Regular Article

Psychotherapy and Psychosomatics

Psychother Psychosom 2012;81:38–43
DOI: 10.1159/000329700

Received: August 11, 2010
Accepted after revision: May 26, 2011
Published online: November 22, 2011

Higher Executive Control and Visual Memory Performance Predict Treatment Completion in Borderline Personality Disorder

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Key Words
Borderline personality disorder · Neuropsychology · Treatment retention · Treatment completion · Treatment adherence · Psychotherapy · Executive function · Memory · Executive control

Abstract
Background: Non-completion of a prescribed course of treatment occurs in 20–60% of individuals diagnosed with borderline personality disorder (BPD). While symptom severity, personality traits and environmental factors have been implicated as predictors of treatment non-completion (TNC), there have been no studies of neuropsychological predictors in this population. ***Methods:*** From a randomized controlled trial, a subsample of 31, unmedicated outpatients diagnosed with BPD with recent self-injurious behavior was assessed on 5 neuropsychological domains. Patients were also assessed for general IQ, demographic and other salient clinical variables. Patients were randomized to one of four treatment conditions, which lasted up to 1 year. Number of weeks in treatment (WIT) up to 1 year was utilized as the index of TNC. ***Results:*** Thirty-three percent of the subsample (n = 12) did not complete 1 year of treatment. However, more WIT were predicted by better baseline executive control (Trails B; $p < 0.01$) and visual memory performance (Benton visual retention; $p < 0.001$); other neuropsychological domains did not predict WIT. ***Conclusion:*** In the treatment of outpatients with BPD, better executive control and visual memory performance predict more WIT. Assessing and addressing these neurocognitive factors in treatment may reduce TNC in this high-risk population.

Introduction

Borderline personality disorder (BPD) is a high-risk disorder that is associated with profound emotional suffering [1]. BPD is prevalent, affecting at least 1–2% of the general population [2]. Individuals with BPD with a history of suicide attempts and non-suicidal self-injurious behavior are at particularly high risk and, simultaneously, can be the most challenging to engage in treatment [3]. An emerging body of evidence suggests that BPD can be treated with specialized interventions [4–6]. While clinicians and researchers now take a guardedly optimistic view of the efficacy of BPD-specific psychosocial [7] and pharmacological treatments [8], attrition or treatment non-completion (TNC) in BPD remains a pressing clinical challenge [9].

TNC is defined as patient dropout, discontinuation, premature termination or attrition in the course of a pre-

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scribed treatment [9]. In efficacious BPD treatments, the prevention of TNC is one of the highest priorities for intervention, ranking just behind self-destructive behavior [10–12]. TNC may not only undermine the recovery of those with BPD, it also reduces the efficient and timely delivery of services [9]. TNC also contributes to stigma among clinicians who may eschew treating those with BPD due to a perceived propensity for TNC.

Potential Role of Neurocognition in Treatment Completion

There are only limited data on the predictors of treatment adherence in patients with BPD [for a review, see 9]. Among potential predictors, basic neuropsychological processes such as executive control (EC), impulse control, attention and memory performance may be prerequisite capacities for effective engagement in psychotherapeutic and other treatments, yet they have not been investigated in BPD. Impaired EC and impulse control may be core vulnerabilities in BPD. Recent reviews indicate that BPD is associated with mild to moderate deficits in neuropsychological task performance, particularly EC, impulse control and long-term memory consolidation [13–15]. Negative affect can further exacerbate deficient EC in BPD [13, 16]. Neurocognitive deficits may be difficult to distinguish from those produced by comorbid affective disorders, although intercurrent anxiety may play a more important role in cognitive deficits in BPD [17].

This study aims to investigate neuropsychological domains as prospective predictors of TNC in a subsample of patients who participated in a randomized controlled trial of 1 year of specialized treatment for BPD. Most prior studies of TNC in BPD have not used randomized controlled trial designs with manualized psychotherapies. We investigate neuropsychological predictors in the context of other key variables including demographics, psychopathological traits and symptoms, as well as clinical history.

Methods

Participants

A subsample of 31 patients with a diagnosis of DSM-IV BPD and recent self-injury and/or suicide attempt that completed the neuropsychological battery participated in this study. The patients were recruited during a randomized controlled trial (NCT00533117 at clinicaltrials.gov; principal investigator: B.S.) from the New York City metropolitan area. The institutional review board approved the study, all participants were informed about the risks and benefits of participation and all provided written consent.

Exclusion criteria for the BPD group were bipolar I disorder, schizophrenia and other psychotic disorders, mental retardation, history of severe head trauma, neurological disease, or other cognitive impairment that might interfere with the accuracy of assessments or the capacity to provide informed consent. The mean age for the group was 29.5 years (SD 8.3), with 14.9 years of education (SD 2.4), 51.6% were white, 87.1% female and 9.7% married. Hamilton depression (HAM-D) scores for the group averaged 18.1 (SD 6.8), 87.1% had a prior suicide attempt, 83.9% a history of non-suicidal self-injury and 66.6% reported a history of physical or sexual abuse before age 18 years. Co-occurring diagnoses included 74.2% with current or past major depression, 32.3% with post-traumatic stress disorder, 9.7% with panic disorder, 6.5% with generalized anxiety disorder, 19.4% with social phobia, 25.8% with an eating disorder, 51.6% with current or past substance abuse/dependence, which are comparable rates to other treatment seeking BPD samples. On Axis II, the most common co-occurring condition was avoidant PD (16.1%) and the least was narcissistic PD (3.2%).

Participants were randomized to one of four treatment conditions: dialectical behavior therapy [10] and fluoxetine, dialectical behavior therapy and placebo, supportive psychotherapy and fluoxetine, or supportive psychotherapy and placebo. Prior to the initiation of treatment, participants were washed out of medication if they were on medication. After washout, neuropsychological assessment was conducted while the patient was unmedicated. Subsequently, randomized treatment was initiated and the length of the trial was 1 year for all treatment conditions. Treatment completion was operationalized as the number of consecutive weeks in treatment (WIT) completed.

Measures

Clinical Assessment

Diagnoses were determined by the Structured Clinical Interview for DSM-IV, patient edition (SCID-I) [19], and the Structured Clinical Interview for DSM-IV Axis II Personality Disorders (SCID-II) [20]. Recent reliability studies within our research division yielded the following intraclass correlation coefficients (ICCs; criterion levels are shown in parentheses): Axis I diagnosis/SCID-I, ICC = 0.80 (0.70); Axis II diagnosis/SCID-II, ICC = 0.70 (0.70); BPD diagnosis, ICC = 0.89 (0.70).

Neuropsychological Assessment

The neuropsychological battery included tests that assessed five general domains: attention, memory, working memory, executive function and impulse control [for further description of tests, see 17]. In addition, general intellectual functioning was assessed with the Peabody picture vocabulary test [21].

Executive Control

Wisconsin Card Sorting Task. The Wisconsin card sorting task (WCST) [22] is a standard clinical measure of abstraction and executive function. The sum of standardized subscores for total errors, perseverative errors and nonperseverative errors were reported and used for the overall domain score of the task.

Trail Making Task. As a measure of diffuse brain injury and psychomotor functioning, the Trail making task [23] is a brief,

paper-and-pencil task composed of two parts. In part A, participants are instructed to draw lines to connect the randomly arranged, numbered circles in ascending order as quickly as possible. In part B, participants must draw a line and connect the circles that include either numbers or letters in a more complex sequence (i.e. alternating between ascending numbers and letters).

Memory

Buschke Selective Reminding Test. The Buschke selective reminding test [24] is a list learning task used extensively in studies of dementia. In this study, the total score of the test included both immediate and delayed recall performance.

Benton Visual Retention Test. The Benton visual retention test (VRT) [25] is a widely used instrument that assesses visual perception, visual memory and visuoconstructive abilities with multiple alternate forms and administrations. Administration 'D' (10-second exposure/15-second delay) was used here to reduce potential ceiling effects.

Attention

Continuous Performance Test. The 4-digit fast condition of the identical pairs version of the continuous performance test [26] was used to assess sustained attention. In this study, there were 150 trials, containing 28 targets (i.e. a series of 4-digit numbers) and 25 'catch' trials (i.e. very similar but not identical to the numbers that preceded it). Hit and false alarm rates were recorded, and the signal detection indices d' (sensitivity) was computed as an outcome measure.

Computerized Stroop Color/Word Task. The computerized Stroop task [27] is designed as a clinical version based on the standard color-word paradigm [28] using a button-press response. The interference effect was based on the percent difference in median reaction time between incongruently colored words and colored Xs.

Working Memory Tasks

Computerized A, Not B Logical Reasoning Task. The A, not B task is a computerized version of a paper-and-pencil working memory and reasoning task developed by Baddeley [29] based on decoding syllogisms [27]. Response time to correct solutions was the key outcome variable.

n-Back Task. The n-back task is adapted from Cohen et al. [30]. Participants were required to monitor a sequence of individually presented letters (500 ms, at the rate of every 3 s) to determine if the letter matched the previous letter presented (1-back), the letter two items previous (2-back), or the letter three times previous (3-back). The hit rate (correct responses/target trials) and error rate (non-target responses/non-target trials) and an overall sensitivity index (d') were computed to evaluate performance [26].

Impulse Control Tasks

Time-Estimation Task. This computer-based time-estimation task asks participants to estimate intervals of 10, 20, 40, 60 or 90 s by pressing a response key when a screen appeared, giving the interval to be estimated with a start tone [27]. Performance was scored as interval estimates, which were collapsed for each task into a single overall average percent deviation scores.

Computerized Go-No Go Task. A participant's ability to withhold responding to less frequent non-target stimuli has been assessed using the go-no go paradigm. In our task [27], when the X appeared in one of six locations on a computer screen, it was accompanied by one of two tones, designated as 'high' (about 400 Hz) or 'low' (about 200 Hz). Participants were instructed to hit a response key when the X appeared in the top half of the screen and was accompanied by the low tone. There were 225 stimuli, 81 of which required a participant to withhold responding. The total number of incorrect responses to these mismatch trials (i.e. commission errors) were reported and adjusted for the total number of correct responses.

Scores were transformed to age, sex and education-adjusted Z-scores before being combined into aggregate domain scores.

Neuropsychological Domain Scores

EC = Wisconsin card sort (errors) plus difference in score between Trails B and Trails A (difference in standardized scores). Memory = Buschke (total) and Benton VRT (errors). Attention = Continuous performance test and Stroop. Working memory = n-back and A, not B. Impulse control = Time production and go-no go (log of commission errors).

Clinical Measures

Depression

Depression severity was assessed using the HAM-D [31].

State Affect

Concurrent negative emotional state was assessed with the profile of mood states [32], a 65-item self-report questionnaire that provides scores for 6 transient emotional states: tension-anxiety, depression-dejection, anger-hostility, confusion-bewilderment, vigor-activity and fatigue-inertia.

Traits

Impulsivity was assessed with the Barratt impulsiveness scale (BIS). The version of the BIS used in this study is the initial version of the 11th revision of the test, provided to us by Barratt [33] and used for the last 14 years in the Suicide Research Center in which this research was based [27].

Data Analysis

The dependent variable in all primary analyses was the number of consecutive WIT during the treatment year (mean 41.2, SD 17.6). Due to the non-normal and highly dispersed and skewed distribution of the WIT variable (skewness –1.15), we used a generalized linear model (GLM) with a negative binomial distribution and robust estimator covariance matrix to evaluate the effect of our independent variables (neuropsychological domains and symptoms/traits) on WIT. Negative binomial GLM performs better than standard GLM with count data or overdispersed data (i.e. where the variance is much larger than the mean) [34].

The analyses of neuropsychological test data were carried out in a hierarchical fashion to reduce and structure the number of statistical comparisons of test scores. The five domain scores were analyzed first, followed by individual tests within domains when a significant difference at the domain level was found. For all neuropsychological main effects on WIT, the impact of depression severity, treatment condition, trait impulsivity (BIS), state negative affect (profile of mood states, total), age and gender were assessed by entering these as covariates into the GLM analyses.

Table 1. GLM (negative binomial) of neuropsychological predictors of WIT in a BPD sample (n = 31)

	Wald χ^2	d.f.	p value
Neuropsychological domain/test			
Executive control	4.6	1	0.03
WCST errors	1.3	1	0.24
Trails B	8.5	1	0.004
Trails A minus Trails B	4.8	1	0.03
Memory	3.5	1	0.06
Memory with depression (HAM-D)	4.8	2	0.02
Buschke selective reminding	1.2	1	0.27
Benton VRT	11.9	1	0.001
Attention	0.1	1	0.78
Working memory	2.4	1	0.12
Impulse control	0.7	1	0.40
IQ (Peabody picture vocabulary test)	0.8	1	0.37

d.f. = Degrees of freedom.

Results

Neuropsychological Domains

Table 1 summarizes the GLM findings for the neuropsychological predictors. Better EC predicted more WIT. When depression severity (HAM-D) was added to this GLM, EC remained a significant main effect predictor, and higher depression severity was an additional main effect predictor of fewer WIT.

Of the two measures that comprise EC (in separate analyses), better Trails B performance was a significant predictor of WIT; however, the number of WCST errors was not. Trails A minus Trails B was also a significant predictor, though less so than Trails B performance independently.

As a single predictor in the GLM, memory performance predicted WIT at the trend level. However, when depression severity (HAM-D) was added to the GLM, better performance in the memory domain was a significant predictor of WIT.

Of the two measures that comprise the memory domain (when assessed separately), the Benton VRT was a significant predictor of WIT. However, Buschke total recall was not.

Additionally, a post-hoc analysis of variance was used to identify differences in neuropsychological performance between treatment completers and non-completers in a binary analysis. The result completely corresponded with the GLM results. The standardized Z-score (higher scores indicate worse performance) for Trails B performance was better in completers (n = 19; mean 0.54, SD 1.00) compared to non-completers (n = 12; mean 0.99, SD 2.51; $F = 5.73$; $p < 0.05$). The standardized Z-score for Benton VRT performance was higher in completers (mean 0.41, SD 0.96) compared to non-completers (mean 0.70, SD 1.04; $F = 14.78$; $p < 0.001$). By contrast, there were no differences between completers and non-completers on the attention, working memory, impulse control or IQ estimate domains.

Unexpectedly, neuropsychological domains of attention, impulse control, as well as working memory performance domains did not predict WIT. In addition, IQ did not predict WIT.

Analysis of Other Potentially Confounding Variables

Depression severity (HAM-D), treatment condition, trait impulsivity (BIS), state negative affect (profile of mood states, total), age or gender did not alter the impact of neuropsychological performance on WIT. The exception was depression severity (reported above), which acted as a suppressor variable in the memory domain.

Discussion

To our knowledge, this is the first study to identify specific domains of neurocognitive performance as prospective predictors of TNC in BPD. WIT was predicted by better EC (Trails B) and visual memory (Benton) performance. By contrast, other neuropsychological domains (i.e. impulse control, working memory, attention and general IQ) were not predictive TNC.

EC in BPD has been proposed as an impaired modulatory system that impacts affective, cognitive and interpersonal domains of symptomatology [14, 35]. Our findings extend this line of research and suggest that behavioral coordination and modulation during the treatment process are largely based on the deployment of EC, rather than on processes of attention, working memory or behavioral inhibition. In particular, in the present study, only one of two EC tasks, Trails B, predicted WIT. A difference between the two EC tasks (WCST and Trails B) is that the Trails B emphasizes both speed and accuracy, whereas the WCST only assesses accuracy. We speculate that the combination of speed and accuracy are jointly important for treatment completion in BPD.

The capacity to flexibly and efficiently apply cognitive rules to novel stimuli may be an important prerequisite for psychosocial interventions, which demand applying new skills and insights to real world situations. Supporting these assertions, the present finding is in line with

several prospective studies of alcoholism and other substance use disorders in which Trails B was predictive of participation in aftercare sessions and length of hospital stay during inpatient treatment [36, 37]. Our negative finding on the WCST is consistent with a study which found that WCST scores did not differ between treatment completers and dropouts in the treatment of cocaine dependence [18].

In the present study, visual memory performance was the strongest neuropsychological predictor of WIT. Although there are a growing number of studies indicating that memory dysfunction predicts general outcomes of treatment in clinical disorders (e.g., schizophrenia, anxiety disorders and substance use disorders), memory performance has rarely been examined as a predictor of treatment completion. A study of cocaine dependence reported a relationship between better memory performance and treatment completion in outpatients receiving cognitive-behavioral therapy [18]. Another recent study suggests that poorer verbal memory limits the response to cognitive-behavioral therapy for schizophrenia [38]. Given that memory and learning are interdependent processes, the findings of the present study may point to a synergistic relationship between memory and EC performance in the effective treatment of BPD.

It is worth noting that once depression severity is accounted for in the GLM model, a significant relationship emerges between better memory and more WIT. This finding suggests that severity of depression obscures the importance of memory performance in the prediction of TNC, perhaps because depression can itself impair memory performance [39].

The strengths of this study include the randomization of patients to manualized psychotherapeutic and controlled psychopharmacologic treatment conditions. Other assets of this study are the prospective nature of the predictions, the medication-free status of the patients and the comprehensive nature of neuropsychological assessment. The limits of this study include the relatively small sample and the potential for type II errors in the number of statistical tests. However, the hierarchical nature of our data analysis reduced the chance of such errors.

Treatment developers need to enhance the role of TNC prevention either as part of existing treatments, or as an independent preparatory phase of intervention prior to initiation of other therapies [40]. Future research also needs to address the impact of neuropsychological functions and TNC on symptomatic and functional outcomes longitudinally [41].

Acknowledgements

This study was supported in part by grants from NIMH (K23 MH077044) to E.F., and NIMH (R01 MH061017 and MH62665) and NIAAA (P20 AA015630) to B.S. Eli Lilly provided the fluoxetine and placebos for this study at no cost. The authors have no financial involvement (including employment, fees, share ownership) or affiliation with any organization whose financial interests may be affected by the material in the manuscript.

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