The Role of Executive Functioning in the Treatment of Borderline Personality Disorder

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Abstract

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Borderline Personality Disorder (BPD) is characterized as a problem of emotion regulation and impulsivity that becomes increasingly problematic over time due to deficits in problem solving. Problem solving incorporates the executive functions, such as planning, organization, cognitive flexibility, decision making, and inhibitory control. Despite their assumed importance in psychotherapy, the executive functions are seldom examined in treatment research. The present study examines three forms of executive functioning (figural fluency, verbal fluency, and inhibition) for their role in the treatment of BPD. This study is based on data previously collected in a one year randomized control trial (Linehan et al., 2006) which compared dialectical behavior therapy (DBT) to a community treatment by experts (CTBE) for its effectiveness in treating BPD. Participants included 101 women with recent suicidal and self-injurious behaviors who met DSM-IV criteria for a diagnosis of BPD. First, this study tested whether any of the three aforementioned forms of executive functioning (figural fluency, verbal fluency, and inhibition) served as predictors of three important post-treatment therapy outcomes: reductions in depression, suicide attempts (SA), and non-suicidal self injury (NSSI). This study also tested a second hypothesis as to whether these three forms of executive functioning moderate the relationship between the treatment condition (DBT vs CTBE) and the outcomes

(depression, SA, NSSI). In a third hypothesis, it was predicted that treatment condition (DBT vs CTBE) could enhance executive functioning. The results for all three of these hypotheses were primarily null findings, with some minor exceptions in the second hypothesis. These exceptions were that while none of the executive functions (figural fluency, verbal fluency, and inhibition) demonstrated consistent moderation across all the outcome measures, they did each show evidence for moderating the treatment on at least one outcome each (depression, SA, or NSSI). Limitations of the study are discussed, particularly emphasizing the possibility for increased Type I and II errors from running many analyses on a moderately sized sample. Though the hypotheses were largely unsupported, these findings remain encouraging as they may suggest that both of these treatments positively benefit therapy clients regardless of their pre-existing executive functioning abilities.

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This dissertation is also done in loving memory of Professor Alan Marlatt, who was among the members of my supervisory committee, but unfortunately passed away before seeing the final completion of the project. His warm smile and cunning intellect will long be missed.

Dedication

To my beloved wife, Heather; without you, I do not think this project would have ever been realized to completion. No matter what went wrong or what went right, I could always count on you to be in my corner; pushing, cheering, and supporting me all the way to the finish line. You have stood with me through the blood, sweat, and tears it took to finally complete this dissertation. I owe you a debt of gratitude for your caring, patience, and commitment. Thank you, my love, from the depths of my heart.

And to my parents, David and Patricia Jean Secrist, who have always been a source of support and encouragement throughout my lifetime. You taught me the importance of being educated and of caring for others. I carry forth those values and they live on in the heart of all the work that I do.

The Role of Executive Functioning in the Treatment of Borderline Personality Disorder

Cory Secrist

Borderline Personality Disorder (BPD) is a serious and highly prevalent mental health problem. In the general population, the prevalence of BPD is roughly 2%- 6% (APA, 2000; Grant et al., 2008; Lenzenweger, Lane, Loranger, & Kessler, 2007). Prevalence rates are even higher among people in treatment. The prevalence of BPD is about 10% among outpatients, and 19%- 23% among inpatients (APA, 2000; Asnaani, Chelminski, Young, & Zimmerman, 2007; Sperry, 2003; Swartz, Blazer, George, & Winfield, 1990). People that meet criteria for BPD are high utilizers of mental health care services, and compared to other clinical disorders, are significantly more likely to have extensive histories of outpatient and inpatient mental health treatment as well as psychopharmacological treatments including antianxiety, antidepressant, and mood stabilizer medications (Bender et al., 2001). Overall, BPD has similar prevalence rates among men and women, is higher among separated/divorced/widowed adults, low income individuals, and those with lower education, and particularly for women, is associated with significant mental and physical disability (Grant et al., 2008). There is high comorbidity with Axis I disorders, especially for substance use disorders, mood disorders (particularly bipolar I and major depressive disorder) and anxiety disorders (particularly post traumatic stress disorder) (Grant et al., 2008; Lenzenweger et al., 2007; Zanarini, Frankenburg, Hennen, Reich, & Silk, 2004). The comorbidity with other disorders is so high, that it is almost unheard of to see a "pure" case of BPD.

Borderline Personality Disorder Defined

Personality disorders are presently defined as rigid and pervasive patterns of behavior that develop in adolescence or early adulthood and persist into later adulthood (APA, 2000). BPD is defined in the DSM-IV-TR as someone that meets five of the following nine criteria: problems with affective instability, impulsivity, recurrent suicidal behavior or self injury, unstable self-image, chaotic interpersonal relationships, inappropriate anger, chronic emptiness, dissociation and stress-related paranoia, and frantic efforts to avoid abandonment (APA, 2000). The characteristic social and emotional instabilities present in people with BPD often lead to exacerbated interpersonal problems and the erosion of social support. These individuals display significant impairments at work, in social relationships, and at leisure (Skodol et al., 2002). Even relationships with mental health workers intended to be helpful can become strained. For example, in a review of the literature on attitudes of registered mental health nurses towards BPD clients, Winship (2008) found that nurses viewed BPD clients more negatively than other clients, were less optimistic about their own abilities to help BPD clients, treated BPD clients with less empathy, and socially distanced themselves more from BPD clients. Despite the disorder's severity, pervasiveness, and classification as an Axis II disorder, there is mounting evidence that BPD may not be as unalterable as was previously thought. Research on BPD patients followed over 10 years demonstrated that as many as 85-88% of the patients achieved remission of symptoms (Gunderson et al., 2011; Zanarini, Frankenburg, Hennen, Reich, & Silk, 2006). Furthermore, the advent of effective treatments for BPD such as Linehan's (1993) Dialectical Behavior Therapy (DBT) further lends evidence that BPD is a more malleable disorder than previously believed.

The Biosocial Theory of BPD

According to Linehan's Biosocial Theory, BPD develops through a transaction between a genetic predisposition for intense emotional reactivity and high impulsivity coupled with an invalidating environment that exacerbates these problems and fails to provide the individual with skills for coping with intense emotions or for impulse control (Crowell, Beauchaine, & Linehan, 2009; Linehan, 1993). BPD is therefore characterized as a problem of emotion regulation and impulsivity that becomes increasingly problematic over time due to deficits in problem solving and coping. Though the biosocial theory hasn't yet been extensively studied, several promising papers have begun to provide support by showing that combinations of affective instability, impulsivity, and environmental invalidation can predict later BPD features (Reeves, James, Pizzarello, & Taylor, 2010; Sauer & Baer, 2010; Tragesser, Solhan, Schwartz-Mette, & Trull, 2007). Genetically, there is significant heritability and substantial familial aggregation for BPD with about 42% of the variance in BPD features being explained by genetic influence (Bornovalova, Hicks, Iacono, & McGue, 2009; Distel et al., 2007; Gunderson et al., 2011). Environmental influences account for the other 58% of the variance (Distel et al., 2007).

BPD and the Prefrontal Cortex and Limbic System

It has long been noted that people with frontal head injuries present with patterns of emotion dysregulation, impulsivity, and problem solving deficits in a manner similar to those with BPD (Cummings, 1985). Traumatic brain injury has been associated with increased risk for later suicide attempts (Wasserman et al., 2008) and for later development of BPD and other psychological disorders (van Reekum, Bolago, Finlayson, Garner, & Links, 1996). Brain imaging studies of people with BPD consistently find problems in areas of the brain associated with affective dysregulation (largely in the limbic system) and impulsivity (largely in the

prefrontal cortex), which has led to a conceptualization of the biological correlates of BPD as representing a "dual brain pathology" wherein both the limbic system and the prefrontal cortex are adversely affected, leading to affective hyperarousal and inhibitory dyscontrol (see Bohus, Schmahl, & Lieb, 2004; New, Goodman, Triebwasser, & Siever, 2008 for reviews).

Recently, MRI and fMRI studies that compare BPD patients with healthy controls conclude that there is evidence that those with BPD have smaller frontal lobe volume and show less activity in the prefrontal cortex areas (Lyoo, Hee Han, & Cho, 1998; Schmahl & Bremner, 2006). MRI studies have also found reduced hippocampal volume (Brambilla et al., 2004; Driessen et al., 2000; Zetzsche et al., 2007) and reduced amygdala volume (Schmahl, Vermetten, Elzinga, & Bremner, 2003; Tebartz van Elst et al., 2007), suggesting limbic dysfunction related to emotion dysregulation. For those with BPD, there is less activity in the anterior cingulated cortices (Silbersweig et al., 2007) and diffusion tensor imaging (DTI) has shown reduced white matter integrity in frontal brain circuits important for behavioral regulation (Grant et al., 2007).

Impairments in Executive Functioning in BPD

The frontal brain regions that are affected in individuals with BPD are vital for executive functioning. Patients with damage to the prefrontal cortex show executive impairment in judgment, organization, planning, and decision making (see Stuss & Benson, 1984 for a review). Executive functioning is often used as an umbrella term for a wide range of complex cognitive processes often associated with frontal lobe functioning. Gioia, Isquith, Guy, & Kenworthy (2000, p. 1) define the executive functions as "a collection of processes that are responsible for guiding, directing, and managing cognitive, emotional, and behavioural functions, particularly during active, novel problem solving." These collected processes include skills such as

inhibition, cognitive flexibility, problem solving, decision making, planning, organization, verbal fluency, working memory, self monitoring, and error correction (Norman & Shallice, 2000).

Norman and Shallice (2000) have identified five scenarios where executive functioning is most needed. 1) when overcoming a strong habitual response; 2) when planning and making decisions; 3) when correcting errors or troubleshooting; 4) when novel sequences of action are required; 5) when situations are dangerous or difficult. Related to BPD, Linehan (1993) has noted the importance these kinds of executive function abilities have for the problem solving required in the typical emotional and behavioral problems present in people with a diagnosis of BPD, stating, "Problem solving, cognitive flexibility, and mood are inextricably linked. Flexibility is related to the ability to actively choose cognitive strategies that fit one's goals at a particular time, to adapt to one's environment, and to find creative yet relevant solutions to problems" (p.252).

As one would expect given the aforementioned deficits in frontal lobe functioning for people with BPD, there are also deficits in performance on a number of neuropsychological tests that measure executive functioning (see Fertuck, Lenzenweger, Clarkin, Hoermann, & Stanley, 2006; LeGris & van Reekum, 2006; Ruocco, 2005 for reviews). When compared with healthy controls, individuals with a diagnosis of BPD show poor executive functioning performance in the areas of inhibition (Nigg, Silk, Stavro, & Miller, 2005), non-impulsive decision making and planning (Bazanis et al., 2002), attention and self regulation (Posner et al., 2002), working memory (Stevens, Burkhardt, Hautzinger, Schwarz, & Unckel, 2004), and nonverbal executive function and nonverbal memory (Dinn et al., 2004). Importantly, in a systematic review comparing studies on the neuropsychology of BPD and the neuropsychology of suicide attempters, Legris and van Reekum (2006) reported that people with BPD more consistently

exhibited impairment in the areas of inhibition and cognitive flexibility (as measured by the Stroop Test and the Wisconsin Card Sort Test), whereas the suicide attempters reported more impairment in verbal fluency. The consistency of findings for inhibitory problems in BPD likely relate to the core problems in impulsivity that are characteristic of this disorder, while deficits in cognitive flexibility may relate to a lack of skills for problem solving. The lower scores on verbal fluency for suicide attempters might be because verbal fluency tests measure one's ability to bring associated memories to mind in a quick and creative way; whereas, suicidal ideation and hopelessness hijack thought and block the generation of alternative solutions.

The Role of Executive Functioning in Psychotherapy

Though various aspects of executive functioning are related to BPD characteristics and suicide attempts, there has been little research on the role that executive functioning might play in psychological treatment studies. This leaves open questions as to whether people of varying executive functioning abilities might differentially respond to treatment, or whether executive functioning can be altered as a result of treatment. Though this is generally an unstudied topic in the area of psychological treatment research, there are a few limited studies that have examined how variations in executive functions can predict later treatment response. For example, better inhibition abilities (as measured by the Stroop test) predicted treatment compliance in cocaine-dependent individuals when looking across studies that included weekly cognitive behavioral therapy (CBT) sessions and one of several pharmacologic agents (Streeter et al, 2008). In a study by Julian and Mohr (2006), three conditions consisting of CBT, supportive-expressive group therapy, and an antidepressant (sertraline) were compared in their ability to alleviate depression in a sample of individuals with major depressive disorder and multiple sclerosis. Their findings were that poor inhibition scores measured on the Stroop predicted poorer

treatment response in the antidepressant treatment condition, while poor Verbal Fluency scores predicted poorer treatment response in the supportive-expressive group therapy condition (Julian & Mohr, 2006).

Some early evidence also exists that would suggest various measures of executive function can be improved by psychotherapy. Cognitive Remediation Therapy is a treatment specifically designed to target executive functioning by engaging patients in skills intended to bolster their executive functioning abilities through their repeated practice. Though the existing studies of this treatment have all been with small samples of schizophrenic patients and firm conclusions cannot yet be drawn about the treatment's effectiveness, the preliminary results at least provide some promise for the ability of a psychological treatment to alter executive functioning in the areas of working memory, verbal fluency, and cognitive flexibility (Wykes et al., 2002; Wykes et al. 2007). If these executive functioning abilities can be trained and improved as Wykes suggests, then presumably any treatment that similarly involves repeated practice of a skill dependent on specific executive functions might likewise show improvements in measures of those required executive functions.

This ability to alter executive functioning through skills training has yet to be evaluated in a BPD population; however, studies involving the drug quetiapine have shown initial evidence that executive functioning in a BPD sample might at least be improved pharmacologically (Van den Eynde et al., 2008; Van den Eynde, 2009). Though these studies lacked control groups and should therefore be interpreted with appropriate caution, a sample of BPD patients that completed a 12-week trial of quetiapine showed improvements in the executive functions of inhibition (Stroop Color Word Task and IOWA Gambling Task; Van den Eynde et al., 2008), as well as improvements in the executive functions of cognitive flexibility (trail making task),

verbal fluency, and planning and problem solving (Tower of London task; Van den Eynde et al., 2009). These studies lend some credence to the notion that some executive functions can be improved in patients with BPD.

Dialectical Behavior Therapy

Given the evidence of executive functioning deficits in BPD and the paucity of research examining the role of executive functioning in a treatment setting, the present study herein evaluates the role of several key aspects of executive functioning as potential predictors, moderators, and outcomes of treatment for BPD. Dialectical Behavior Therapy (DBT; Linehan, 1993) is presently the gold standard treatment for suicidal clients that meet criteria for BPD. Multiple randomized control trials support DBT's efficacy for use in the treatment of BPD (Koons, et al., 2001; Linehan, Armstrong, Suarez, Allmon, & Heard, 1991; Linehan et. al, 1999; Linehan et al., 2002; Linehan et al., 2006). DBT is a cognitive behavior therapy that targets suicidal behavior, behaviors that interfere with the delivery of the treatment, and other behaviors that pose a threat to the individual's quality of life. Within the context of this treatment, BPD is primarily understood as a disorder of emotion regulation and impulsivity that can be improved through the use of behavioral skills in the areas of mindfulness, emotion regulation, distress tolerance, and interpersonal effectiveness.

Aside from being a highly effective treatment for BPD, DBT is also a good candidate for studying executive functioning's role in treatment due to the nature of the therapy. DBT is focused on the training and routine practice of skills that theoretically should require the use of various kinds of executive function. For example, inhibition (often tested using the Stroop Color Word Task) is an executive function that requires the suppression of a dominant response that is then replaced with a novel response. This kind of function is routinely called upon in DBT

whenever clients are asked to replace their usual dysfunctional behaviors with more effective ones. This can be seen in such DBT skills as "opposite-to-emotion-action" where clients are asked to behave in a manner opposite to what an emotion would normally urge them to do, such as to approach someone or something they are irrationally afraid of (and thus feel an urge to avoid). Response generation (often measured using verbal fluency and figural fluency tests) is another example of an executive function frequently utilized in DBT whenever skills require the quick generation of novel responses for problem solving. This can be seen in such DBT skills as "pros and cons" where clients are asked to generate reasons for and against engaging in dysfunction behavior. For example, a therapist may quickly go around the room and ask each group member to generate a new reason not to use illegal drugs so that these ideas will spring to their minds more quickly during the times when they are outside of the therapy room and feeling tempted to use.

Study Goals

The central aim of this study was to evaluate the role of several aspects of executive functioning as potential predictors and/or moderators of outcomes in the treatment of people with borderline personality disorder (BPD). The executive functions of interest are response generation (as measured by either the COWA and/or the Ruff Figural Fluency Test; RFFT), verbal fluency (as measured by the Benton Controlled Oral Word Association Test; COWA), and inhibition (as measured by the Stroop Color Word Task). Additionally, a second aim of this research was to evaluate whether Dialectical Behavior Therapy (DBT) improves these executive functions better than a Community Treatment by Experts (CTBE) comprised of community recommended expert therapists. Participants were matched and assigned to either the DBT or

CTBE conditions for 12 months of treatment. Each of these measures will be more fully described in the method section.

Hypothesis 1

It is hypothesized that better performance on the executive functioning tasks (RFFT, COWA, Stroop) at baseline will predict better outcome at post-treatment as evidenced by reductions in depression (Ham-D), suicide attempts, and non-suicidal self injury (NSSI).

Hypothesis 2

Because DBT focuses on behavioral skills-training that routinely calls upon the executive functions of response generation and inhibition, it is plausible that this training will make DBT a better option for a wider range of baseline executive functioning levels than a treatment that does not provide such training. It is therefore hypothesized that the executive functioning measures (RFFT, COWA, Stroop) will moderate the relationship between treatment (DBT vs CTBE) and outcome (Ham-D, Suicide Attempts, NSSI). DBT will be effective regardless of low or high baseline executive functioning abilities, whereas the non-behavioral and non-skills-focused control condition will be less effective for clients that have lower baseline executive functioning scores.

Hypothesis 3

Because DBT focuses on training clients in skills that should theoretically require the executive function of response generation and inhibition, it is hypothesized that participants in the DBT condition will see improvement in design fluency (RFFT), verbal fluency (COWA), and. inhibition (Stroop).

Method

The present study uses previously collected data from a randomized control trial evaluating the effectiveness of DBT for treating BPD when compared to a group of non-behavioral therapists nominated as having high expertise according to community leaders, referred to as Community Treatment by Experts (CTBE; Linehan et al., 2006).

Participants

All participants (*N*=101) in the study were female. Ages ranged from 18 to 45 with an average age for the sample of 29.3 (SD=7.5). The majority of participants reported their race as Caucasian (87%), had an annual income of less than $15,000 (78%), and had an education beyond high school (75%). All participants met criteria for borderline personality disorder. Diagnoses were made using the structured clinical interviews for Axis I and Axis II DSM-IV (SCID-IV; First, Spitzer, Gibbon, Williams, & Benjamin, 1996; White & Freedman, 1978) and the International Personality Disorder Examination (PDE, Loranger, 1995). All participants exhibited a history of self-injurious behaviors. This was defined as at least 2 suicide attempts or self-injuries in the past 5 years, with at least 1 within the 8 weeks preceding their participation in the study.

Exclusion criteria included 1) a lifetime diagnosis of schizophrenia, schizoaffective disorder, psychotic disorder, or bipolar disorder; 2) mental retardation as determined with the Peabody Picture Vocabulary Test-revised (Dunn, 1981); 3) a seizure disorder requiring medication; 4) a court mandate for treatment, or 5) the need for primary treatment for another debilitating condition.

Participant Matching

Eligible study participants were matched to treatment condition (DBT or CTBE) on five primary prognostic variables: 1) The number of lifetime suicide attempts plus number of non-suicidal self-injuries; 2) the number of psychiatric hospitalizations; 3) a history of only suicide attempts, only nonsuicidal self-injury, or both; 4) age; and 5) a score above 30 on the Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) or a Global Assessment of Functioning (First, Spitzer, Gibbon, & Williams, 1995) score lower than 45 for a comorbid condition. Participants were matched to condition using a computerized adaptive minimization randomization procedure (White & Freedman, 1978). The number of subjects was based on 0.8 power to detect significant differences between conditions (p=.05, 1-sided).

Treatment Conditions

Dialectical Behavior Therapy (DBT)

DBT is a cognitive behavioral therapy originally developed for the treatment of individuals who meet criteria for BPD and engage in suicidal behaviors. This approach to treatment manages the dialectic between evoking behavioral change while also fostering acceptance. There are five major functions that comprise DBT: 1) training clients' capabilities for skillful behavior, 2) improving clients' motivation for the use of skillful behavior, 3) promoting the generalization of behavioral skills usage to the client's natural every day environment, 4) creating a structured treatment environment that reinforces functional behaviors, and 5) enhancing therapist capabilities and motivation to continue providing optimal treatment to clients. These functions are carried out in the treatment via DBT's five modes. 1) Training clients' capabilities is fostered through DBT skills training in the areas of mindfulness, emotion regulation, distress tolerance, and interpersonal effectiveness. This is done in a classroom-style

setting with a weekly 2 ½ hour class. 2) Improving clients' motivation is fostered in a one-on-one weekly therapy session with a trained DBT therapist who uses strategies such as contingency management, cognitive restructuring, and emotion regulation coaching. 3) Generalization of skills is fostered by as-needed telephone consultation and coaching with the therapist. 4) Structuring the treatment environment to reinforce functional behaviors is fostered within the treatment by team meetings and consultation and is fostered outside of the treatment by as-needed family sessions. 5) Enhancing therapist capabilities and motivation is fostered by having therapists attend a one-hour per week consultation meeting that serves as both training and therapy for the therapist.

Community Treatment by Experts (CTBE)

The parent study was an interval validity trial, so the group of community nominated expert therapists was developed as a means of controlling for therapist expertise across DBT and the control condition. The therapists recruited for the CTBE control condition were self described as either "eclectic but nonbehavioral" or "mostly psychodynamic" in their treatment approach. To distinguish the control from DBT, no cognitive behavior therapists were selected for the CTBE condition. The CTBE condition is similar to a treatment-as-usual control condition in that the treatment provided is not controlled by the research team. However, the CTBE condition controls for characteristics of the therapists thought to be universally beneficial for treatment, including expertise, allegiance to treatment, availability of a clinical supervision group, institutional prestige, affordability of treatment, sex of clinician, training, and clinical experience. CTBE therapists were nominated for their *expertise* by community mental health leaders. They were asked to provide the type and dose of the therapy they believed most appropriate for the client (with a minimum of at least one scheduled individual session per week),

thus controlling for *allegiance* to treatment. To control for availability of *supervision*, CTBE therapists were given the opportunity to attend a weekly supervision group, though attendance was not required. The CTBE clinical supervision group met at the Seattle Psychoanalytic Society and Institute and was led by the training director of the institute. The institute's *prestige* outside of behavior therapy rivals the prestige of the University of Washington within the field of behavior therapy. The study paid for CTBE at the same rate as for DBT and participants paid a small sliding scale fee determined before assignment to treatment condition, thus controlling for *affordability* of treatment. Clients were randomly assigned to DBT or CTBE therapists after matching on the therapist's sex, doctoral vs master's level training, and years of clinical experience. Therapist *sex* and *training* did not differ between DBT and CTBE; however, the CTBE condition had more years of clinical *experience*, which was expected given they were selected for their expertise.

Assessment

Initial assessments were done prior to treatment assignment. Primary treatment outcomes were measured every 4-months during one year of treatment and one year of follow up. Assessments were conducted by independent assessors kept blind to condition. Two lead assessors were trained on interview measures by the instrument developers or approved trainers. They then trained, supervised, and evaluated for inter-rater reliability (κ statistic or intraclass correlation coefficient for all ratings ranged from 0.74 to 1.00).

Executive Functioning Measures

Figural Fluency

Figural fluency was measured with the Ruff Figural Fluency Test (RFFT; Ruff, Light, & Evans, 1987). The RFFT was originally designed to be a nonverbal analogue to verbal fluency

tests such as the COWA, though they measure both separate and related abilities (Ruff et al., 1987). The psychological mechanisms thought to underlie figural fluency include response generation, memory for temporal order, speeded information processing, and nonverbal reasoning. The original RFFT has five design tasks that are all similar. Ruff et al (1987) have noted no significant differences among the five parts of the test and they are thus redundant. In an effort to reduce participant assessment fatigue, only the fourth of these five was used in this study. In this task, participants are given a sheet of 35 squares. Each square in this grid has five points arranged in the same pattern within every square. Participants are asked to connect two or more dots using straight lines to create unique patterns. Each participant is given one minute to draw as many unique designs as possible across the 35 squares of the grid. The number of non-repeated patterns is counted for the score.

The test-retest reliability for the RFFT over a 12-month period between assessments was acceptably high (.71; Basso, Bornstein, & Lang, 1999). Interrater reliability has also been found to be high (r=.80-.98; Ross, Foard, Hiott, & Vincent, 2003).

In terms of validity of the measure, scores on the RFFT converge with scores on the COWA (Ruff et al., 1987). The RFFT also is affected by compromised frontal brain regions more than posterior (Ruff, Allen, Farrow, Niemann, & Wylie, 1994; Suchy, Sands, & Chelune, 2003). Suchy et al. (2003) have even proposed that the RFFT is a more sensitive measure of frontal lobe functioning as it is affected by both right and left frontal lobe lesions.

Verbal Fluency

The Benton Controlled Order Word Association test (COWA; Benton, Hamsher, & Sivan, 1994) is a measure of verbal associative fluency. The psychological mechanisms underlying the task are also thought to include response generation, self-initiation, word knowledge, episodic

memory, working memory, and speeded information processing. The COWA assesses word finding difficulties and has been shown to be sensitive to frontal lobe dysfunction (Borkowski, Benton, & Spreen, 1968).

During the COWA test, participants are presented with a letter of the alphabet and are given one minute to generate as many unique words as they can that begin with that letter. The letters used are either C, F, and L; or P, R, and W. These sets of letters are chosen based on the number of words to be found in standard English dictionaries that begin with each letter. The sequence the letters are presented in is ordered to increase the difficulty of the task across the set For example, more words in the dictionary begin with C than with F, and more begin with F than with L. The number of non-repeated phrases is counted for the score.

Reliability for the COWA test tends to be high. Test-retest correlations are typically above .70 whether looking at a short (one month) or long (one year) interval (Basso et al., 1999; Ross et al., 2003). Internal consistency of the measure is also high. A coefficient alpha was calculated by taking the total number of words generated for each letter separately as three individual items and comparing against the COWA total test score (r=.83, Ruff, Light, Parker, & Levin, 1996). Interrater reliability has also been shown to be high (.99; Ross, 2003).

There is good evidence for the validity of the COWA. Convergent validity is seen in correlations between verbal IQ and verbal fluency with ranges of .44 to .87 (Henry & Crawford, 2004). Another commonly used verbal fluency test uses the letters F, A, and S in the same way that the COWA uses the letter C, F, and L. Analyses of the equivalence of the letters 'FAS' and 'CFL' show that the two sets are comparable (Cohen & Stanczak, 2000; Troyer, 2000).

Inhibition:

Inhibition was measured using the Victoria version of the Stroop Color and Word Test (Regard, 1981 as cited in Strauss, Sherman, & Spreen, 2006). The Stroop is primarily used as a measure of inhibitory control, though the psychological mechanisms underlying the task also involve speeded information processing, attention, working memory, semantic activation, and the ability to strengthen a particular response characteristic (Strauss, Sherman, & Spreen, 2006). The Stroop Color and Word Test has a long history of study (Stroop, 1935) and several versions of the test exist. The Victoria Stroop Test is a shortened version of the test, which may be preferable to other versions because the examinee is not allowed extensive time to improve from practice (Strauss, Sherman, & Spreen, 2006).

The basic Stroop paradigm of response inhibition is that the task requires a dominant response to be suppressed and replaced with a non-dominant response. This is tested in the Victoria Stroop Test by a 3 phase task. In the 1st phase, participants are shown a series of colored dots and asked to identify the color. In the 2nd phase, they are shown a series of colored words. Each word is the name of the color that the word is printed with (e.g., the word "blue" is printed in a blue font color). In the 3rd phase, participants are shown a series of colored words; however, in this instance the words are color names that do not match the color that the word is printed in (e.g., the word "blue" is printed in a red font color). The 2nd and 3rd phases each contain 24 words. The time it takes for participants to label the color of the full set of words in each phase is recorded with a stop watch. Participants will ordinarily take longer to complete the 3rd phase than the 1st or 2nd because they have to suppress a habitual response (reading the word) in support of producing an unusual response (identifying the color of the word). The increase in

time taken to perform in the suppressed 3rd phase compared to the basic habitual 1st phase is known as the Stroop interference effect. This is the main score of interest.

Test-retest reliability for the Victoria Stroop Test is high. When university students were tested twice on the test with a one month interval between sessions, reliability coefficients of .90, .83, and .91 were found for the three phases of the test (Bullock et al., unpublished, as cited in Strauss, Sherman, & Spreen, 2006). Correlations among the test trials within the Victoria Stroop Test tend to be moderate (Pineda & Merchan, 2003).

Validity of the Stroop test also appears to be good. The Stroop interference score correlates with other measures of attentional control including the PASAT (MacLeod & Prior, 1996) and omission errors on continuous performance tasks (R^2= .31; Weinstein, Silverstein, Nader, & Turnbull, 1999). Neuroanatomical correlates show that Stroop test is most consistently activated in the frontal lobe brain regions (Mead et al., 2002).

Suicide Attempts and Self Injury

Suicide Attempts and Nonsuicidal Self Injury were assessed using the Suicide Attempt Self-Injury Interview (SASII; Linehan, Comtois, Brown, Heard, & Wagner, 2006). The SASII is an interviewer conducted measure that measures the topography, suicide intent, and medical severity of each suicide attempt and nonsuicidal self-injury. Thus, this measure provides information about both the quantity of suicidal behavior and nonsuicidal self injury, but also the severity of these acts.

Interrater reliability of the SASII was evaluated with Intraclass Correalations (ICCs), or kappa when there were binary variables. The reliabilities across nine assessor rated items ranged from .87-.98. Validity was also shown to be high for the SASII by comparing ratings of the

assessors against physicians or nurses, therapist notes, and client diary cards, all of which was exhibited high agreement (Linehan et al., 2006).

Depression

Depression ratings were measured using the Hamilton Rating Scale for Depression 17-item (Ham-D; Hamilton, 1960). The Ham-D is a 17 item questionnaire that asks participants about the severity of various aspects of depression. The Ham-D has long been considered a gold standard for measuring therapeutic efficacy in clinical trials related to depression and it has both high reliability and validity (Bech, 2009; Furukawa, 2010; Jiang & Ahmed, 2009).

Potential Covariates

Several variables are known to have an effect on executive functioning that could create confounds in the proposed study. Older *age* is associated with lower scores on the Stroop (van der Elst, van Boxtel, van Breukelen, & Jolles, 2006), the COWA (Rodriguez-Aranda & Martinussen, 2006), and the RFFT (Ruff et al., 1987). *Education* is positively correlated with better scores on the Stroop (van der Elst, et al., 2006), the COWA (Rodriguez-Aranda & Martinussen, 2006), and the RFFT (Ruff et al., 1987). Moderate drug use and polysubstance drug use have been shown to impair scores on the Stroop, spatial working memory, verbal working memory, and verbal fluency (Fernandez-Serrano, Perez-Garcia, Perales, & Verdejo-Garcia, 2009; Piechatzek et al., 2009). Frontal lobe *head injury* is also associated with lowered ratings on executive functioning (Golden, 1978).

Age, education, recent drug use, and head injury are therefore evaluated as covariates for the hypotheses where changes in executive functioning are measured. Age and education level were both assessed using the Demographic Data Survey (DDS; Linehan, 1982). This provides a simple measure of age in years, and an ordinal category for education that classifies highest

degree of education into one of four categories (1= some high school, 2 = high school or GED degree, 3 = some college or technical school, 4 = college graduate or higher). Drug use was evaluated by a question on the Substance Abuse History Interview (Linehan, 1996) that asks how many total days the client was abstinent in the last 4 months. Head Injury was answered as part of a medical health history form that contains a "yes/no" question as to whether the client had sustained any prior head injuries.

Results

Descriptive Statistics

Suicide attempts are not a frequently occurring behavior, though they are obviously of high clinical relevance. Relatedly, while NSSI is a high frequency behavior for a small set of individuals, there is a lot of variability across clients in the amount of self harm they inflict. Many never engage in NSSI, some self harm only occasionally, and others routinely engage in NSSI. Neither suicide attempts nor NSSI were normally distributed in this sample, and therefore both variables were recoded before analysis. Suicide attempts were coded into a binary variable where a score of zero means no suicide attempt and a score of one means there has been at least one suicide attempt over the past year which may have been either clearly intentional or ambivalent. NSSI was ranked on an ordinal category from zero to four. Roughly 20% of the participants had no NSSI at pretreatment, so the remaining participants were divided into five ordinal categories containing roughly 20% of the sample each (0 = no self injury, 1 = 1 self injury, 2 = 2 self injuries, 3 = 3-4 self injuries, 3 = 5 or more self injuries).

An overview of the descriptive statistics for each of the variables examined in this study can be found in Table 1. There are also descriptives given for each of the treatment conditions separately in Tables 2 and 3 which provide descriptives for DBT and CTBE respectively. One of the first questions to ask about this data is whether this BPD sample differs from a normative sample. As can be seen in Table 1, the mean figural fluency score on the RFFT was 13.82 designs at pre-treatment. It is difficult to compare this average to a normative sample because the present study only examined one of the five design creation tasks in the RFFT and the existing normative studies report results based on the full test. Nevertheless, the five tasks are considered similar enough to be redundant. In a normative sample collected by Ruff et al. (1987)

in which all five of the design tasks were used, the average number of unique designs created ranged from 94-110 designs for females with ages ranging from 16-54 years and with 13-15 total years of education. By dividing these norms by five, we might expect a roughly estimated average range between 18.8- 22.0 unique designs. This could suggest that our BPD sample's mean of 13.82 designs indicates below average figural fluency in the sample, but there is not enough information to determine this conclusively.

As Table 1 illustrates, the verbal fluency scores collected from the COWA had a mean of 39.723 (*SD* = 10.723) unique words generated for the letters CFL within the present study's BPD sample. Compare this to a normative study by Ruff et al. (1996) where females with 13-15 years of education produced an average of 39.4 (*SD*=10.1) unique words. The means are very similar, suggesting that verbal fluency does not appear to be impaired in this study's sample of BPD individuals.

As seen in Table 1, the mean Stroop interference score is 10.312 seconds in this study. Normative data on the Victoria Stroop for ages 18-49 show mean interference ratings ranging from 11.1-14.6 seconds (Troyer, Leach, & Strauss, 2006). This might suggest that our BPD sample is on the lower end of a normal range for Stroop scores.

Hypothesis 1: Aspects of Executive Functioning as Predictors of Outcomes

A series of regression analyses were used to determine if any of the aspects of executive functioning (figural fluency, verbal fluency, and inhibition) could predict improvements on any of the treatment outcomes (depression, suicide attempts, or NSSI). While the depression scores were normally distributed, the suicide attempt and NSSI ratings were not and were recoded. Since the suicide attempt outcomes were recoded into a binary variable and the NSSI outcomes were recoded into an ordinal variable, a different type of regression analysis was required for

each of the three primary outcomes. When depression scores (Ham-D) were the outcome, an ordinary least squares multiple regression analysis was used. When suicide attempts were the outcome, a logistic regression analysis was used. And when NSSI ratings were the outcome, an ordinal regression analysis was used.

To evaluate the first hypothesis that certain aspects of executive functioning would predict treatment outcomes, measures of design fluency, verbal fluency, and inhibition (RFFT, COWA, and Stroop respectively) were entered into various regression models. For hypothesis 1a, each of these three executive functioning measures was examined in a regression analysis for their ability to predict depression as rated by the Ham-D. The model was examined first with potential covariates in the model, and later without. The covariates were age, education, prior head injury, and abstinence from drugs and alcohol in the past 30 days. As can be seen in Table 4, none of the three executive functioning measures were significant predictors of depression. Since none of the covariates were significant either, the model was also examined with them taken out to add more degrees of freedom. As can be seen in Table 5, their results were not significant whether the covariates were included in the model or not. The null hypothesis still could not be rejected even if the executive functioning measures were analyzed independently in separate regression analyses or if they were all put into the model at once.

For hypothesis 1b, logistic regression analyses were used to test for the ability of executive functioning measures of figural fluency, verbal fluency, and inhibition to predict the occurrence of any suicide attempts over the treatment year. As can be seen in Table 6, none of these three aspects of executive functioning were significant predictors of suicide attempts. This was the case whether covariates (age, education, prior head injury, and abstinence from drugs and alcohol in the past 30 days) were entered into the model or not, which can be seen in Table 7.

Additional tests were run on each individual executive function measure as a predictor of suicide attempts over the treatment year, but the results were not significant whether the measures were examined separately in the model or all together.

For hypothesis 1c, ordinal regression analyses were used to test whether executive function measures of figural fluency, verbal fluency, and inhibition could predict NSSI. As can be seen in Table 8, there were no significant findings for these three aspects of executive functioning as predictors of NSSI. This was also the case when the potential covariates (age, education, recent drug use, or prior head injury) were removed from the model (see Table 9). Examining each executive functioning measure independently in its own model also failed to support any of the measures as significant predictors of NSSI.

Hypothesis 2: Aspects of Executive Functioning as a Moderator of Treatment

To evaluate whether aspects of executive functioning serve as moderators for the effects of treatment on outcome, another set of regression analyses were conducted, similar to those analyses conducted in hypothesis 1. For hypothesis 2, however, treatment condition was included in the model along with interaction terms representing the combination of design fluency, verbal fluency, and inhibition (RFFT, COWA, and Stroop respectively) with each treatment condition (DBT vs CTBE).

First, in hypothesis 2a, I examined whether any of the executive functions served as a moderator of treatment for effects on depression as measured by the Ham-D. As can be seen in Table 10, for this multiple regression analysis there was a statistically significant interaction between verbal fluency (number of words generated on the COWA) and the treatment condition (β=.416, p=.03). No other elements of the model were significant. This finding can be further understood by examining Figure 2 where it can be seen that there is a linear trend for better

verbal fluency to be associated with lower depression in the CTBE condition, whereas in the DBT condition, the opposite relationship appears to be true.

Second, in hypothesis 2b, I examined whether any of the executive function measures served as a moderator of treatment for effects on suicide attempts over the year. As can be seen in the logistic regression presented in Table 12, the only significant finding was for an interaction between inhibition (Stroop) and treatment condition (β=8.043, p=.013). However, there is an extremely large odds ratio that resulted from this analysis (*OR* = 3111.545), which likely represents that this was a spurious finding. When the other covariates are taken away from the model, as seen in Table 13, the interaction is no longer significant, though a trend still exists (β=4.936, p=.079).

Third, in hypothesis 2c, I examined whether any of the executive function measures served as a moderator of treatment for effects on NSSI. As can be seen in Table 14, for this ordinal regression analysis there was a significant finding for the interaction of figural fluency and treatment condition (*Wald*=6.880, *p*=.009). Figure 4 demonstrates that better figural fluency is associated with less NSSI in the DBT condition, but that the opposite is true in the CTBE condition.

Hypothesis 3: Executive Functioning as an Outcome of Treatment

To evaluate whether executive functioning could be modified by dialectical behavior therapy better than by a community treatment by experts, three ANCOVA models were tested. First, for hypothesis 3a, an ANCOVA analysis was used to examine whether there was a difference in the effect of DBT or CTBE on figural fluency as measured by the number of unique designs generated during the RFFT (while controlling for pre-treatment scores on the RFFT). As seen in Table 16, there were no significant differences in design fluency scores across the

treatment conditions at post-treatment. This was true whether the potential covariates of age, education, recent drug use, and prior head injury were included in the model or not, as seen in Table 17.

Second, in hypothesis 3b, an ANCOVA model was used to evaluate whether there was a difference in the effect of DBT or CTBE on verbal fluency as measured by the number of correct words generated during the COWA (while controlling for pre-treatment scores on the COWA). As seen in Table 18, there were no significant differences in verbal fluency scores across the treatment conditions at post-treatment. This was true whether the potential covariates of age, education, recent drug use, and prior head injury were included in the model or not, as seen in Table 19.

Lastly, in hypothesis 3c, I examined whether there was a difference in the effect of DBT or CTBE on inhibition as measured with the Stroop Interference Effect (while controlling for pre-treatment scores on the Stroop). Again, there were no significant differences in inhibition scores across the treatment conditions at post-treatment as demonstrated in Table 20. This was true whether the potential covariates of age, education, recent drug use, and prior head injury were included in the model or not, which can be seen in Table 21.

Despite the failure to find differences across treatment conditions for improving figural fluency, verbal fluency, or inhibition, paired t-test for each of these measures suggest that figural fluency ($t(72)=-3.547$, $p<.001$) and verbal fluency ($t(71)=3.467$, $p<.001$) significantly improved over the course of treatment, as can be seen in Table 22. It is not entirely clear though, if this was due to expected improvements from practice effects or due to the benefits of the treatments.

Table 1 shows that there is an increase of 2.35 unique designs on the RFFT in this study from pretreatment to post treatment one year later. There are known practice effects for figural

fluency. A normative sample shows an average increase of 6.81 designs over 12 months for the full RFFT (Basso et al., 1999). This study uses only one of the five subscales on the full RFFT, but when roughly estimating by dividing by five, there would be 1.362 new designs. This may suggest a small increase in figural fluency over the year of treatment beyond what one would expect from mere practice effects alone, though this is not conclusive from this study, nor does it appear to be a clinically meaningful increase.

The present study shows an increase in verbal fluency from pre- to post-treatment of an average 4.871 words (see Table 1). In a study evaluating practice effects for verbal fluency scores, 50 healthy males were tested twice over a twelve month interval and noted no gains in generating words based on the letters FAS (Basso et al., 1999). The COWA uses the letters CFL, but the two sets are comparable. However, Levine, Miller, Becker, Selnes, and Cohen (2004) reported gains of about three words on the FAS for a sample of 145 healthy men (age, $M = 38.8$, $SD = 7.9$; education, $M = 16.4$, $SD = 2.3$, mostly Caucasians) that were reassessed across a wide time interval of four to 24 months (mean interval = 191 days, SD = 38). There is some chance that the gains in verbal fluency scores seen in the present study were due to more than simple practice effects.

Bullock et al. (unpublished data, in Strauss et al., 2006) found significant practice effects on the Victoria Stroop Test over a one month test interval. Performance improved by about three seconds on the interference score. There was no substantive improvement seen on Stroop scores in the present study's overall sample, though as can be seen in Table 3, there may be improvement in the CTBE condition only, though this did not hold as being significantly different from the DBT condition in the ANCOVA models.

Discussion

The main purpose of this study was to examine whether aspects of executive functioning play a role in the success of treatment for people with borderline personality disorder. The executive functions of figural fluency, verbal fluency, and inhibition did not serve as predictors for any of the treatment outcomes of depression, suicide attempts, or NSSI. Additionally, neither of the treatments (DBT and CTBE) did a better job than the other at improving executive functioning. The results of this study do provide some tentative support for executive functioning as a moderator of treatment outcomes when comparing DBT and CTBE in terms of their ability to effect change in depression ratings, suicide attempts, and nonsuicidal self injury. While none of the executive function measures (RFFT, COWA, Stroop) showed consistent moderation across all the outcome measures, they did each show evidence for moderating the treatment on at least one outcome each (Ham-D, suicide attempts, or NSSI).

Verbal Fluency x Treatment Condition on Ham-D Depression Scores

Verbal fluency as measured by the number of correct words generated based on the letters F, A, and S during the COWA test was shown to moderate treatment in respect to depression scores on the Ham-D. There were linear trends showing that within the CTBE condition, greater verbal fluency scores were associated with lower depression scores, while within the DBT condition, greater verbal fluency scores were associated with higher depression scores (see Figure 2). It was expected that depression ratings within the DBT condition would be uninfluenced by verbal fluency scores, but that CTBE would lead to differential outcomes predictable by pre-treatment verbal fluency scores. This was not exactly the case. While there is a moderation effect of verbal fluency, it appears significant because the DBT and CTBE scores cross over. This would mean that clients primarily concerned with reducing depression would be

better in the CTBE condition if they are beginning treatment with high verbal fluency, but better in the DBT condition if they are beginning treatment with low verbal fluency.

Inhibition x Treatment Condition on Suicide Attempts

The results additionally suggested a possible moderating effect of Stroop interference scores on treatment in regards to suicide attempts. Those within the DBT condition with better performance on the Stroop tended towards having fewer suicide attempts, while in the CTBE condition, better performance on the Stroop was associated with more suicide attempts. Nevertheless, the overall logistic regression model that included this significant interaction term was able to correctly classify cases where there was not a suicide attempt 82.3% of the time, and correctly classify cases where there was a suicide attempt 48.1% of the time. This leads to an overall percentage of 71.9% correct predictions. While this is not particularly strong predictive accuracy, due to the potentially life ending consequences of a suicide attempt, this may still be of clinical importance and the overall model is still statistically significant. The original randomized control trial from which the data for this study was collected shows that DBT is better at reducing suicide attempts than CTBE (Linehan et al., 2006), and the current study further suggests that this might be particularly true for clients with better inhibitory control and cognitive flexibility, as measured on the Stroop test.

Figural Fluency x Treatment Condition on NSSI

The evidence suggests that figural fluency as measured by the number of unique designs created on the RFFT moderated treatment in terms of NSSI. Those in the CTBE condition with higher RFFT scores tended to show more episodes of NSSI, whereas in the DBT condition, this was not the case (see figure 4). This suggests that greater figural fluency is associated with more

nonsuicidal self injury for those in the CTBE therapy, but not for those in DBT. DBT would therefore be the preferred treatment for those with greater figural fluency.

Executive Functioning as a Predictor of Outcomes

The first hypothesis of this study which proposed that executive functioning could predict outcomes was wholly unsupported. There were no significant findings for any of the executive functioning measures as predictors for any of the treatment outcome measures. This may be due in part to the cross-over interactions canceling out any main effects; however, there were only a limited number of statistically significant crossed interactions found in this study that could explain all of the non-significant findings for the proposed predictors. Every executive functioning measure compared against every outcome measure failed to show executive functioning as a significant predictor. Knowing that much of the power for these models to show an effect is lost to the number of covariates included, these models were examined again with the covariates taken out. Again, there were no significant findings for any of the executive functioning measures as predictors of any of the outcome measures even without the covariates in the model. Executive Functioning (as measured by the RFFT, COWA, and Stroop) does not predict therapy outcome when collapsing across DBT and CTBE treatments. Though the first hypothesis was not supported, this is still an encouraging finding as it suggests that both of these treatments are able to positively benefit therapy clients who span a range of pre-existing executive functioning abilities.

Executive Functioning as a Treatment Outcome

The third hypothesis examined executive functioning as a treatment outcome itself, rather than as a predictor or moderator. It was predicted that improvements to executive functioning would be seen in the DBT conditions more so than in the CTBE condition; however, there was

no significant difference between the DBT and CTBE conditions in their effect on any of the three executive functioning measures. Through an examination of the means ratings before and after treatment, however, it does appear that there were some slight improvements across all of the executive functioning ratings for both treatment conditions. It is not clear if this was due to a direct effect of treatment, practice effects, or whether the improvement was mediated by the treatment's effects on other factors such as drug use. Nevertheless, participants did see improvement across types of executive functioning in both treatment conditions at the end of one year in therapy.

Implications of Findings

The RFFT, the COWA, and the Stroop are all relatively short and simple assessments that can be given as part of a larger assessment battery, but if the goal of using these assessments is to predict response to treatment in terms of reduction of depression, suicide attempts, and nonsuicidal self injury, then these three executive functioning measures will largely be of little utility when DBT or CTBE are the treatments in question. The exceptions to this are that those with better scores on the RFFT or the Stroop are particularly better off in the DBT condition for reducing NSSI and suicide attempts respectively. Nevertheless, knowing that DBT outperforms TBCE in general, any client would likely be recommended to the DBT condition over TBCE, so the prognostic information gained from an understanding of their pre-treatment RFFT and Stroop scores still provides little clinical utility. For clients planning to begin treatment with a nonbehavioral expert therapist, however, these two measures may serve as potentially useful indicators of suicide risk. For DBT clients, performance on the COWA might serve a related use as a pre-treatment indicator for slower depression relief than would be had in CTBE therapy.

Limitations of the Study and Future Directions for Research

This study used previously collected data from a study regarding the effectiveness of DBT as a treatment for borderline personality disorder (Linehan et al, 2006). As such, the executive functioning measures in this study were only a small part of a much larger assessment battery that was not primarily concerned with the topic of executive functioning. Though the parent study was designed in a methodologically sound manner with an appropriate structure to allow for testing the hypotheses set forth in this study, the amount of neuropsychological assessment was limited to only the RFFT, COWA, and Stroop tests. While each of these is a well established valid assessment with known relationships to BPD and suicide, as a whole they do not cover the full breadth of the concept of executive functioning. They provide information regarding figural fluency, verbal fluency, and inhibitory control, but they do not account for executive functioning in its entirety. Neuropsychological studies regarding executive functioning as a general concept often include more comprehensive testing batteries. While the executive functioning measures in this study are commonly used and were a good choice for this study given past research suggesting their association with BPD and suicide, there are still other neuropsychological assessments that would be worth examining for their role in treatment research. For example, the Wisconsin Card Sorting Task has been shown to be positively related to suicidal behavior, suggesting that increased problem solving ability is associated with greater likelihood of attempted suicide (Burton, Vella, Weller, & Twamley, 2011).

On a related note, it was surprising to find that when the executive functioning measures moderated treatment outcomes in this study, it was often in a direction opposite of what was expected. One would expect better executive functioning to be associated with better outcomes in either condition, but in this study better executive functioning in certain domains of executive

functioning was associated with worse outcomes within the CTBE condition in relation to suicide attempts and NSSI, or within the DBT condition in relation to depression. This moderation finding, taken along with findings like those just mentioned for the Wisconsin Card Sorting Task in the Burton et al. (2011) study imply that better executive functioning is not always better for mental health outcomes, particularly in regards to suicide. This may be explained by the fact that many suicidal patients view suicide as a form of problem solving for the troubles of their life and history (Linehan, 1993). This could mean that the aspects of executive functioning related to better planning and creative problem solving could lead suicidal people to more effective ways of killing themselves. If this is the case, then it would be a fruitful avenue for further research to study how to help clients with higher executive functioning apply their problem solving abilities to finding other methods of improving their lives rather than ending them.

Another limitation of this study is that many analyses were run while there was only a moderately sized sample. This increases the possibility for both Type I and Type II errors. It is possible that real effects were missed that would have been detected with a larger sample size. It is also possible that some of the statistically significant findings in this paper were simply due to chance. For this reason, the results in this study should be interpreted with due caution. Practical limitations in the ability to pull together a large population of people that meet criteria for borderline personality disorder and provide them with different treatments makes it prohibitive to pull together even larger sample sizes than the one found in this study. Further research, however, may still better illuminate the role of executive functioning for predicting suicidal behavior, perhaps by examining large archival data in settings where neuropsychological assessment is routine and records are kept regarding patient suicide. It would also be worthwhile

to conduct smaller experimental studies regarding the types of problem solving done by patients with high executive functioning abilities that have BPD. This could illuminate the amount of problem solving they do towards planning suicide in comparison to the amount of problem solving they do towards creating a life worth living. Perhaps small intervention techniques could be tested to apply their executive functioning skills towards more life enhancing practices rather than life ending behaviors.

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Table 1

Descriptive Statistics All Groups

	N	Minimum	Maximum	Mean	Std. Deviation
RFFT: figural fluency pre	94	5	28	13.82	4.541
RFFT: figural fluency post	77	5	29	16.17	4.873
COWA: verbal fluency pre	94	16.00	67.00	39.723	10.723
COWA: verbal fluency post	76	23.00	68.00	43.592	10.747
Stroop Interference: pre	94	-3.80	60.01	11.831	8.295
Stroop Interference: post	77	1.99	38.83	9.753	6.912
HAM-D: depression pre	98	7	36	20.82	6.601
HAM-D: depression post	83	2	35	15.00	8.274
Any suicide attempts: pre	101	0	1	.75	.434
Any suicide attempts: post	97	0	1	.31	.465
NSSI: pre	101	.00	4.00	2.069	1.451
NSSI: post	89	.00	4.00	.9663	1.394
Age	101	18	45	29.30	7.535
Education	101	1.00	4.00	2.911	.850
Head Injury	98	0	1	.19	.397
Drug & alcohol abstinent days in last 30 days	101	0	30	23.73	8.480

NSSI: 0=0, 1=1, 2=2, 3=3 or 4, 4=5+ self injuries
Education: 1=some highschool., 2=highschool or GED, 3=some college, 4=college graduate
Head Injury: 0=no, 1=yes

Table 2

Descriptive Statistics (DBT only)

	N	Minimum	Maximum	Mean	Std. Deviation
RFFT: pre	49	5	24	13.78	4.740
RFFT: post	43	6	29	16.42	5.039
COWA: pre	49	16.00	65.00	39.653	11.054
COWA: post	42	23.00	68.00	44.524	10.814
Stroop Interference: pre	49	-3.80	28.61	10.312	6.185
Stroop Interference: post	43	2.08	38.83	10.078	7.693
HAM-D: pre	52	7	33	20.21	5.922
HAM-D: post	47	2	30	13.81	7.333
Any suicide attempts: pre	52	0	1	.67	.474
Any suicide attempts: post	52	0	1	.21	.412
NSSI: pre	52	.00	4.00	2.115	1.395
NSSI: post	50	.00	4.00	.780	1.266
Age	52	18	44	29.04	7.303
Education	52	1.00	4.00	2.904	.891
Head Injury	50	0	1	.14	.351
Drug & alcohol abstinent days in last 30 days	52	0	30	23.60	8.752

NSSI: 0=0, 1=1, 2=2, 3=3 or 4, 4=5+ self injuries
Education: 1=some highschool., 2=highschool or GED, 3=some college, 4=college graduate
Head Injury: 0=no, 1=yes

Table 3

Descriptive Statistics (CTBE only)

	N	Minimum	Maximum	Mean	Std. Deviation
RFFT: pre	45	8	28	13.87	4.367
RFFT: post	34	5	25	15.85	4.711
COWA: pre	45	22.00	67.00	39.800	10.474
COWA: post	34	25.00	60.00	42.441	10.712
Stroop Interference: pre	45	-.34	60.01	13.485	9.916
Stroop Interference: post	34	1.99	25.99	9.342	5.864
HAM-D: pre	46	7	36	21.50	7.299
HAM-D: post	36	2	35	16.56	9.238
Any suicide attempts: pre	49	0	1	.84	.373
Any suicide attempts: post	45	0	1	.42	.499
NSSI: pre	49	.00	4.00	2.020	1.521
NSSI: post	39	.00	4.00	1.205	1.525
Age	49	18	45	29.57	7.840
Education	49	1.00	4.00	2.918	.8123
Head Injury	48	0	1	.25	.438
Drug & alcohol abstinent days in last 30 days	49	0	30	23.88	8.271

NSSI: 0=0, 1=1, 2=2, 3=3 or 4, 4=5+ self injuries
Education: 1=some highschool., 2=highschool or GED, 3=some college, 4=college graduate
Head Injury: 0=no, 1=yes

Table 4

Hypothesis 1a: Multiple Regression for Measures of Executive Functioning as Predictors of Post Treatment Depression Scores (Covariates in the Model)

Independent Variables	Multiple Regression Ham-D Depression Scores			
	β	SE	t	p
Block 1				
Baseline score on Ham-D	.489	.134	3.646	.001*
Age	.118	.118	1.001	.320
Education Level	-.569	1.024	-.555	.580
Head Injury	2.105	2.550	.826	.412
Number of drug & alcohol abstinent days in last 30 days	.191	.103	1.859	.067
Block 2				.273
Baseline score on Ham-D	.486	.139	3.512	.001*
Age	.115	.124	.928	.357
Education Level	-.561	1.068	-.525	.601
Head Injury	2.133	2.626	.812	.420
Number of drug & alcohol abstinent days in last 30 days	.193	.107	1.811	.075
RFFT: # of Unique Designs	-.019	.198	-.095	.924
COWA: Total Correct Words	.003	.096	.035	.972
Stroop Interference Effect	.026	.145	.178	.859

Overall Model Summary	Block 1	Block 2
F	4.542	2.723
df	5, 69	8, 66
P	.001**	.012*
R^2	.248	.248

Note. *Significant at p<.05, **Significant at p<.01.
Education: 1=some highschool., 2=highschool or GED, 3=some college, 4=college graduate.
Head Injury: 0=no, 1=yes

Table 5

Hypothesis 1a: Multiple Regression for Measures of Executive Functioning as Predictors of Post Treatment Depression Scores (Covariates Removed)

Independent Variables	Multiple Regression Ham-D Depression Scores			
	β	SE	t	p
Block 1				
Baseline score on Ham-D	.534	.133	4.028	.000**
Block 2				
Baseline score on Ham-D	.533	.136	3.908	.000**
RFFT: # of Unique Designs	-.019	.194	-.100	.920
COWA: Total Correct Words	.000	.088	.003	.998
Stroop Interference Effect	.016	.140	.117	.907

Overall Model Summary	Block 1	Block 2
F	16.226	3.903
df	1, 75	4, 72
p	.000**	.006**
R^2	.178	.178

Note. *Significant at p<.05, **Significant at p<.01.

Table 6

Hypothesis 1b: Logistic Regression for Measures of Executive Functioning as Predictors of a Suicide Attempt During the Treatment Year (Covariates in the Model)

Independent Variables	Suicide Attempt (no/yes)			
	β	SE	Odds Ratio	p
Block 1				
Baseline: Any Suicide Attempt	2.959	1.071	19.282	.006**
Age	.046	.035	1.047	.189
Education Level	.236	.321	1.266	.463
Head Injury	-.825	.698	.438	.237
Number of drug & alcohol abstinent days in last 30 days	.012	.030	1.012	.694
Block 2				
Baseline score: Any Suicide Attempt	3.140	1.105	23.114	.004**
Age	.040	.037	1.041	.277
Education Level	.213	.331	1.237	.521
Head Injury	-.875	.736	.417	.234
Number of drug & alcohol abstinent days in last 30 days	.020	.031	1.020	.526
RFFT: # of Unique Designs	.038	.062	1.039	.537
COWA: Total Correct Words	.025	.028	1.025	.367
Stroop Interference Effect	.042	.039	1.043	.277

Overall Model Summary	Block 1	Block 2
N	89	89
Overall Model χ^2	18.362	2.292
df	5	3
p	.003**	.514
Nagelkerke R^2	.264	.293
% correctly classified	71.9%	71.9%

Note. *Significant at p<.05, **Significant at p<.01.
Education: 1=some highschool., 2=highschool or GED, 3=some college, 4=college graduate.
Head Injury: 0=no, 1=yes

Table 7

Hypothesis 1b: Logistic Regression for Measures of Executive Functioning as Predictors of a Suicide Attempt During the Treatment Year (Covariates Removed)

Independent Variables	Suicide Attempt (no/yes)			
	β	SE	Odds Ratio	p
Block 1				
Baseline: Any Suicide Attempt	2.747	1.051	15.600	.009**
Block 2				
Baseline score: Any Suicide Attempt	2.842	1.062	17.155	.007**
RFFT: # of Unique Designs	.010	.059	1.010	.866
COWA: Total Correct Words	.027	.025	1.027	.281
Stroop Interference Effect	.046	.037	1.047	.212

Overall Model Summary	Block 1	Block 2
N	91	91
Overall Model χ^2	13.764	2.397
df	1	3
p	.000**	.494
Nagelkerke R^2	.199	.231
% correctly classified	70.3%	69.2%

Note. *Significant at p<.05, **Significant at p<.01.

Table 8

Hypothesis 1c: Ordinal Regression for Measures of Executive Functioning as Predictors of NSSI at Post Treatment (Covariates in the Model)

Independent Variables	Ordinal NSSI Ratings			
	Estimate	SE	Wald	p
Threshold				
Ordinal NSSI at Post Tx = 0	2.460	1.998	1.516	.218
Ordinal NSSI at Post Tx = 1	3.152	2.012	2.456	.117
Ordinal NSSI at Post Tx = 2	3.550	2.020	3.087	.079
Ordinal NSSI at Post Tx = 3	4.660	2.050	5.169	.023*
Location				
Age	.026	.036	.528	.468
Number of drug & alcohol abstinent days in last 30 days	.044	.032	1.944	.163
RFFT: # of Unique Designs	-.066	.057	1.340	.247
COWA: Total Correct Words	.050	.028	3.185	.074
Stroop Interference Effect	.008	.042	.040	.841
Ordinal NSSI at Pre Tx = 0	-2.287	1.187	3.714	.054
Ordinal NSSI at Pre Tx = 1	-.856	.722	1.406	.236
Ordinal NSSI at Pre Tx = 2	.537	.694	.599	.439
Ordinal NSSI at Pre Tx = 3-4	1.110	.751	2.188	.139
Ordinal NSSI at Pre Tx = >4	0[a]	.	.	.
Education Level = 1	.017	1.019	.000	.986
Education Level = 2	-.599	.742	.653	.419
Education Level = 3	-.261	.612	.182	.669
Education Level = 4	0[a]	.	.	.
Head Injury = 0	-.590	.661	.797	.372
Head Injury = 1	0[a]	.	.	.

Overall Model Summary

N	81
Overall Model χ^2 (13)	22.784
p	.044*
Nagelkerke R^2	.268
% correctly classified	61.7%

Note. *Significant at p<.05, **Significant at p<.01.
NSSI: 0=0, 1=1, 2=2, 3=3 or 4, 4=5+.
Education: 1=some highschool., 2=highschool or GED, 3=some college, 4=college graduate.
Head Injury: 0=no, 1=yes

Table 9

Hypothesis 1c: Ordinal Regression for Measures of Executive Functioning as Predictors of NSSI at Post Treatment (Covariates Removed)

Independent Variables	Ordinal NSSI Ratings			
	Estimate	SE	Wald	p
Threshold				
Ordinal NSSI at Post Tx = 0	1.068	1.348	.628	.428
Ordinal NSSI at Post Tx = 1	1.766	1.359	1.690	.194
Ordinal NSSI at Post Tx = 2	2.135	1.367	2.440	.118
Ordinal NSSI at Post Tx = 3	3.184	1.401	5.167	.023*
Location				
RFFT: # of Unique Designs	-.046	.054	.716	.398
COWA: Total Correct Words	.037	.024	2.353	.125
Stroop Interference Effect	-.006	.039	.027	.869
Ordinal NSSI at Pre Tx = 0	-1.811	1.120	2.611	.106
Ordinal NSSI at Pre Tx = 1	-.616	.636	.939	.333
Ordinal NSSI at Pre Tx = 2	.531	.627	.718	.397
Ordinal NSSI at Pre Tx = 3-4	1.207	.723	2.788	.095
Ordinal NSSI at Pre Tx = >4	0[a]	.	.	.

Overall Model Summary

N	83
Overall Model χ^2 (7)	15.764
p	.027*
Nagelkerke R^2	.189
% correctly classified	60.0%

a. This parameter is set to zero because it is redundant.
NSSI: 0=0, 1=1, 2=2, 3=3 or 4, 4=5+ self injuries
Education: 1=some highschool., 2=highschool or GED, 3=some college, 4=college graduate
Head Injury: 0=no, 1=yes
*Significant at p<.05, **Significant at p<.01.

Table 10

Hypothesis 2a: Multiple Regression Examining the Moderating Effect of Executive Functions on Treatment for Improving Depression (Covariates Included)

Independent Variables	Multiple Regression Ham-D Depression Scores			
	β	SE	t	p
Block 1				
Baseline score on Ham-D	.489	.134	3.646	.001**
Age	.118	.118	1.001	.320
Education Level	-.569	1.024	-.555	.580
Head Injury	2.105	2.550	.826	.412
Number of drug & alcohol abstinent days in last 30 days	.191	.103	1.859	.067
Block 2				
Baseline score on Ham-D	.484	.138	3.518	.001**
Age	.111	.124	.890	.377
Education Level	-.638	1.087	-.587	.559
Head Injury	1.953	2.661	.734	.466
Number of drug & alcohol abstinent days in last 30 days	.195	.110	1.782	.079
Treatment Condition	-1.551	1.815	-.855	.396
RFFT: # of Unique Designs	-.027	.198	-.138	.891
COWA: Total Correct Words	-.002	.091	-.026	.980
Stroop Interference Effect	2.361	4.495	.525	.601
Block 3				
Baseline score on Ham-D	.462	.135	3.422	.001**
Age	.121	.123	.981	.330
Education Level	-.349	1.074	-.325	.746
Head Injury	3.559	2.736	1.300	.198
Number of drug & alcohol abstinent days in last 30 days	.253	.110	2.290	.025*
Treatment Condition	-1.558	1.768	-.882	.381
RFFT: # of Unique Designs	-.256	.293	-.874	.385
COWA: Total Correct Words	-.225	.135	-1.669	.100
Stroop Interference Effect	1.088	6.374	.171	.865
RFFT X Treatment Condition	.161	.404	.398	.692
COWA X Treatment Condition	.416	.188	2.216	.030*
Stroop X Treatment Condition	7.586	8.863	.856	.395

Overall Model Summary	Block 1	Block 2	Block 3
F	4.542	2.548	2.562
df	5, 69	9, 65	12, 62
p	.001	.014	.008
R^2	.248	.261	.332

Note. *Significant at p<.05, **Significant at p<.01.
NSSI: 0=0, 1=1, 2=2, 3=3 or 4, 4=5+ self injuries
Education: 1=some highschool., 2=highschool or GED, 3=some college, 4=college graduate
Head Injury: 0=no, 1=yes

Table 11

Hypothesis 2a: Multiple Regression Examining the Moderating Effect of Executive Functions on Treatment for Improving Depression (Covariates Removed)

Independent Variables	Multiple Regression Ham-D Depression Scores			
	β	SE	t	p
Block 1				
Baseline score on Ham-D	.534	.133	4.028	.000**
Block 2				
Baseline score on Ham-D	.531	.135	3.939	.000**
Treatment Condition	-2.197	1.759	-1.249	.216
RFFT: # of Unique Designs	-.026	.194	-.133	.895
COWA: Total Correct Words	-.005	.085	-.058	.954
Stroop Interference Effect	.831	4.186	.198	.843
Block 3				
Baseline score on Ham-D	.515	.136	3.781	.000**
Treatment Condition	-2.342	1.768	-1.325	.190
RFFT: # of Unique Designs	-.065	.291	-.225	.823
COWA: Total Correct Words	-.164	.133	-1.230	.223
Stroop Interference Effect	.582	6.067	.096	.924
RFFT X Treatment Condition	-.059	.400	-.147	.884
COWA X Treatment Condition	.287	.178	1.611	.112
Stroop X Treatment Condition	3.119	8.541	.365	.716

Overall Model Summary	Block 1	Block 2	Block 3
F	16.226	3.479	2.528
df	1, 75	5, 71	8, 68
p	.000**	.007**	.018*
R^2	.178	.197	.139

Note. *Significant at p<.05, **Significant at p<.01.

Table 12

Hypothesis 2b: Logistic Regression Examining the Moderating Effect of Executive Functions on Treatment for Reducing Suicide Attempts (Covariates Included)

Independent Variables	Suicide Attempt (no/yes)			
	β	SE	Odds Ratio	p
Block 1				
Baseline: Any Suicide Attempt	2.959	1.071	19.282	.006**
Age	.046	.035	1.047	.189
Education Level	.236	.321	1.266	.463
Head Injury	-.825	.698	.438	.237
Number of drug & alcohol abstinent days in last 30 days	.012	.030	1.012	.694
Block 2				
Baseline score: Any Suicide Attempt	2.967	1.101	19.431	.007**
Age	.037	.037	1.038	.315
Education Level	.121	.343	1.129	.724
Head Injury	-.939	.770	.391	.223
Number of drug & alcohol abstinent days in last 30 days	.026	.032	1.027	.413
Treatment Condition	-.726	.552	.484	.188
RFFT: # of Unique Designs	.024	.065	1.024	.715
COWA: Total Correct Words	.021	.027	1.022	.427
Stroop Interference Effect	.973	1.305	2.645	.456
Block 3				
Baseline score: Any Suicide Attempt	3.372	1.244	29.123	.007**
Age	.067	.043	1.069	.124
Education Level	.314	.396	1.369	.428
Head Injury	-1.392	.869	.249	.109
Number of drug & alcohol abstinent days in last 30 days	.053	.036	1.054	.138
Treatment Condition	-.972	.624	.378	.120
RFFT: # of Unique Designs	-.034	.084	.966	.683
COWA: Total Correct Words	.000	.037	1.000	.989
Stroop Interference Effect	-1.963	1.736	.140	.258
RFFT X Treatment Condition	.099	.154	1.104	.520
COWA X Treatment Condition	.069	.066	1.071	.295
Stroop X Treatment Condition	8.043	3.234	3111.545	.013*

Overall Model Summary	Block 1	Block 2	Block 3
N	89	89	89
Overall Model χ^2	18.362	22.125	31.216
df	5	9	12
p	.003	.008	.002
Nagelkerke R^2	.264	.311	.418
% correctly classified	71.9	70.8	71.9

Note. *Significant at p<.05, **Significant at p<.01.

Education: 1=some highschool., 2=highschool or GED, 3=some college, 4=college graduate

Table 13

Hypothesis 2b: Logistic Regression Examining the Moderating Effect of Executive Functions on Treatment for Reducing Suicide Attempts (Covariates Removed)

Independent Variables	Suicide Attempt (no/yes)			
	β	SE	Odds Ratio	p
Block 1				
Baseline: Any Suicide Attempt	2.747	1.051	6.830	.009**
Block 2				
Baseline score: Any Suicide Attempt	2.716	1.071	15.115	.011*
Treatment Condition	-.728	.515	.483	.157
RFFT: # of Unique Designs	-.006	.062	.994	.929
COWA: Total Correct Words	.023	.025	1.023	.360
Stroop Interference Effect	1.364	1.143	3.912	.233
Block 3				
Baseline score on Ham-D	2.675	1.080	14.513	.013*
Treatment Condition	-.877	.551	.416	.112
RFFT: # of Unique Designs	-.018	.077	.982	.819
COWA: Total Correct Words	.008	.034	1.008	.819
Stroop Interference Effect	-.149	1.417	.862	.916
RFFT X Treatment Condition	-.014	.136	.986	.918
COWA X Treatment Condition	.053	.055	1.054	.338
Stroop X Treatment Condition	4.936	2.808	139.231	.079

Overall Model Summary	Block 1	Block 2	Block 3
N	91	91	91
Overall Model χ^2	13.764	18.627	22.796
df	1	5	8
p	.000**	.002**	.004**
Nagelkerke R^2	.199	.263	.315
% correctly classified	70.3	71.4	74.7

Note. *Significant at p<.05, **Significant at p<.01.

NSSI: 0=0, 1=1, 2=2, 3=3 or 4, 4=5+ self injuries

Education: 1=some highschool., 2=highschool or GED, 3=some college, 4=college graduate

Head Injury: 0=no, 1=yes

Table 14

Hypothesis 2c: Ordinal Regression Examining the Moderating Effect of Executive Functions on Treatment for Reducing NSSI (Covariates Included)

	Ordinal NSSI Ratings			
Independent Variables	Estimate	SE	Wald	p
Threshold				
Ordinal NSSI at Post Tx = 0	1.175	1.710	.472	.492
Ordinal NSSI at Post Tx = 1	1.957	1.721	1.293	.256
Ordinal NSSI at Post Tx = 2	2.404	1.730	1.930	.165
Ordinal NSSI at Post Tx = 3	3.681	1.765	4.350	.037*
Location				
Age	.019	.038	.234	.628
Number of drug & alcohol abstinent days in last 30 days	.037	.034	1.165	.280
RFFT: # of Unique Designs	.115	.080	2.087	.149
COWA: Total Correct Words	.083	.040	4.318	.038*
Stroop Interference Effect	-.002	.047	.001	.971
RFFT X Treatment Condition	-.328	.125	6.880	.009**
COWA X Treatment Condition	-.035	.053	.454	.501
Stroop X Treatment Condition	2.079	2.113	.968	.325
Treatment Condition = 0	.446	.548	.661	.416
Treatment Condition = 1	0[a]	.	.	.
Ordinal NSSI at Pre Tx = 0	-2.597	1.205	4.642	.031*
Ordinal NSSI at Pre Tx = 1	-1.270	.808	2.470	.116
Ordinal NSSI at Pre Tx = 2	.770	.746	1.067	.302
Ordinal NSSI at Pre Tx = 3-4	1.045	.801	1.702	.192
Ordinal NSSI at Pre Tx = >4	0[a]	.	.	.
Education Level = 1	-.259	1.133	.052	.819
Education Level = 2	-.795	.788	1.018	.313
Education Level = 3	-.269	.672	.160	.689
Education Level = 4	0[a]	.	.	.
Head Injury = 0	-.352	.708	.247	.619
Head Injury = 1	0[a]	.	.	.

Overall Model Summary

N	81
Overall Model χ^2 (17)	34.961
p	.006
Nagelkerke R^2	.383
% correctly classified	60.5

Note. *Significant at p<.05, **Significant at p<.01.
NSSI: 0=0, 1=1, 2=2, 3=3 or 4, 4=5+ self injuries
Education: 1=some highschool., 2=highschool or GED, 3=some college, 4=college graduate
Head Injury: 0=no, 1=yes

Table 15

Hypothesis 2c: Ordinal Regression Examining the Moderating Effect of Executive Functions on Treatment for Reducing NSSI (Covariates Removed)

	Ordinal NSSI Ratings			
Independent Variables				
	Estimate	SE	Wald	P
Threshold				
Ordinal NSSI at Post Tx = 0	.419	.708	.351	.554
Ordinal NSSI at Post Tx = 1	1.231	.722	2.906	.088
Ordinal NSSI at Post Tx = 2	1.660	.737	5.072	.024
Ordinal NSSI at Post Tx = 3	2.870	.814	12.428	.000**
Location				
RFFT: # of Unique Designs	.138	.076	3.330	.068
COWA: Total Correct Words	.087	.036	5.734	.017*
Stroop Interference Effect	-.010	.044	.051	.821
RFFT X Treatment Condition	-.281	.115	5.942	.015*
COWA X Treatment Condition	-.074	.049	2.325	.127
Stroop X Treatment Condition	.115	1.858	.004	.951
Treatment Condition = 0	.500	.517	.936	.333
Treatment Condition = 1	0a	.	.	.
Ordinal NSSI at Pre Tx = 0	-1.991	1.118	3.169	.075
Ordinal NSSI at Pre Tx = 1	-.833	.691	1.452	.228
Ordinal NSSI at Pre Tx = 2	.678	.661	1.053	.305
Ordinal NSSI at Pre Tx = 3-4	1.070	.767	1.945	.163
Ordinal NSSI at Pre Tx = >4	0a	.	.	.

Overall Model Summary	
N	83
Overall Model χ^2 (17)	29.508
p	.002
Nagelkerke R^2	.327
% correctly classified	60.2

Note. *Significant at p<.05, **Significant at p<.01.
NSSI: 0=0, 1=1, 2=2, 3=3 or 4, 4=5+ self injuries

Table 16

Hypothesis 3a: ANCOVA for whether DBT can improve Figural Fluency better than CTBE (Covariates Included)

Descriptive Statistics
Dependent Variable: RFFT Unique Designs

Tx Condition	Mean	Std. Deviation	N
.00	-.2938	4.844	32
1.00	.1132	5.241	39
Total	-.0702	5.035	71

Tests of Between-Subjects Effects
Dependent Variable: RFFT Number of Unique Designs at Post Treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	594.814a	6	99.136	5.379	.000**	.335
Intercept	4.812	1	4.812	.261	.611	.004
Age	98.882	1	98.882	5.365	.024*	.077
Education Level	99.239	1	99.239	5.385	.024*	.078
Head Injury	13.152	1	13.152	.714	.401	.011
Number of drug & alcohol abstinent days in last 30 days	14.778	1	14.778	.802	.374	.012
RFFT Designs at Pre Tx	344.180	1	344.180	18.675	.000**	.226
Treatment Condition	12.517	1	12.517	.679	.413	.011
Error	1179.495	64	18.430			
Total	1774.660	71				
Corrected Total	1774.310	70				

a. R Squared = .335 (Adjusted R Squared = .273)
*Significant at p<.05, **Significant at p<.01.

Table 17

Hypothesis 3a: ANCOVA for whether DBT can improve Figural Fluency better than CTBE (Covariates Removed)

Descriptive Statistics
Dependent Variable: RFFT Unique Designs

Tx Condition	Mean	Std. Deviation	N
.00	-.2938	4.844	32
1.00	.1482	5.130	41
Total	-.0455	4.978	73

Tests of Between-Subjects Effects
Dependent Variable: RFFT Number of Unique Designs at Post Treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	403.349[a]	2	201.674	10.226	.000**	.226
Intercept	3.447	1	3.447	.175	.677	.002
RFFT Designs at Pre Tx	399.836	1	399.836	20.274	.000**	.225
Treatment Condition	10.064	1	10.064	.510	.477	.007
Error	1380.542	70	19.722			
Total	1784.042	73				
Corrected Total	1783.890	72				

a. R Squared = .226 (Adjusted R Squared = .204)
*Significant at p<.05, **Significant at p<.01.

Table 18

Hypothesis 3b: ANCOVA model for whether DBT can improve Verbal Fluency better than CTBE (Covariates Included)

Descriptive Statistics
Dependent Variable: COWA Correct Words

Tx Condition	Mean	Std. Deviation	N
.00	-.7484	10.896	32
1.00	1.1184	10.070	38
Total	.2650	10.421	70

Tests of Between-Subjects Effects
Dependent Variable:COWA correct words at post-treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3416.055 [a]	6	569.343	8.799	.000**	.456
Intercept	67.781	1	67.781	1.048	.310	.016
Age	9.656	1	9.656	.149	.701	.002
Education Level	50.750	1	50.750	.784	.379	.012
Head Injury	.696	1	.696	.011	.918	.000
Number of drug & alcohol abstinent days in last 30 days	86.725	1	86.725	1.340	.251	.021
COWA correct words at pre-treatment	2949.776	1	2949.776	45.587	.000**	.420
Treatment Condition	38.878	1	38.878	.601	.441	.009
Error	4076.516	63	64.707			
Total	7497.489	70				
Corrected Total	7492.571	69				

a. R Squared = .456 (Adjusted R Squared = .404)
*Significant at p<.05, **Significant at p<.01.

Table 19

Hypothesis 3b: ANCOVA model for whether DBT can improve Verbal Fluency better than CTBE (Covariates Removed)

Descriptive Statistics
Dependent Variable: COWA Correct Words

Tx Condition	Mean	Std. Deviation	N
.00	-.7484	10.896	32
1.00	1.683	10.422	40
Total	.6023	10.629	72

Tests of Between-Subjects Effects
Dependent Variable:COWA correct words at post-treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3655.031[a]	2	1827.515	28.880	.000	.456
Intercept	1.751	1	1.751	.028	.868	.000
COWA correct words at pre-treatment	3549.947	1	3549.947	56.100	.000	.448
Treatment Condition	45.414	1	45.414	.718	.400	.010
Error	4366.247	69	63.279			
Total	8047.400	72				
Corrected Total	8021.278	71				

a. R Squared = .456 (Adjusted R Squared = .404)
*Significant at p<.05, **Significant at p<.01.

Table 20

Hypothesis 3c: ANCOVA model for whether DBT can improve Stroop Interference Effects better than CTBE (Covariates Included)

Descriptive Statistics
Dependent Variable: Stroop Interference Effect

Tx Condition	Mean	Std. Deviation	N
.00	-.157	5.96	32
1.00	-.401	7.44	39
Total	-.291	6.77	71

Tests of Between-Subjects Effects
Dependent Variable: Stroop Interference Effect at Post Treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	950.735a	6	158.456	4.500	.001**	.297
Intercept	218.657	1	218.657	6.210	.015*	.088
Age	168.884	1	168.884	4.796	.032*	.070
Education Level	91.581	1	91.581	2.601	.112	.039
Head Injury	31.963	1	31.963	.908	.344	.014
Number of drug & alcohol abstinent days in last 30 days	47.175	1	47.175	1.340	.251	.021
Stroop Interference Effect at Pre-Treatment	579.104	1	579.104	16.447	.000**	.204
Treatment Condition	18.541	1	18.541	.527	.471	.008
Error	2253.496	64	35.211			
Total	3210.251	71				
Corrected Total	3204.231	70				

a. R Squared = .456 adjusted R Squared = .440)
*Significant at p<.05, **Significant at p<.01.

Table 21

Hypothesis 3c: ANCOVA model for whether DBT can improve Stroop Interference Effects better than CTBE (Covariates Removed)

Descriptive Statistics
Dependent Variable: Stroop Interference Effect

Tx Condition	Mean	Std. Deviation	N
.00	-.1571	5.956	32
1.00	-.3191	7.264	41
Total	-.2481	6.678	73

Tests of Between-Subjects Effects
Dependent Variable: Stroop Interference Effect at Post Treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	593.278[a]	2	296.639	7.932	.001	.185
Intercept	456.970	1	456.970	12.220	.001	.149
Stroop Interference Effect at Pre-Treatment	592.806	1	592.806	15.852	.000	.185
Treatment Condition	10.127	1	10.127	.271	.604	.004
Error	2617.749	70	37.396			
Total	3215.519	73				
Corrected Total	3211.027	72				

a. R Squared = .297 (Adjusted R Squared = .231)
*Significant at p<.05, **Significant at p<.01.

Table 22

Paired Samples t-test (all conditions combined)

		Paired Differences					t	df	Sig. (2-tail)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	RFFT: # of unique designs Pre to Post	-2.055	4.949	.579	-3.210	-.900	-3.547	72	.001
Pair 2	COWA: # of correct words Pre to Post	-3.486	8.533	1.006	-5.491	-1.481	-3.467	71	.001
Pair 3	Stroop: Interference Effect Pre to Post	1.418	7.133	.835	-.246	3.082	1.698	72	.094

*Significant at p<.05, **Significant at p<.01.

Table 23

Paired Samples t-test (DBT condition only)

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	RFFT: # of unique designs Pre to Post	-2.512	4.838	.756	-4.039	-.985	-3.325	40	.002
Pair 2	COWA: # of correct words Pre to Post	-4.025	9.233	1.460	-6.978	-1.072	-2.757	39	.009
Pair 3	Stroop: Interference Effect Pre to Post	.565	7.569	1.182	-1.824	2.954	.478	40	.635

*Significant at p<.05, **Significant at p<.01.

Table 24

Paired Samples t-test (CTBE condition only)

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	RFFT: # of unique designs Pre to Post	-1.469	5.105	.902	-3.309	.372	-1.627	31	.114
Pair 2	COWA: # of correct words Pre to Post	-2.813	7.660	1.354	-5.574	-.0508	-2.077	31	.046
Pair 3	Stroop: Interference Effect Pre to Post	2.510	6.485	1.146	.172	4.848	2.189	31	.036

*Significant at p<.05, **Significant at p<.01.

Figure 1.
Relationship of figural fluency scores with depression Scores across treatments.

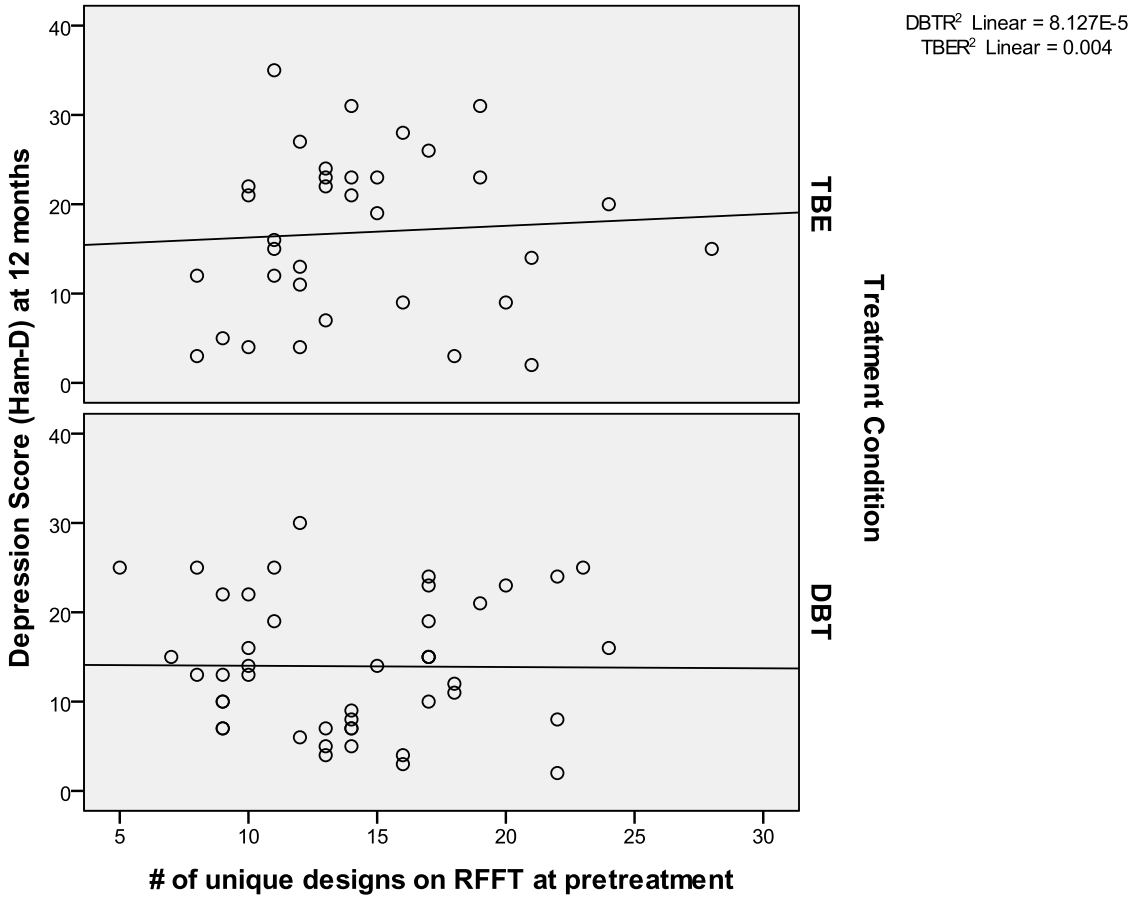

Figure 2.
Relationship of verbal fluency scores with depression scores across treatments.

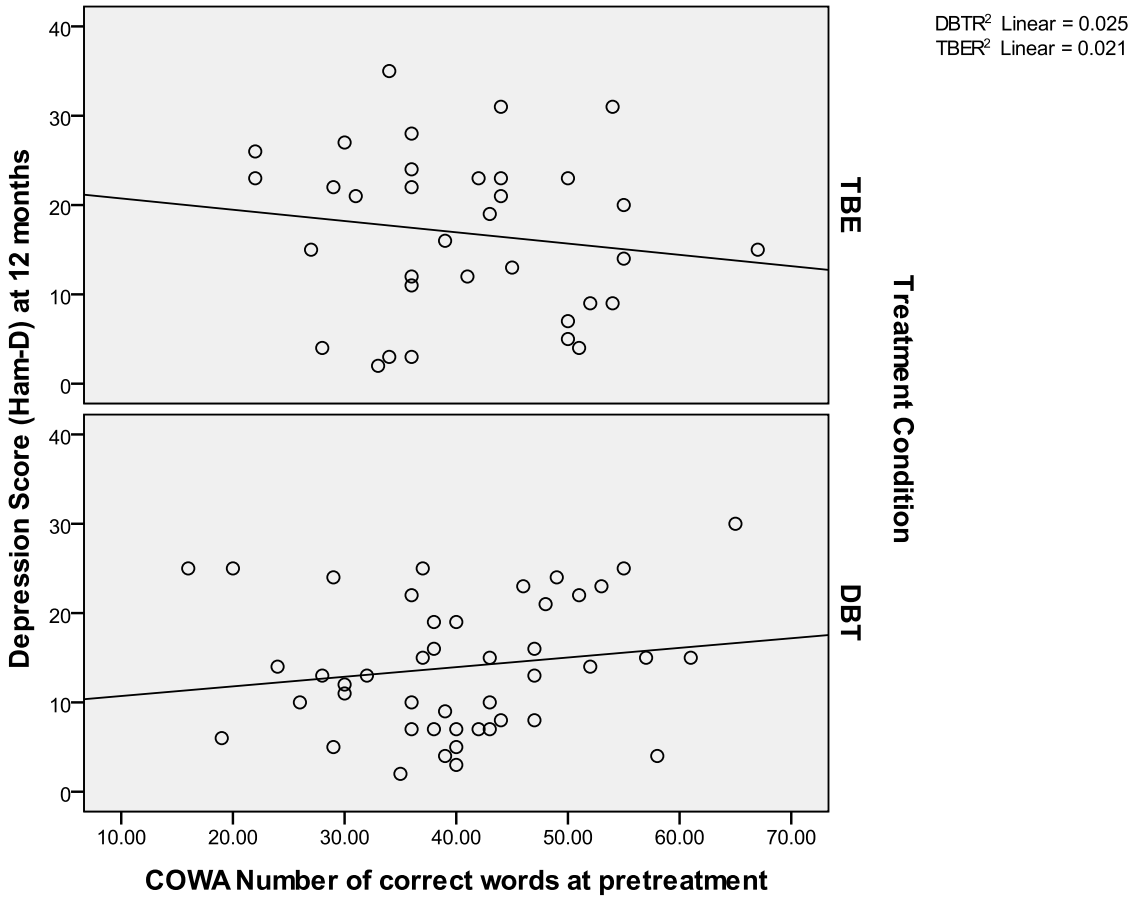

Figure 3.
Relationship of the Stroop Interference Effect with depression scores across treatments.

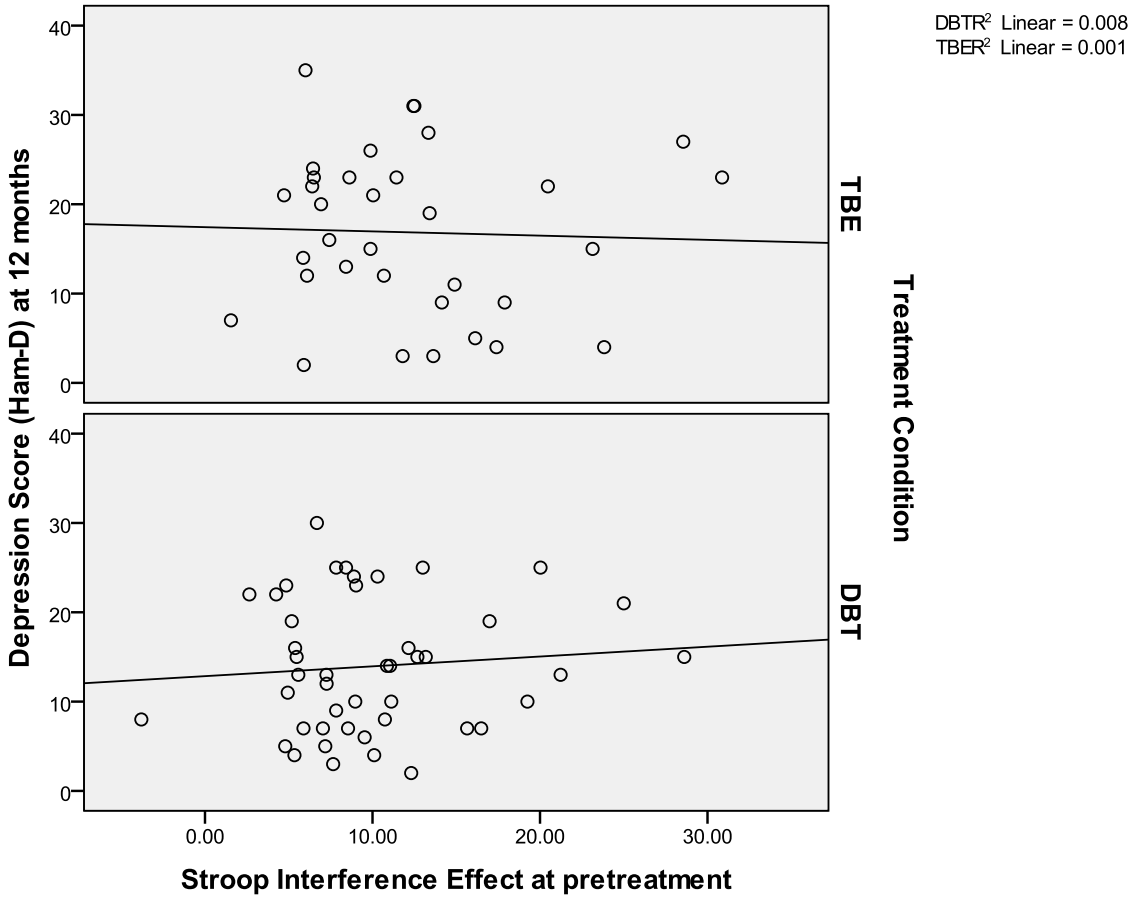

Figure 4.
Relationship of figural fluency scores with NSSI Scores across treatments.

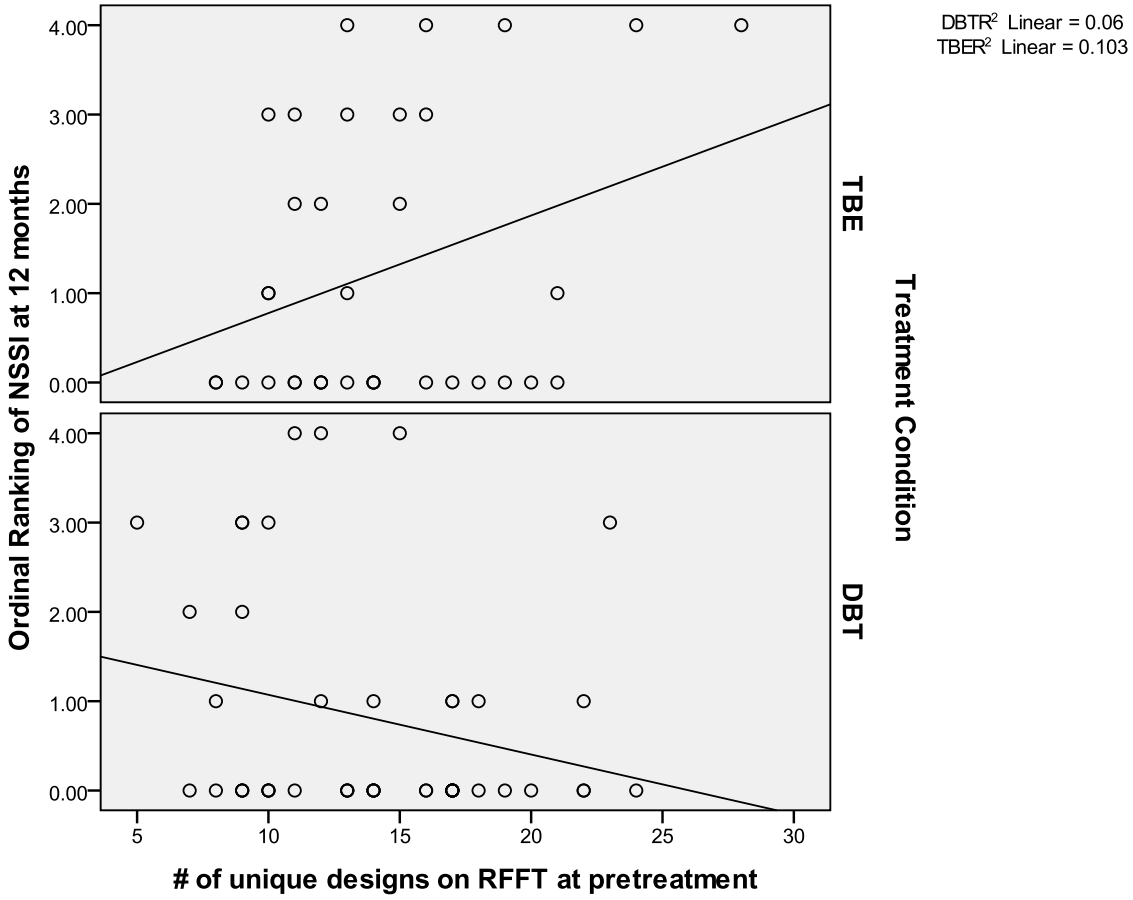

Figure 5.
Relationship of verbal fluency scores with NSSI Scores across treatments.

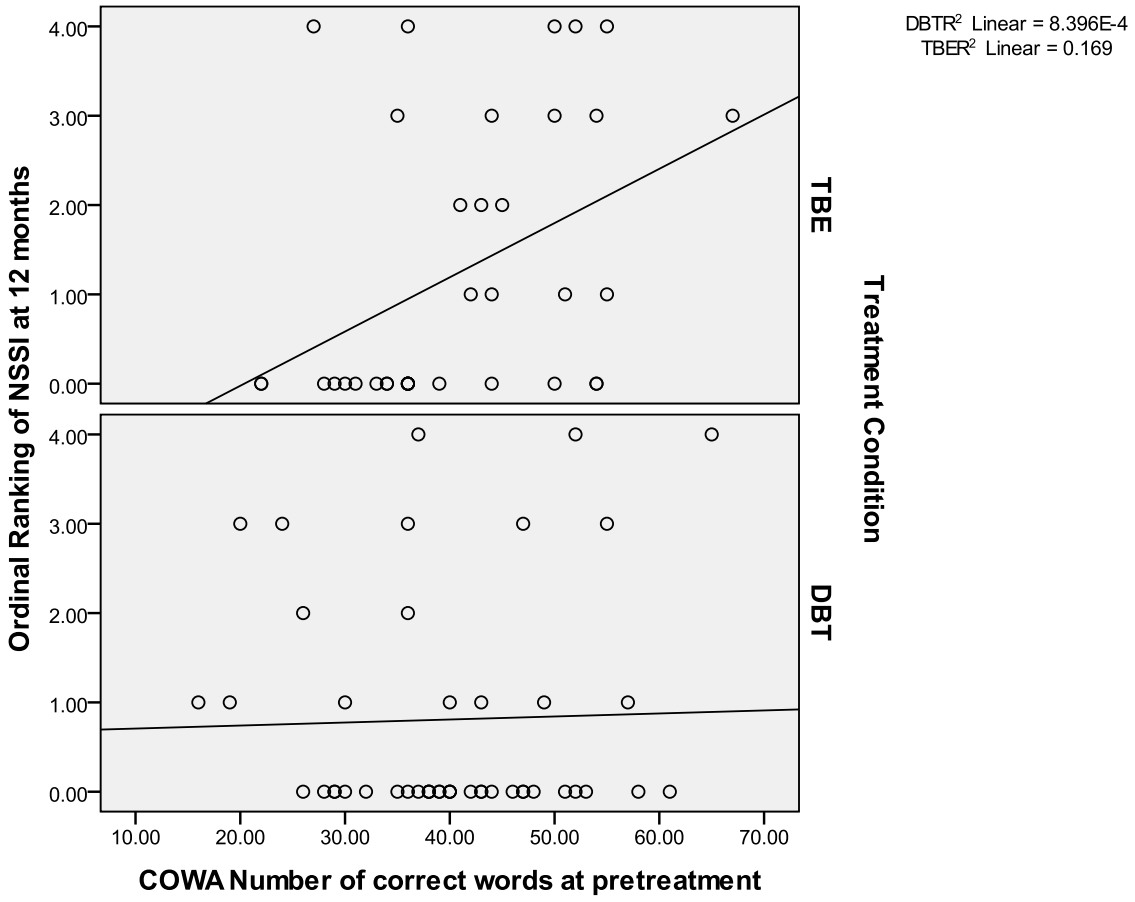

Figure 6.
Relationship of the Stroop Interference Effect with NSSI Scores across treatments.