course of psychotherapy (Wang et al., 2013).

More recently, Goldin et al. (2014) investigated the effect of CBT on emotional reactivity and regulation among adults with social anxiety disorder (SAD) in comparison to waitlisted adults. With regards to reacting to social praise, the authors identified increased neural activation in the right superior frontal gyrus, inferior parietal lobule, and middle occipital gyrus when comparing CBT to waitlist (Goldin et al., 2014). On the other hand, with regards to reacting to social criticism, the authors identified increased neural activation in the superior frontal gyrus and inferior parietal lobule and reduced neural activation in the left poster superior temporal gyrus when comparing CBT to the waitlist (Goldin et al., 2014).

In terms of cognitive reappraisals, the results indicated that individuals in the CBT condition had larger decreases in self-reported negative emotionality and increased neural activation in the superior frontal gyrus and middle occipital gyrus and reduced neural activation in the left posterior superior temporal gyrus (Goldin et al., 2014). Moreover, after the authors controlled for the effect of self-reported negative emotionality and neural response to praise or criticism, CBT-related increases in neural activity for criticism reappraisals were predictive of CBT-related decreases in symptoms with regards to social anxiety (Goldin et al., 2014).

Lastly, there has also been DBT outcome research by Goodman et al. (2014) exploring the effect this intervention on amygdalar activity, habituation, and emotional regulation among adults with borderline personality disorder in comparison to a healthy control group. In the study, Goodman et al. (2014) exposed individuals to different types

of pictures that were classified as unpleasant, neutral, and pleasant at baseline and post-treatment of a 12-month DBT program, while the neural responding in the amygdalae of the healthy control group was used a reference point for a profile of normal activation.

The results indicated that adults with borderline personality disorder demonstrated reduced amygdalar activity for each picture condition in comparison to the control group (Goodman et al., 2014). The decreased neural activity was also more pronounced in the left hemisphere when the patients were exposed to the repeated emotional picture trials (Goodman et al., 2014). In addition, amydalar habituation in response to repeated-unpleasant stimuli was correlated with improvement on a self-report measure of emotion regulation (Goodman et al., 2014). As a result, the authors suggested that the results provide evidence that DBT has an impact on amygdalar activity, which contributes to ameliorating the emotion dysregulation that is characteristic of borderline personality disorder (Goodman et al., 2014). The authors also stated that future DBT research should examine the functional connectivity between the amygdala and PFC and its implications for emotion regulation (Goodman et al., 2014).

In summary, the results from these various studies are promising for DBT-A, as these cognitive-based treatments were shown to be effective in improving mental health outcomes as well as positively impacting brain structure and neural activity. Moreover, DBT-A has also been effective in improving the EFs of emotion regulation (Fleischhaker et al., 2011; Goldstein et al., 2007), inhibition (Rathus & Miller, 2002) and interpersonal functioning (Fleischhaker et al., 2011; Rathus & Miller, 2002) in basic clinical outcome studies as well.

Rationale for DBT-A Improving EFs in Adolescents with DSH

The five treatments targets of DBT-A are emotional, interpersonal, intrapersonal, behavioral, and cognitive dysregulation (Linehan, 1993). More specifically, DBT-A treats emotional instability, anger problems, dysfunctional relationships, and abandonment fears (Linehan, 1993). DBT-A also treats impulsivity, suicidal and/or self-harming thoughts and behaviors, problems thinking clearly, and feeling numb and/or disconnected (Linehan, 1993). The core DBT-A principle of mindfulness is essential to all DBT-A skills for improved functioning in these various areas of impairment because mindfulness allows individuals to utilize a period of time to respond to an impulse by critically evaluating a situation (Linehan, 1993). Next, individuals then choose an appropriate DBT-A skill and select an adaptive behavioral response (Linehan, 1993). The DBT-A skill of emotion regulation strengthens individuals' awareness of their emotions and ability to label them (Linehan, 1993). In addition, individuals learn to better communicate their emotions with others and utilize planning and problem solving as well as understand how emotions can be used to engender positive experiences and opportunities for effective validation (Linehan, 1993).

On the other hand, the distress tolerance skill helps individuals learn how to manage distress in the moment through a variety of coping strategies (Linehan, 1993).The next DBT-A skill of interpersonal effectiveness facilitates the ability for individuals to build healthy and beneficial relationships (Linehan, 1993). Additionally, this skill helps improve their interpersonal awareness and helps them more effectively interact with their environment (Linehan, 1993). With regards to distress tolerance, this DBT-A skill enables individuals to cope with painful emotions and difficult situations in

the moment (Linehan, 1993). In addition, the DBT-A skill of "walking the middle path" addresses the cognitive aspect by balancing the concepts of acceptance and change through dialectics and validation (Linehan, 1993). More specifically, dialectics teaches the skills of understanding multiple and possibly differing points of view, while validation teaches the skills active listening and tolerance of individuals in terms of observing and describing the emotions of self and others (Linehan, 1993).

As previously mentioned, DBT-A research with adolescents indicates that DBT-A treatment is related to improvements in suicidality, DSH, aggressive behaviors, depression, anxiety, hopelessness, fewer hospitalizations, and higher treatment completion rates. In addition, DBT-A has also demonstrated improvements in EFs such as inhibition, emotion regulation, and interpersonal functioning. Moreover, cognitive-based interventions (including DBT) have also had a positive impact on treatment outcomes and neural functioning and/or brain structure in adults. As a result, DBT-A for adolescents with DSH should also have beneficial effect in improving EFs. However, the review of the literature highlights the lack of research comprehensively examining the impact of DBT-A on DSH adolescents' EFs.

Furthermore, the DBT-A skills presented should be related to improvements in the EFs that are used in the adolescents' everyday lives such as inhibition, emotion regulation, and interpersonal functioning. This effect should also extend to the EF of shifting in terms of flexibly adjusting to situations, stressors, or problems and tolerating changes in the environment. Additionally, DBT-A skills should improve key aspects of problem solving, which are important for shifting in response to difficulties in these adolescents' daily environment. As a result, changes in these aspects of EFs and

subsequent treatment implications for potential brain and behavior relationships involving prefrontal networks will be examined in this study.

Other Factors Potentially Affecting Executive Functioning

This study will also examine if factors such as gender, age, ethnicity, funding type, and previous history of psychiatric hospitalizations differentially affect EF outcomes for various groups of adolescents receiving DBT-A. Research by Huizinga and Smidts (2012) found age and gender differences in EFs on the BRIEF-SR among Dutch adolescents. In terms of ethnicity, findings on prevalence rates of DSH have been mixed (Gratz, 2001; Guertin et al., 2001; Nock & Mendes, 2008; Zetterqvist et al., 2013). As a result, EF outcomes among the groups in the study may also be differentially affected.

With regards to DSH adolescents receiving DBT-A, other research has examined mental health outcomes based on funding type (i.e. insurance-funded versus grant-funded) and found improvements in clinical functioning irrespective of funding type (James et al., 2014). On the other hand, another unpublished preliminary study, found differences based on funding type and history of psychiatric hospitalizations for initial status of clinical functioning entering the DBT-A program; however, similarly to the previously mentioned study, adolescents in the different groups improved at the same rate (James et al., 2013). As such, these factors of importance may potentially impact EF outcomes.

CHAPTER THREE

RESEARCH DESIGN

The purpose of this study was to examine changes in levels of EFs in DSH adolescents receiving DBT-A. The first goal was to investigate the treatment effectiveness of DBT-A in reducing adolescents' scores on specific scales of the BRIEF-SR as well as on the overall composite from baseline to post-treatment assessment. The second goal was to investigate the impact of factors such as gender, age, ethnicity, funding type, and previous history of psychiatric hospitalizations on EF pre- post-change scores. In order to address the aims of the study two hypotheses were developed as indicated below.

Hypotheses

Hypothesis 1: There will be a significant reduction in the level of executive dysfunction for adolescents' baseline and post-treatment scores on the Inhibition scale, Emotional Control scale, Monitor scale, Shift scale, and the Global Executive Composite (GEC) of the BRIEF-SR.

Hypothesis 2: Gender, age, ethnicity, funding type, and previous history of psychiatric hospitalizations will be predictive of EF pre- post-change scores on the Emotional Control scale, Monitor scale, Shift scale, and GEC of the BRIEF-SR.

Method

Participants

Participants were selected from a de-identified dataset of adolescents who attended an intensive outpatient program for adolescent DSH at a major university treatment facility in Southern California. More specifically, adolescents between the ages of 12-18 were admitted to the program if they endorsed symptoms of emotion dysregulation, behavioral problems, and DSH during the clinical intake interview. Adolescents included in the study were selected from a larger group of 260 participants based on if they completed the BRIEF-SR at baseline and at post-treatment, were no longer attending the program as of December 31, 2014, and graduated from the program. Graduates were defined as adolescents who completed at least 30 or more sessions and/or were deemed clinically appropriate to be successfully discharged from the program. The current study reported on 93 adolescents who satisfied the inclusion criteria.

Materials

In terms of demographic variables, Information about participants' age, gender, ethnicity, funding type, previous history of psychiatric hospitalizations, and number of days attended in program was collected directly from the patient at intake or through a chart review. The information was then entered into a database and was de-identified before use in the current study.

With respect to the outcome measure, The Behavior Rating Inventory of Executive Function - Self-Report Version (BRIEF-SR) was used to examine changes in self-perception of EFs among adolescents. This self-report, face-valid rating scale

captures an individual's view of EFs at home, school, and their daily environment (Guy, Isquith, & Gioia, 2004). The BRIEF-SR was intended to measure EFs for children and adolescents 11 to 18 years of age that can read at a 5th grade reading level or higher (Guy et al., 2004). The BRIEF-SR consists of 80 items, eight non-overlapping clinical scales, two indices, and an overall composite score, which are used to measure various aspects of EFs (Guy et al., 2004). In addition, there is an Inconsistency Scale and Negativity scale, which serve as the validity measures (Guy et al., 2004).

The eight clinical scales measure inhibition, shifting, emotional control, monitoring, working memory, planning and organizing, organization of materials, and task completion (Guy et al., 2004). The Inhibit Scale "assesses inhibitory control (i.e. the ability to inhibit, resist, or not act on impulse) and ability to stop one's own behavior," while the Shift scale "assesses the ability to move freely from one situation, activity, or aspect of a problem to another, as the circumstances demand" (Guy et al., 2004). The Emotional Control Scale " addresses the manifestation of EFs within the emotional realm and assesses an adolescent's ability to modulate emotional responses" (Guy et al., 2004). The Monitor Scale "measures a personal self-monitoring function – the extent to which the adolescent keeps track of the effect that his or her behavior has on others," while the Working Memory Scale "measures the capacity to actively hold information in mind for the purpose of completing a task or generating a response" (Guy et al., 2004). The Plan/Organize Scale "assesses the adolescent's ability to manage current and future-oriented task demands within a situational context" (Guy et al., 2004).

On the other hand, the Organization of Materials Scale "assesses organization in the adolescent's everyday environment with respect to orderliness of work, play, and

storage spaces," while the Task Completion Scale " assesses the adolescent's ability to finish or complete tasks appropriately and/or in a timely manner" (Guy et al., 2004). An example item on the BRIEF-SR from the Inhibition Scale would be, "I don't think of consequences before acting." Respondents would then the have the option to rate this item as *Never*, *Sometimes*, and *Often*.

The two indices are comprised of the Behavioral Regulation Index and Metacognition Index. The Behavioral Regulation Index measures an " adolescent's ability to maintain appropriate regulatory control of his or her behavior and emotional responses" (Guy et al., 2004). This index consists of the Inhibit, Shift, Emotional Control, and Monitor Scales (Guy et al., 2004). The Metacognition Index "assesses the ability to systematically solve problems via planning and organization while sustaining task these task completion efforts in active working memory" (Guy et al., 2004). This index consists of the Working Memory, Plan/Organize, Organization of Materials, and Task Completion Scales (Guy et al., 2004).

Lastly, the Global Executive Composite (GEC) is the overall executive dysfunction summary score derived from the Behavioral Regulation and Metacognition Indices, which is used to measure the behavioral and cognitive aspects of EFs (Guy et al., 2004). The BRIEF-SR is based on a mean of 50 and a standard deviation of 10 where scores above 65 are considered clinically significant and are indicative of difficulties in a particular domain of EFs (Guy et al., 2004). In addition, scores ranging from 60-64 are considered as falling in the at-risk range, while scores of 59 or lower are considered as falling in the average range (Guy et al., 2004). Additionally, the BRIEF-SR shows moderate to high internal consistency (α = .72 to .96). The Inhibit (α = .87), (Emotional

Control (α = .86), Monitor (α = .73), and Shift (α = .82), scales along with the Global Executive Composite (α = .96) were used to measure executive dysfunction.

Treatment Protocol

The Shield program is an intensive outpatient treatment for adolescent males and females that engage in DSH. The Shield Program, which is located at the Behavioral Medicine Center, utilizes a modified version Miller's DBT-A model where patients attend the DBT-A program twice a week for 16 weeks. In this model, an adolescent skills training group, parent skills training group, multifamily skills training group, and individual therapy sessions for each adolescent are a part of the comprehensive DBT-A treatment. During this program, the core DBT-A skills of mindfulness, emotion regulation, distress tolerance, interpersonal effectiveness, and "walking the middle path" are taught and reinforced. In the weekly adolescent group patients develop these skills and other strategies in order reduce and ultimately stop self-harming patterns of behavior. The other goal of this group is to help adolescents more effectively regulate their emotions in order for them to better tolerate and manage emotional pain and distress.

In the weekly multifamily skills group, adolescents and parents learn the DBT-A skills together, which allows for parents to develop their skills as effective coach for their child while also learning strategies for improving family communication. The weekly parent skills training group is focused on helping caregivers develop skills to cope with their possible emotional difficulties, frustration, and guilt associated with parenting adolescents with DSH. More specifically, parents learn about DBT-A skills and family roles, which in turn provides them with tools and strategies to help prevent negative

residual emotional and physical effects from DSH behaviors. In addition, adolescents also meet with their DBT-A therapist weekly in order to assess their individual progress in the program and to solve their problems.

As previously mentioned, the DBT-A program was a modified version of Miller's model. This was due to the limited resources and demands of the treatment facility. Patients are referred to a clinical setting where they are expected to receive efficient service delivery. As a result, telephone consultations could not be provided to adolescents and parents. This is important to note because in the same way parents learn to coach their children and remind them of DBT-A skills in order to manage their emotions, the consultations also serve to reinforce these skills for both adolescents and parents.

Another modification was that adolescents were not required to enter the DBT-A program at the mindfulness module. This again was due to the nature of the outpatient facility and the referral process where the focus is on helping the adolescents receive treatment as opposed to a more research-focused institution where there is a heightened emphasis on research design. In addition, there were supplemental adolescent and parent support groups structured from other adolescent programs at the site. The adolescent group also included music and art therapy, while the parent group was educational with regards to discussing the concepts of DBT-A and parenting issues. With regard to the BRIEF-SR, this assessment tool as well as other measures, were administered at baseline and at post-treatment at the end of 16 weeks.

Analysis of Data

In examining the demographic variables, Chi-square goodness of fit tests were

used to assess for differences in gender, ethnicity, funding type, and number of psychiatric hospitalization among the study participants. It should be noted that ethnicity and number of psychiatric hospitalizations were collapsed into two categories, respectively, Caucasian and other ethnicity groups combined and previous history of psychiatric hospitalizations (yes or no). In order to assess for any demographic differences between the sample group and the remaining graduates in the database, Chi-square tests of independence were used to assess for differences in gender, ethnicity, previous history of psychiatric hospitalizations, and funding type. Independent *t*-tests were used to assess for mean differences in age and number of treatment days among graduates who completed the BRIEF-SR and graduates who did not complete the BRIEF-SR. In addition, assumptions for normality were met and there was also no multicollinearity among predictors. In terms of missingness, the 93 graduates who completed the BRIEF-SR used in the primary analyses had complete data.

Hypothesis 1: Paired *t*-test analyses were performed to examine changes in level of EFs at baseline to post-treatment for the Inhibition scale, Emotional Control scale, Monitor scale, Shift scale, and GEC. An a priori analysis indicated that in order to achieve a power of .80 with a moderate effect size ($d = .5$) and an alpha level of .05, a sample size of 34 participants was required. Based on the current sample size ($n = 93$), the achieved power with an effect size of .5 is at .99. The Bonferroni correction method was used to correct multiple comparisons.

Hypothesis 2: In terms of predictors, a preliminary bivariate correlational analysis was performed with gender, age, ethnicity, previous history of psychiatric hospitalizations, and funding type with the Inhibition scale, Emotional Control scale,

Shift scale, Monitor scale, and the GEC. The significant correlations were then used to build four linear regression models with these factors as predictors of EF change scores. For the correlational and regression analyses, ethnicity was again collapsed into two categories (Caucasian and other ethnicity groups combined) (see Table 1).

Table 1. Correlational analyses of predictors with the pre- post-change scores on the BRIEF-SR scales.

Variable	1	2	3	4	5	6	7	8	9	10
1. Gender	-									
2. Age	.03	-								
3. Ethnicity	-.03	-.02	-							
4. Hospital	.08	.03	-.05	-						
5. Funding	-.02	.11	.09	.06	-					
6. Inhibit	-.11	.02	-.03	-.08	-.19	-				
7. Emotional	.002	-.05	-.11	-.23*	-.20	.47**	-			
8. Shift	.001	.04	-.22*	-.04	-.23*	.55**	.61**	-		
9. Monitor	.01	-.01	-.20	-.12	.28**	.42**	.50**	.52**	-	
10. GEC	-.01	.06	-.07	-.09	-.23*	.70**	.78**	.79**	.64**	-

Note. Hospital = previous history of psychiatric hospitalization; Funding = funding type; Inhibit = Inhibit Scale; Emotional = Emotional Control Scale; Shift = Shift Scale; Monitor = Monitor Scale; GEC = Global Executive Composite
*$p < .05$
**$p < .01$

CHAPTER FOUR

RESULTS

Adolescent Demographics

A total of 93 adolescents were involved in the study. There were 12 males and 81 females, with a mean age of 15.05 years (*SD* = 1.40). There were significantly more females than males in the current sample, χ^2 (1, *n* = 93) = 51.19, *p* < .01. Similarly, the current sample showed significant differences in terms of ethnicity as the majority of the patients identified as Caucasian as compared to the other ethnicity groups combined χ^2 (1, *n* = 93) = 5.69, *p* < .05. Likewise, there were significantly more adolescents with a previous history of psychiatric hospitalizations than adolescents without a previous history, χ^2 (1, *n* = 93) = 9.04, *p* < .01. There was no significant effect for funding type as a total of 56 patients paid for treatment with their insurance providers, while 37 patients were grant-funded, χ^2 (1, *n* = 93) = 3.88, *p* > .05.

A comparison of demographic information between graduates who completed and did not complete the BRIEF-SR was also performed. There were no observed significant differences for gender, age, ethnicity, funding type, previous history of psychiatric hospitalizations, or treatment days (*p* > .05) suggesting that the study sample group is similar to the graduates who did not complete the BRIEF-SR. Table 2 provides further information regarding patient demographics along with a comparison of demographic information between graduates who completed and did not complete the BRIEF-SR.

Table 2. Shield graduate demographic information for BRIEF-SR completers and non-completers.

Demographic Information	Completers (N = 93) *n* (%)	Non-Completers (*N* = 70) *n* (%)
Gender*		
Male	12	9
Female	81	61
Ethnicity*		
Caucasian	58	40
African-American	3	2
Hispanic	19	17
Asian	4	1
Other	9	10
History of Previous Hospitalizations*		
Yes	61	49
No	32	21
Funding Type		
Insurance	56	41
Grant-funded	37	29
	M (SD)	M (SD)
Age	15.05 (1.40)	14.99 (1.36)
Number of Treatment Days	30.73 (3.58)	30.12 (2.91)

Note. M = mean; SD = standard deviation
* $p < .05$ in regards to demographic differences within the sample group

Paired T-test Analyses

There was statistically significant improvement in scores from the at-risk range to the non-clinical range for the Emotional Control scale from baseline (M = 63.86, SD = 12.37) to post-treatment (M = 55.67, SD = 12.47), t (92) = 6.69, $p < .01$, Shift scale from baseline (M = 61.54, SD = 13.76) to post-treatment (M = 54.23, SD = 13.55), t (92) = 5.24, $p < .01$, Monitor scale from baseline (M = 60.08, SD = 13.44) to post-treatment (M = 51.35, SD = 12.16), t (92) = 5.71, $p < .01$, and GEC from baseline (M = 64.25, SD = 15.47) to post-treatment (M = 55.40, SD = 14.95), t (92) = 6.01, $p < .01$ (see Table 3). Although there was a statistically significant reduction on the Inhibit scale from baseline (M = 57.89, SD = 14.00) to post-treatment (M = 52.72, SD = 11.99), t (92) = 3.99, $p <$ .01), adolescents' scores were already in the non-clinical range entering treatment (see Table 3).

Table 3. Baseline to post-treatment EF outcomes among self-harming adolescents who completed DBT-A.

	Baseline EF Scores	Post-Treatment EF Scores	Paired Differences	*t*	*df*	*p*	95% CI
	M (SD)	M (SD)	M (SD)				
Inhibit	57.89 (14.00)	52.72 (11.99)	5.17 (12.50)	3.99	92	.001**	[2.60, 7.75]
Emotional	63.86 (12.37)	55.67 (12.47)	8.19 (11.81)	6.69	92	.001**	[5.76, 10.63]
Shift	61.54 (13.76)	54.23 (13.55)	7.31 (13.47)	5.24	92	.001**	[4.54, 10.09]
Monitor	60.08 (13.44)	51.35 (12.16)	8.72 (14.72)	5.71	92	.001**	[5.69, 11.75]
GEC	64.25 (15.47)	55.40 (14.95)	8.85 (14.21)	6.01	92	.001**	[5.92, 11.78]

Note. Inhibit = Inhibit Scale; Emotional = Emotional Control Scale; Shift = Shift Scale; Monitor = Monitor Scale; GEC = Global Executive Composite; *t* = *t* value; *df* = degrees of freedom; M = mean; SD = standard deviation; *p* = *p* value; CI = confidence interval
**$p < .01$

Linear Regression Analyses

In order to address the second research question, four separate multiple regressions were proposed using each pre- post-change score scale on the BRIEF-SR as the criterion variable. In order to determine the appropriateness of the predictor variables, the relationship between each predictor variable and criterion variable was assessed using correlations (see Table 1). The relationship among the predictors was also explored in order to assess for multicollinearity. Results indicated that there was a significant relationship between previous history of psychiatric hospitalizations and change scores on the Emotional Control scale (r = -.23, p < .05), while there were no significant effects observed for gender, age, ethnicity, or funding type on this scale.

As such, previous history of psychiatric hospitalization was the only predictor variable included in the first regression using Emotional Control as the criterion. In regards to the Shift subscale, significant predictors included funding type (r = -.23, p < .05) and ethnicity (r = -.22, p < .05), which were both included in the second multiple regression. There were no significant effects for age, gender, and previous history of psychiatric hospitalizations. For the third regression, only funding type was related to the change scores on the Monitor scale (r = -.28, p < .01) and was therefore the only predictor included in the analysis. Funding type was also the only significant predictor for the GEC (r = -.23, p < .05) variable. Please see Table 4 through 7 for a summary of variables included in each of the regression analyses along with the means and standard deviations of each of the change scores.

Table 4. Means and standard deviations for previous history of psychiatric hospitalizations on the emotional control scale change scores.

Predictor Variable	M	SD
Previous Hospitalizations		
No	11.90	12.97
Yes	6.24	10.76
Total	8.19	11.81

Note. Previous Hospitalizations = previous history of psychiatric hospitalizations; M = mean; SD = standard deviation; Higher scores indicate greater pre-post change improvement across treatment

Table 5. Means and standard deviations for funding type on the shift scale change scores.

Predictor Variable	M	SD
Funding Type		
Grant	11.13	12.92
Insurance	4.78	13.32
Total	7.31	13.46

Note. M = mean; SD = standard deviation; Higher scores indicate greater pre-post change improvement across treatment

Table 6. Means and standard deviations for funding type on the monitor scale change scores.

Predictor Variable	M	SD
Funding Type		
Grant	13.70	14.14
Insurance	5.43	14.28
Total	8.72	14.72

Note. M = mean; SD = standard deviation; Higher scores indicate greater pre-post change improvement across treatment

Table 7. Means and standard deviations for funding type on the GEC change scores.

Predictor Variable	M	SD
Funding Type		
Grant	12.78	13.58
Insurance	6.25	14.13
Total	8.85	14.21

Note. M = mean; SD = standard deviation; Higher scores indicate greater pre-post change improvement across treatment

In order to assess the relationship between previous history of psychiatric hospitalizations and the Emotional Control scale change scores, a simple linear regression was conducted. Results indicated that approximately 5.0% of the proportion of variance on the Emotional Control scale change scores was accounted for by previous history of psychiatric hospitalizations and this proportion was significant [R^2 = .05, adjusted R^2 = .04, $F(1, 91) = 5.03$, $p < .05$] (see Table 8). On average, adolescents with no previous history of psychiatric hospitalizations had a pre- post-change score that was 5.66 points higher than adolescents with one or more previous psychiatric hospitalizations on the Emotional Control scale (b = -5.66, 95% CI [-10.67, -.65], β = -.23, $t(91) = -2.24$, $p <$ .05) (see Table 8). In other words, adolescents without a previous history of psychiatric hospitalizations experienced a greater magnitude of change over the course of DBT-A treatment when compared to adolescents with a previous history of hospitalizations in regards to their emotion regulation.

Table 8. Linear regression model for previous history of psychiatric hospitalizations and emotional control scale change scores.

Predictor Variable	*b*	*SE*	95% CI (*b*)	β	*p*
Previous Hospitalizations	-5.66	2.52	[-10.67, -.65]	-.23	.03*

Note. Previous Hosp. = previous history of psychiatric hospitalizations; *b* = unstandardized regression coefficient; *SE* = standard error; 95% CI (*b*) = the 95% confidence interval associated with the unstandardized regression coefficient; β = standardized regression coefficient; *p* = *p*-value
*$p < .05$

As there were significant correlations with both funding type and ethnicity on the Shift scale change scores, the second model was performed using the stepwise regression method with these predictors. This approach was utilized as neither of these variables was viewed as more important than the other conceptually or in the research literature for predicting shifting skills. The results indicated that after the effect of funding type was accounted for ethnicity did not significantly add to the model and was excluded from the analysis. Approximately 5.0% of the proportion of variance on the Shift scale change scores was accounted for by funding type and this proportion was significant [R^2 = .05, adjusted R^2 = .04, $F(1, 91) = 5.18$, $p < .05$] (see Table 9). On average, grant-funded adolescents had a pre- post-change score that was 6.35 points higher than insurance-funded adolescents on the Shift scale. (b = -6.35, 95% CI [-11.89, -.81], β = -.23, $t(91) = -2.25$, $p < .05$) (see Table 9). As a result, grant-funded adolescents experienced a greater magnitude of change over the course of DBT-A treatment when compared to insurance-funded adolescents in regards to their shifting skills.

Table 9. Linear regression model for funding type and shift scale change scores.

Predictor Variable	*b*	*SE*	95% CI (*b*)	β	*p*
Funding Type	-6.35	2.79	[-11.89, -.81]	-.23	.03*

Note. *b* = unstandardized regression coefficient; *SE* = standard error; 95% CI (*b*) = the 95% confidence interval associated with the unstandardized regression coefficient; β = standardized regression coefficient; *p* = *p*-value
*$p < .05$

In order to assess the relationship between funding type and the Monitor scale and GEC change scores, two simple linear regressions were conducted. Results indicated that approximately 8.0% of the proportion of variance on the Monitor scale change scores was accounted for by funding type and this proportion was significant [R^2 = .08, adjusted R^2 = .07, $F(1, 91) = 7.54$, $p < .01$] (see Table 10). On average, grant-funded adolescents had a pre- post-change score that was 8.27 points higher than insurance-funded adolescents on the Monitor Scale (b = -8.27, 95% CI [-14.26, -2.29], β = -.27, $t(91) = -2.75$, $p < .05$) (see Table 10). As a result, grant-funded adolescents experienced a greater magnitude of change over the course of DBT-A treatment when compared to insurance-funded adolescents in regards to their interpersonal functioning.

Table 10. Linear regression model for funding type and monitor scale change scores.

Predictor Variable	*b*	*SE*	95% CI (*b*)	β	*p*
Funding Type	-8.27	3.01	[-14.26, -2.29]	-.28	.01*

Note. *b* = unstandardized regression coefficient; *SE* = standard error; 95% CI (*b*) = the 95% confidence interval associated with the unstandardized regression coefficient; β = standardized regression coefficient; *p* = *p*-value
*$p < .05$

Additionally, the results indicated that approximately 5.0% of the proportion of variance on the GEC change scores was accounted for by funding type and this proportion was significant [R^2 = .05, adjusted R^2 = .04, F(1, 91) = 4.91, p < .05] (see Table 11). On average, grant-funded adolescents had a pre- post-change score that was 6.53 points higher than insurance-funded adolescents on the GEC (b = -6.53, 95% CI [-12.39, -.68], β = -.23, t(91) = -2.22, p < .05) (see Table 11). As a result, grant-funded adolescents experienced a greater magnitude of change over the course of DBT-A treatment when compared to insurance-funded adolescents in regards to their overall executive functioning.

Table 11. Linear regression model for funding type and GEC change scores.

Predictor Variable	*b*	*SE*	95% CI (*b*)	β	*p*
Funding Type	-6.53	2.95	[-12.39, -.68]	-.23	.03*

Note. GEC = Global Executive Composite; *b* = unstandardized regression coefficient; *SE* = standard error; 95% CI (*b*) = the 95% confidence interval associated with the unstandardized regression coefficient; β = standardized regression coefficient; *p* = *p*-value
*$p < .05$

CHAPTER FIVE

DISCUSSION

Patient Demographic Findings

The demographic characteristics of graduates who completed the BRIEF-SR were generally consistent with other DBT-A findings. More specifically, the larger amount of female participants and age of the sample observed in this study was similar to prior DBT research in adolescents with DSH (James et al., 2011; James et al., 2014; McDonell et al., 2010; Mehlum et al., 2014; Uliaszek et al., 2013). However, despite the lower amount of males in the study, other research with community samples has demonstrated that adolescent males are still at-risk to engage in DSH (Guerreiro et al., 2013; Laye-Gindhu & Schonert-Reichl, 2005) as this may be related to deficits in EFs. As a result, increasing recruitment among adolescent males with DSH in future DBT-A studies will provide this underserved population with more opportunities for treatment as an adapted form of DBT has already been shown to be effective in improving mental health outcomes among aggressive, incarcerated adolescent males (Shelton, Kesten, Zhang, & Trestman, 2011). This expanded focus will also provide evidence for DBT-A's generalizability in improving EFs and allow for a more comprehensive gender analysis of EF outcomes.

In terms of ethnicity, more Caucasian adolescents with DSH were enrolled than other ethnic groups in this intensive outpatient setting as this was consistent with other DBT-A research with DSH adolescents in outpatient (James et al., 2014; Uliaszek et al., 2013), residential (Sunseri, 2004), and clinical trial (Mehlum et al., 2014) settings. Although prevalence rates of DSH among ethnicities in studies have been mixed in terms

of finding differences (Gratz et al., 2012; Guertin et al., 2001; Hilt et al., 2008; Zetterqvist et al., 2013), engagement of at-risk adolescents from these underrepresented ethnic groups in DBT-A needs to be augmented to help treat their impaired EFs as evidenced by their lack of enrollment in this study. Consequently, improving community outreach efforts for these minority groups and utilizing a form of DBT-A that is more culturally adapted to patients may serve to increase enrollment and improve EF outcomes as this type of approach has been shown to be effective across other mental health interventions (Griner & Smith, 2006).

With regards to previous history of psychiatric hospitalizations, more adolescents received treatment than did not before starting DBT-A (66% to 34%) and these findings were similar to other DBT-A studies with DSH adolescents (James et al., 2014; Mehlum et al., 2014). However, DSH adolescents without the previous exposure to these psychiatric services were more severe in terms of impaired emotional regulation, but experienced a greater magnitude change on their pre- post change scores. As such, earlier detection and identification of these high-risk patients for treatment with DBT-A may lead to greater improvements in EF outcomes as other early psychological intervention programs have been shown to reduce externalizing psychopathology among adolescents with borderline personality disorder (Chanen et al., 2008).

Funding type, which was viewed as a gross indicator of socioeconomic status, was consistent with the findings of James et al. (2014) as there were more insurance-funded adolescents than grant-funded adolescents (60% to 40%) in this study. Additionally, most of the adolescents who received grant assistance were individuals that either received or were eligible for Medicaid based on their families' income level. Based

on the findings, the DBT-A program at the treatment facility in the study should be further expanded to include more grant-funded adolescents from economically challenged backgrounds as they demonstrated a greater magnitude of change on their pre-post EF change scores in terms of shifting, interpersonal functioning, and overall executive functioning than insurance-funded adolescents. Providing this comprehensive treatment for these patients is a clinical necessity as adolescents from disadvantaged socioeconomic backgrounds are at 2-3 times higher risk for developing mental health problems in addition to having an earlier onset of mental health problems (Reiss, 2013).

Lastly, graduates who completed the BRIEF-SR did not significantly differ from graduates who did not complete the BRIEF-SR with regards to gender, age, ethnicity, previous history of psychiatric hospitalizations, and number of treatment days. These results suggest that the study findings should be generalizable to the graduates that did not complete the BRIEF-SR.

Changes in Baseline and Post-treatment Functioning

In regards to the primary aim of the study, the results indicated that DSH adolescents collectively experienced significant improvement from the at-risk to non-clinical range with regards to emotion regulation, shifting, interpersonal functioning, and with overall executive functioning from baseline to post-treatment. Because this a novel outcome study, it is important to gauge these improvements in baseline to post-treatment functioning in the context of other outcome research with clinically severe adolescents and the BRIEF-SR as well. Like adolescents with DSH, individuals with anorexia nervosa also have EF deficits in inhibition (Kullmann et al., 2014), emotion regulation

(Manuel & Wade, 2013), shifting (Galimberti et al., 2013), and interpersonal functioning (Carter, Kelly, & Norwood, 2012).

Dahlgren, Lask, Landro and Ro (2014) examined EF outcomes with the BRIEF-SR following the completion of cognitive remediation therapy with female adolescents with anorexia nervosa. When compared to the current study, adolescents with DSH had higher levels of executive dysfunction on the Inhibit scale, Emotional scale, Monitor scale, and GEC at baseline (all in the at-risk range). Although adolescents with anorexia nervosa had slightly higher levels of executive dysfunction on the Shift scale at baseline, adolescents with DSH still scored in the at-risk range as well for that scale. Notably, adolescents with DSH experienced greater improvement from baseline to post-treatment on all the previously mentioned scales and the GEC when compared to adolescents with anorexia nervosa.

Additionally, in order to appreciate the clinically severity of DSH adolescents' initial EF scores entering DBT-A, it is important to compare these findings against other adolescent populations with neurological impairments known to disrupt EFs. When compared to adolescents' EF scores on the BRIEF-SR following traumatic brain injury (Byerley & Donders, 2013; Wilson, Donders, & Nguyen, 2011) or adolescents with epilepsy (Slick, Lautzenhiser, Sherman, & Eyrl, 2006), spina bifida (Zabel et al., 2011), or specific language impairment (Hughes, Turkstra, & Wulfeck, 2009), DSH adolescents' baseline scores correspond with higher levels of EF dysfunction than these groups. However, despite adolescents with DSH having more elevated scores than these populations with neurological deficits, these adolescents nonetheless showed improvement from the at-risk to non-clinical range in their EFs by the conclusion of

DBT-A. As such, the skills presented in DBT-A appear to be a very effective intervention for improving EFs in DSH adolescents with severe deficits.

On the other hand, adolescents also experienced a statistically significant reduction in EF symptoms with regards to inhibition despite their scores at baseline already falling in the non-clinical range. However, these scores on the Inhibit scale were surprising given DSH adolescents' neurobiological vulnerability for problems with inhibition (Crowell et al., 2005; Fikke et al., 2013) and observed difficulty with this EF on neuropsychological tasks (Fikke et al., 2011) and with self-report measures (Cloutier et al., 2010; Madge et al., 2011). The lack of convergence of the BRIEF-SR with performance-based, neuropsychological measures of inhibition may be related to the BRIEF-SR only capturing specific aspects of inhibition in the daily activities of DSH adolescents that are not problematic for them. Moreover, various studies have demonstrated that self-report and performance-based measures of EFs do not always correlate strongly with each other and can capture different levels of cognition and functioning (Buchanan, 2015; Toplak, West, & Stanovich, 2013). Likewise, the discrepancies between self-report instruments may be related to the scales in the studies by Cloutier et al. (2010) and Madge et al. (2011) assessing different aspects of inhibition as these measures were a part of psychiatric inventories rather than a neuropsychological EF inventory like the BRIEF-SR.

In summary, the baseline to post-treatment EF analysis uniquely contributed to the understanding of DSH adolescents in DBT-A by providing a neuropsychological treatment profile for clinicians and researchers. Because the BRIEF-SR has not been extensively researched with this population, this analysis provided a subjective view of

changes in EFs that are used in these adolescents' everyday environment. Adolescents with DSH entering DBT-A have EF deficits that are largely more severe than adolescents with anorexia nervosa (Dahlgren et al., 2014) as well as adolescents with traumatic brain injury (Byerley & Donders, 2013; Wilson et al., 2011), epilepsy (Slick et al., 2006), spina bifida (Zabel et al., 2011), specific language impairment (Hughes et al., 2009). This pre-treatment profile was characterized by clinically elevated problems with emotion dysregulation, shifting, interpersonal functioning, and overall executive functioning and a lack of difficulty with inhibition.

Knowledge of these pre-treatment deficits is important because this will allow clinicians to tailor treatment to specific DBT skills. For example, emphasis should be placed on presenting the DBT skills of emotion regulation, distress tolerance, and interpersonal effectiveness throughout therapy since they directly map on to treating the specific problem areas of emotion dysregulation, shifting, and interpersonal functioning in these DSH adolescents.

At the conclusion of DBT-A, the post-treatment profile was characterized by improvements from the at-risk to non-clinical range in the aforementioned areas of EF deficits as well as by the maintenance of below clinical levels of inhibition problems. Furthermore, these improvements surpassed changes observed in adolescents with anorexia nervosa enrolled in cognitive remediation therapy that also have EF dysfunction (Dahlgren et al., 2014). Awareness of this trajectory will allow clinicians to better gauge what kind of changes in EFs to expect by the end of DBT-A during this sensitive period of neural development. As a result, this will also allow clinicians to better inform

adolescents with DSH and their parents about potential improvements in EFs and possibly instill hope and commitment among them for DBT-A before starting treatment.

Based on this baseline to post-treatment analysis, the next step in research is to add a control group and/or comparison therapy group with random assignment and then determine the relative contribution of each DBT-A skill (mindfulness, emotion regulation, distress tolerance, interpersonal effectiveness, and walking the middle path) to each specific EF. This will help clarify the direct role of each DBT-A skill in the course of treatment with DSH adolescents. After these relationships have been established, additional scales and composites on the BRIEF-SR such as Working Memory, Plan/Organize, Organization of Materials, Task Completion, Metacognition Index, and the Behavioral Regulation Index, should be included to determine if and how DBT-A skills help improve these areas of EFs.

In addition, the neuropsychological treatment profile from the BRIEF-SR should be used in future DBT-A outcome studies that utilize neuroimaging and other neuropsychological measures to analyze brain-behavior relationships in the context of EFs. This combined approach will provide researchers with not only a neurobiological and an objective, neuropsychological view of EFs, but also with DSH adolescents' unique, self-perception of EFs in their daily lives. This will allow for a more complete viewpoint of changes. Because the adolescent's brain is ever changing (Blakemore & Choudhury, 2006) and cognitive-based interventions have been shown to positively affect neural activation (Goldin et al., 2014; Kumari et al., 2011) and structure (Penades et al., 2013; Wang et al., 2013), this future research can assess if the self-reported changes in EFs from DBT-A correlate with changes in brain structure, neural activation, and with

improvement on objective neuropsychological testing of EFs during this critical period of neural development.

Impact of Demographic Variables

The final primary aim of the study was to determine how predictors such as gender, age, ethnicity, funding type, and previous history of psychiatric hospitalizations differentially affect EF pre- post change scores for DSH adolescents receiving DBT-A. Preliminary correlational analyses with the predictors demonstrated that previous history of psychiatric hospitalizations significantly correlated with change scores on the Emotional Control scale ($p < .05$) and funding type and ethnicity significantly correlated with change scores on the Shift Scale ($p < .05$). Funding type also significantly correlated with change scores on the Monitor scale and GEC ($p < .05$). These variables were then used in the succeeding linear regression analyses.

On the other hand, the predictors of age and gender did not correlate with any of the change scores ($p > .05$). These findings for age were especially surprising as previous research with a Dutch parent report version of the BRIEF demonstrated age-related reductions in executive dysfunction on the majority of the scales with the exception of the Shift scale (Huizinga & Smidts, 2011). This may indicate that DBT-A is similarly effective for improving EF outcomes among older and younger adolescents with DSH.

Another possibility is that this discrepancy between studies may be related to differences in parent and adolescent responding styles. More specifically, various research with parent and self report forms of the BRIEF has demonstrated that parents can endorse higher levels of executive dysfunction than adolescents (Hughes et al., 2009;

Wilson et al., 2011), in contrast to another study, which demonstrated that adolescents can report higher levels of executive dysfunction than their parents (Dahlgren et al., 2014). Consequently, potential DBT-A research with DSH adolescents could possibly incorporate the self-report and parent report forms of the BRIEF to more comprehensively examine age-related improvements in EFs and assess for any discrepancies between the versions.

In terms of gender, Huizinga and Smidts (2011) also demonstrated that females had less executive dysfunction than males on the parent version of the BRIEF. However, the current study had significantly less males than females (12 to 81; $p < .05$). As a result, future DBT-A studies examining EF change scores should strive to increase the enrollment of DSH adolescent males to improve the power to detect differential effects associated with gender.

With respect to the linear regression analyses, the first model with the Emotional Control scale regressed on previous history of psychiatric hospitalizations was significant ($p < .05$). The model demonstrated that adolescents without a previous history of psychiatric hospitalizations experienced a greater magnitude of change in the course of treatment for their emotion regulation skills (5.66 points) than adolescents with a previous history. This may possibly be related to adolescents with a previous history of psychiatric hospitalizations receiving a more intensive level of care earlier than adolescents without a previous history of psychiatric hospitalizations as the latter group had higher scores of EF dysfunction on the Emotional Control scale at baseline.

Research has demonstrated that adolescents who have received inpatient psychiatric services have had beneficial outcomes in clinical functioning following

discharge due to increased exposure to intervention and support. More specifically, Clemens, Welfare, and Williams (2011) asserted that following psychiatric hospitalizations, improved communication among outpatient and inpatient providers, school staff, family members, and adolescents might facilitate the process of adolescents successfully re-integrating back into school. Additionally, the authors contended that individualized, comprehensive re-entry plans, support from all parties involved including the adolescent, and consistency of care following psychiatric hospitalization may beneficially affect school re-integration (Clemens, Welfare, & Williams, 2011).

Furthermore, Czyz, Liu, and King (2012) examined the role social connectedness in suicidal adolescents following psychiatric hospitalization. The authors demonstrated that following this acute psychiatric care, adolescents that experienced increased connectedness had a decreased probability (by half) of attempting suicide over a one-year year period (Czyz, Liu, & King, 2012). Improved connectedness with family and peers was also associated with a significant decrease in depressive symptoms and suicidal ideation following psychiatric hospitalization (Czyz et al., 2012). Moreover, the authors asserted that following psychiatric hospitalizations, adolescent exposure to increased support, closeness, and responsiveness from family and friends could improve emotional functioning and reduce suicidal behavior (Czyz et al., 2012). This may translate to the smaller pre- post Emotional Control scale change scores as well as decreased severity in executive dysfunction observed on that measure at baseline in adolescents with a previous history of psychiatric hospitalizations.

On the other hand, no history of exposure to psychiatric services has been associated with increased severity with respect to risk for treatment drop-out at

community mental health centers (Berghofer, Schmidl, Rudas, Steiner, & Schmitz, 2002; Reneses, Munoz, & Lopez-Ibor, 2009) and in an university psychiatric outpatient setting (Morlino, Martucci, Musella, Bolzan, & de Girolamo, 1995). As a result, DSH adolescents without a previous history of psychiatric hospitalizations may lack exposure to intensive mental health services and adequate support from family and peers before starting DBT-A. This may result in the higher levels of executive dysfunction on the Emotional Control scale observed at baseline for these adolescents. As such, DBT-A appears to have a differentially beneficial effect for treating these severe adolescents over the course of treatment in terms of improving their emotion regulation skills.

The second model with the Shift scale utilized stepwise regression with the predictors of funding type and ethnicity as neither of these predictors was viewed as more important than the other in this regression method. Ethnicity was subsequently excluded from the analysis, as this predictor did not significantly add to the model. Consequently, future DBT-A studies with DSH adolescents should recruit a more diverse sample of participants to expand the EF analysis from only grouping ethnicity into two groups (e.g. Caucasian and non-Caucasian adolescents). For example, having an adequate amount of participants in various ethnicity groups (e.g. Caucasian, Hispanic, African-American, Asian) may possibly show differential EF outcomes as differences have been observed for ethnic groups with respect to prevalence of DSH (Gratz et al., 2012; Guertin et al., 2001).

After ethnicity was excluded, the model was then run with the Shift scale regressed on funding type and was significant ($p < .05$). The model demonstrated that grant-funded adolescents experienced a greater magnitude of change in the course of

treatment for their shifting skills (6.35 points) than insurance-funded adolescents. The third model with the Monitor scale regressed on funding type was significant ($p < .05$). The model demonstrated that grant-funded adolescents experienced a greater magnitude of change in the course of treatment for their interpersonal functioning (8.27 points) than insurance-funded adolescents. Lastly, the fourth model with the GEC scale regressed on funding type was significant ($p < .05$). The model demonstrated that grant-funded adolescents experienced a greater magnitude of change in the course of treatment for their overall executive functioning (6.53 points) than insurance-funded adolescents.

In this study, funding type was viewed as a rough estimate of socioeconomic status with respect to the way services were accessed (grant-funded versus insurance-funded). Nearly 40% of DSH adolescents either received or were eligible for Medicaid based on their families' income level. Research has demonstrated that adolescents from disadvantaged socioeconomic backgrounds are at a higher risk for dropping out of DBT-A (James et al., 2014), developing mental health problems (Reiss, 2013) and having an earlier onset mental health problems (Reiss, 2013).

These adolescents are also disadvantaged with regards to the access of mental health services and lack satisfaction with these programs (Newacheck, Hung, Park, Brindis, & Irwin, 2003). As such, grant-funded adolescents' may enter DBT-A at a higher level of clinical severity and with a lack of exposure to access quality mental health services. This may result in the higher levels of executive dysfunction for grant-funded adolescents on the Shift scale, Monitor scale, and GEC observed at baseline. As a result, these disadvantaged adolescents appear to benefit more over the course of

treatment from DBT-A than insurance-funded adolescents with regards to their shifting, interpersonal functioning, and overall executive functioning.

In summary, the linear regression analyses uniquely contributed to the understanding of DSH adolescents in DBT-A by providing specific neuropsychological treatment profiles of pre- post EF change scores for two demographic groups. Although, adolescents with DSH as a collective group improved from the at-risk to non-clinical range, previous history of psychiatric hospitalizations was predictive of changes in emotion regulation over the course DBT-A. Likewise, funding type was predictive of changes in shifting, interpersonal functioning, and overall executive functioning over the course DBT-A.

Based on these findings, the next step in research and clinical practice is to build on the recommendations mentioned from the previous section by utilizing these demographic predictors. Researchers and clinicians should incorporate this demographic information from intake and screening measures before the start of DBT-A to classify which adolescents may excel in the development particular EFs during DBT-A. Next, a treatment plan should be formulated to determine the usage of skills respectively. For example, adolescents without a previous history of psychiatric hospitalizations may differentially benefit from the increased usage of the DBT-A skill of emotion regulation. Additionally, grant-funded adolescents may differentially benefit from the increased usage of the DBT-A skills of distress tolerance and interpersonal effectiveness. As stated earlier, using this information to identify and detect high-risk groups of such as adolescents with previous psychiatric hospitalizations or grant-funded adolescents may

result in improved outcomes like in other early psychological intervention programs with adolescents with borderline personality disorder (Chanen et al., 2008).

Limitations of the Data

Because this was a clinical study, the design did not include random assignment or a control group, treatment as usual group, or delayed treatment group. As a result, the changes in EF could be impacted by regression to the mean, nonspecific therapeutic effects, or maturation of the adolescents over the course of the 16-week DBT-A program. However, this type of research design is consistent with DBT-A effectiveness studies with DSH adolescents when measuring baseline to post-treatment changes in a clinical setting (Goldstein et al., 2007; James et al., 2008; James et al., 2011).

The second limitation of this study was the sample composition as the majority of the sample was female which was consistent with previous DBT-A studies (James et al., 2011; James et al., 2014; McDonell et al., 2010; Mehlum et al., 2014; Uliaszek et al., 2013). However, this may have affected power to detect differences on EF change scores with respect to gender. Additionally, the majority of the sample was comprised of Caucasian females, which may affect the potential external validity of this study for non-Caucasian, non-female adolescents with DSH. The third limitation was that only 93 participants out of the 260 participants met eligibility criteria. However, demographic analyses indicated that study sample was not significantly different from the graduates who did not complete the BRIEF-SR. Therefore, the findings from this study should be generalizable to those DSH adolescents as well.

An additional limitation in this study was the collection of secondary data due to the clinical setting with the measurement of EFs at baseline and post-treatment. Because of the limited resources and demands of the clinical setting for administering the BRIEF-SR, the study only focused on EF outcomes. As a result, the lack of multiple measurement points did not permit the analysis of different types of growth or changes.

Another drawback for this study was the use of a single self-report measure of EFs. Using more objective neuropsychological measures in combination with this subjective measure in the future would potentially provide a richer clinical profile of adolescents' EF skills during DBT-A. Lastly, because this is a real life effectiveness study with self-report measures, an additional limitation is potential response bias of the adolescents; however, the BRIEF-SR contains validity measures (Inconsistency and Validity Scales) to account for this limitation. Future DBT-A studies should further address this issue with validity by adding the parent and teacher forms of the BRIEF to provide multiple perspectives, improve accuracy assessing EFs, and examine inter-rater reliability.

Despite these limitations, DBT-A appears to be an effective therapy for treating the executive dysfunction observed in DSH adolescents and for specific demographic groups of these youth during this critical time of neural development. The incorporation of the neuropsychological EF treatment profiles from this study will not only allow clinicians to tailor DBT skills to corresponding EF deficits, but also have utility for future DBT-A outcomes studies that utilize neuroimaging and other objective neuropsychological measures.

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