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Neurocognitive Predictors of Financial Capacity In Traumatic Brain Injury

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Abstract

Objective—To develop cognitive models of financial capacity (FC) in patients with traumatic brain injury (TBI).

Design—Longitudinal design.

Setting—Inpatient brain injury rehabilitation unit.

Participants—20 healthy controls, and 24 adults with moderate-to-severe TBI were assessed at baseline (30 days postinjury) and 6 months postinjury.

Main Outcome Measures—The Financial Capacity Instrument (FCI) and a neuropsychological test battery. Univariate correlation and multiple regression procedures were employed to develop cognitive models of FCI performance in the TBI group, at baseline and 6 month time follow-up.

Results—Three cognitive predictor models of FC were developed. At baseline, measures of mental arithmetic/working memory and immediate verbal memory predicted baseline FCI performance (R^2=.72). At 6 month follow-up, measures of executive function and mental arithmetic/working memory predicted 6 month FCI performance (R^2=.79), and a third model found that these two measures, at baseline predicted 6 month FCI performance (R^2=.71).

Conclusions—Multiple cognitive functions are associated with initial impairment and partial recovery of FC in moderate-to-severe TBI patients. In particular, arithmetic, working memory, and executive function skills appear critical to recovery of FC in TBI. The study results represent an initial step towards developing a neurocognitive model of FC in patients with TBI.

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Conflict of Interest: Dr. Marson is the inventory of the Financial Capacity Instrument (FCI), which is owned by the University of Alabama at Birmingham Research Foundation. Dr. Marson does not currently receive royalty payments for the FCI, but anticipates receiving royalty payment sin the future when the FCI is made commercially available. For the remaining authors none were declared.

Keywords

Financial capacity; financial decision making; cognitive function; traumatic brain injury; head injury; brain injury

INTRODUCTION

Instrumental activities of daily living (IADLs) can be significantly impacted as a result of traumatic brain injury (TBI), resulting in diminished or lost personal autonomy and independence.[1–3] Financial capacity (FC) is an important IADL integral to independent living that is often affected following TBI.[4, 5] FC represents a complex set of abilities ranging from simple monetary calculation abilities, to more complex financial tasks such as managing a checkbook or bank statement and to making judgments regarding investment decisions. Diminished capacity to perform these financial tasks can result in significant compromise and delay in returning to personal independence.[6, 7]

Several survey-based TBI outcome studies have identified post-injury money management difficulties as critical long-term issues in TBI.[8, 9] In a recent review paper, Lillie et al.[10] cited statistics estimating that upwards of 30% of persons suffering from TBI experienced long lasting compromise of financial capacity. In a series of studies Crowe and colleagues[11–13] noted that persons with acquired brain injury (including TBI patients) were more likely to exhibit money management problems in everyday life compared to healthy adults in the forms of automated teller machine misuse[12], making more late bill payments, and displaying higher rates of inappropriate spending.[13]

Using a performance-based instrument, our research group recently investigated FC following TBI longitudinally.[5] We administered the Financial Capacity Instrument (FCI)[14], a psychometric measure that comprehensively measures the financial capacity construct and measures financial skills at the task, domain, and global level.[5] We found that compared to a demographically matched control group, TBI patients with moderate to severe injury 30 days post injury, displayed significant performance impairment across most FCI variables. At six months post-injury, the study found that TBI patients displayed significant within group improvement on both simple and complex FCI domains, although global FC and complex financial domains (such as checkbook management, bank statement management, bill payment, investment decisions) remained impaired relative to controls.[5]

An outstanding clinical question concerns the neurocognitive basis of FC over the course of TBI. Identification of key neurocognitive predictors of FC may provide important guidance to clinicians who are developing patient rehabilitation plans, or who are making clinical decisions regarding patients' capacity to resume financial activities and decision-making. Prior studies have found that money mismanagement behaviors are associated with neuropsychological measures of executive function and attention.[12, 13] Interestingly, both studies found that brain-injured patients' performance on verbal memory tests was not related to the clinician's judgment of the patient's money management ability. No prior studies, however, have sought to identify cognitive models of FC in a longitudinal sample of TBI patients using a performance-based measure. The goal of the present study was to expand upon our prior work investigating FC impairment after TBI[5] by identifying key neurocognitive predictors of FC at different time points in the TBI recovery process. Specifically, we developed exploratory multivariate cognitive models of FC in a sample of patients with TBI assessed at two time points: (1) in the subacute period (30 days post injury) and (2) at 6 months post injury.

METHODS

Participants

A group of 24 adults with moderate to severe TBI participated in the present study. This sample has been described elsewhere.[3, 5] All patients were initially enrolled in the Traumatic Brain Injury Model Systems (TBIMS) database and volunteered to participate in this separate study. We recruited patients during their stay in the TBI inpatient service at Spain Rehabilitation in the Department of Physical Medicine and Rehabilitation at the University of Alabama at Birmingham (UAB).

Inclusion criteria for moderate to severe TBI included an initial *Glasgow Coma Scale* (*GCS*)[15] of 12 or less, posttraumatic amnesia (PTA) continuing a day or more, and objective signs of structural lesion on cranial computed tomography (CT) or cranial magnetic resonance imaging scan (MRI) (i.e., contusion or hematoma). Exclusion criteria included a history of any other disease or condition potentially affecting cognition, such as psychiatric disturbance (with the exception of mild depression), substance abuse, cerebrovascular disease, or other neurologic disorders (excluding headache).

We recruited 20 healthy adult control participants (12 men, 8 women) through advertisements at UAB and in a local newspaper. Controls were healthy adults without any diseases or conditions that could potentially affect cognition, including psychiatric disturbance (except mild depression), substance abuse, cerebrovascular disease, or other neurological diseases (except headache). No control participants were taking any medications known to significantly affect cognition. Recruitment of the control participants was also selective and involved individual demographic matching of controls with participants with TBI based on age, gender, ethnicity, and educational level.[5]

Informed consent was obtained from all participants or their legally authorized representatives (LARs) or caregivers, in accordance with procedures of the UAB Institutional Review Board (IRB). All participants received monetary compensation for their study participation.

Measures

Financial Capacity—The *Financial Capacity Instrument* (*FCI*) is a conceptually based, objective psychometric measure for direct assessment of financial skills and abilities.[14, 16] The FCI evaluates financial capacity at three levels: specific financial abilities (tasks), broader financial activities (domains), and two global levels representing overall financial capacity (global).[5, 14, 17, 18] The FCI, which has good reliability and validity, comprises eighteen tasks, nine domains, and two global level scores.

The FCI has an operationalized and detailed scoring system.[14, 18] It uses interval level scoring to assess participant performance on tasks. Task scores are summed to obtain domain scores, and domain scores are summed to obtain global level scores. Higher scores on the FCI indicate greater financial abilities. For the present neurocognitive predictor study, we used a global or overall FCI score (sum of Domains 1–7) as our primary outcome measure of interest. Detailed results for FCI performance among our current TBI sample were recently reported.[5] Table 1 presents a conceptual schematic of the FCI including tasks, domains and global scores.

Neuropsychological Test Battery—A standardized neuropsychological test battery was administered to all participants. Attention was measured using the Digit Span subtest from the *Wechsler Adult Intelligence Scale-Third Edition* (WAIS-III).[19] Expressive language was assessed with phonemic word fluency (CFL)[20] and semantic word fluency (animals, fruits/vegetables, clothing).[21] Memory was assessed using the Logical Memory I and II subtests of the *Wechsler Memory Scale-Revised* (WMS-R)[22], the learning score from the *Rey Auditory Verbal Learning Test*[23], and the *7/24 Spatial Memory Test.*[24] Processing speed was assessed using the *Symbol Digits Modalities Test* (oral and written forms)[25], and the *Trail Making Test A.*[26] Motor speed was assessed using the *Grooved Pegboard Test.*[27] Visual spatial abilities were assessed using the *Benton Visual Forms Discrimination Test*[28] and the Block Design subtest from the *Wechsler Adult Intelligence Scale-III*. Executive function was assessed using the *Wisconsin Card Sorting Test* (WCST[29]), *Executive Interview* (EXIT-25[30]), *Tokens Test*[20], and the *Trail Making Test B.*[26] The Arithmetic subtest from the WAIS-III, a measure of working memory and arithmetic skill, was also administered. Group differences on the FCI and neuropsychology test battery, for this sample were previously published in an earlier paper by our group.[31] In the present paper, we focus on the neurocognitive predictors of FC.

Procedures

All participants with TBI underwent a baseline assessment of FC and neuropsychological status during their inpatient stay at Spain Rehabilitation Center at UAB. The baseline assessment was conducted approximately 30 days post-injury when TBI participants' confusional states and post-traumatic amnesia (PTA) had cleared. The TBI group also received a second identical assessment at 6 months post injury. Control participants underwent identical baseline and 6 month follow-up assessments at the UAB Department of Neurology.

Statistical Analyses

Group differences—One-way ANOVA (for continuous variables) or chi-square (for categorical variables) was used for demographic variables, FCI total score, and neuropsychological variables. Raw scores were used for all analyses. Post hoc analyses for significant ANOVA findings were analyzed using Bonferroni correction.

Correlation and multiple regression analyses at Time 1 and Time 2—The cognitive predictor analyses were based upon a data analysis approach used in a prior capacity predictor study (treatment consent capacity) using the present TBI patient sample.[31]

Specifically, we developed three cognitive models of FC in TBI: (1) a model using baseline cognitive predictors to predict baseline FCI total score (Baseline Model), (2) a model using 6 month cognitive predictors to predict 6 month FCI total scores (Six Month Model), and (3) a model using baseline cognitive predictors to predict 6 month FCI total score (Baseline-Six Month Model). For each of the three sets of analyses, we first used univariate correlation analyses (Pearson *r*) to reduce the cognitive variable pool. For each model, we then selected the four cognitive variables with the highest correlations with the FCI total score for entry into the stepwise (forward) multiple linear regression analysis. Only cognitive variables making a statistically significant contribution to the model were included ($p < .05$).

RESULTS

Demographic and Mental Status Variables

As discussed above, individual demographic matching of controls with TBI participants occurred during the recruitment phase. There were no group differences in terms of gender (controls: 12 male/8 females; TBI: 16 male/8 females), age (controls: M = 32.2 years [*SD* = 13.4]; TBI: M = 30.0 years [*SD* =11.7], racial/ethnic background, or educational level. The TBI group included 19 Caucasian and 5 African-American participants, and the average level of education was 12 years. No statistically significant differences were found between the control group and the TBI group across all demographic variables.

For TBI participants, the average GCS score at the time of acute hospitalization was 7.1 (*SD* = 3.2) and was indicative of moderate to severe injury. For the TBI group alone, orientation was also measured using information and orientation items of the *Galveston Orientation and Amnesia Test* (GOAT).[32] TBI participants obtained an average GOAT score of 89.6 (SD = 7.2) at baseline and 93 at 6 month follow-up. One TBI participant had no GOAT score available at baseline. Two TBI participants had no GOAT scores at 6 month follow-up.

FCI Performance Results

As found in our recent study,[5] FCI total score was significantly higher in the control group ($p < .001$) at baseline and at 6 months post-injury (see Table 2). However, a significant interaction effect was found in which controls displayed stable scores across the two time points, while the TBI group displayed significant performance score improvement in FCI total score (see Table 2).

Neuropsychological Test Results

Table 2 provides the baseline cognitive test results. Without exception cognitive test performance was poorer in the TBI group compared to healthy controls at baseline. At 6 month follow-up, a number of significant interaction effects were found in which the TBI group demonstrated improved cognitive test performance while the healthy adult control group displayed stable performance.

Cognitive Models of FCI Total Score

Tables 3, 4, and 5 present the univariate correlations and the three multivariate predictor models of FC for the TBI participants. Table 3 presents the baseline model, Table 4 presents the 6 month model, and Table 5 presents the baseline-6 month model.

Baseline Cognitive Model: At a univariate level, significant statistically significant associations were found between the baseline cognitive measures and the baseline FCI total score (see Table 3). All correlations were in direction of worse cognitive test performance associated with worse FCI performance.

At the multivariate level, WAIS-III Arithmetic and WMS-R Logical Memory I entered the final model and predicted TBI patient baseline performance on FCI total score. The two predictor model accounted for a substantial amount of variance in the baseline FCI total score (R^2 *cum* = .72, $p < .001$) (Table 3).

Six Month Cognitive Model: At 6 month follow-up, measures of executive function were strongly associated with FCI total score at the univariate level (Table 4). The final multivariate model for 6 month FCI performance consisted of the Tokens Test and WAIS-III Arithmetic. The two variable predictor model also accounted for a substantial amount of variance in FCI total score at 6 month follow-up (R^2 *cum* = .79, $p < .001$).

Baseline – 6 month Cognitive Model: For the third model, measures of executive function were again strongly associated with FCI total score at the univariate level (Table 5). A two variable predictor model emerged very similar to the 6 month cognitive model. Baseline performance on the WAIS-III Arithmetic subtest and the Token Test predicted 6 month FCI total score and accounted for a substantial amount of variance in FCI total score (R^2 *cum* = .71, $p < .001$).

Discussion

The present study investigated cognitive predictors of FC in a group of persons with moderate/severe TBI assessed at two time points in the post-injury period. This study builds upon our group's recent work which found that persons with moderate/severe TBI demonstrate continuing significant impairment in FC at both the time of subacute injury (30 days post injury) and at six months post injury.[5] In that study, we found that while TBI patients showed significant improvement on both simple and complex financial skills over the six month period, they remained impaired on complex financial domains and overall financial capacity.[5]

In the present study, we found that multiple, and changing, cognitive functions are associated with initial impairment and subsequent partial recovery of FC in patients with moderate to severe TBI. Early in the post-TBI recovery process, mental arithmetic, working memory, and immediate verbal recall were the key cognitive abilities that predict FC performance a month following injury. In contrast, at 6 month follow-up, executive function, as well as mental arithmetic and working memory, were the key cognitive abilities mediating financial capacity performance, while verbal memory became less important. These same mental arithmetic, working memory, and executive function abilities also turn out to be the best baseline predictors of TBI patients' FC performance at six month follow-up. The study thus highlights the changing role of verbal memory, and the ongoing importance of arithmetic, working memory, and executive function skills, to recovery of financial capacity in patients with moderate to severe TBI.

Baseline Cognitive Model

Our baseline multivariate cognitive model of FC included a primary predictor of mental arithmetic/auditory working memory (WAIS-III Arithmetic) and a secondary predictor of immediate verbal memory (WMS-R Logical Memory I) (see Table 3). It is not surprising that an arithmetic measure would emerge as a key predictor of FC in our TBI sample. Prior work with the FCI has demonstrated that a measure of written arithmetic (WRAT-3 Arithmetic) was the preeminent predictor of global FC in a sample of cognitively normal elderly, patients with amnestic MCI, and patients with mild AD, accounting for substantial amounts of variance particularly in the two patient groups.[33] It appears that numeracy skills and knowledge of simple mathematical operations are critical to daily application of financial skills, and that impairment in such arithmetic skills adversely affects everyday financial activities.

In addition to being a measure of mental arithmetic, WAIS-III Arithmetic assesses auditory working memory abilities. It is well recognized that WAIS-III Arithmetic test has strong associations with other tasks of auditory working memory, and it comprises one of the subtests on the WAIS-III Working Memory Index.[34] The Arithmetic subtest also has strong associations with many other WAIS-III subtests and is viewed as robust measure reflecting general intelligence (g factor).[34] Insofar as problems with working memory and concentration are hallmark signs of severe TBI shortly after injury, it is again not surprising that WAIS-III Arithmetic was the primary predictor in the baseline model. In a prior TBI study by our group, utilizing the same subject sample, the measure emerged multiple times as a key predictor of medical decision making capacity, both in the baseline and 6 month follow-up model.[31]

Finally, a prior study of financial abilities following acquired brain injury found associations between WAIS-III Arithmetic and functional tasks.[11] In that study, simulated ATM use in persons having acquired brain injuries, WAIS-III Arithmetic performance, together with measures of verbal learning, verbal fluency, and psychomotor processing, were significantly related to ATM use and loaded into the same cognitive predictor model.[11]

Logical Memory I, the second predictor in the baseline model (Table 3), is a measure of immediate auditory verbal recall for prose material. Impairments in short-term verbal memory are well-established features of acutely injured patients with moderate to severe TBI.[35–37] Thus the emergence of Logical Memory I as a baseline model predictor indicates that the capacity to retain newly learned verbal information, immediately after presentation, appears significantly associated with performance of financial tasks (and likely many other functional skills) in the acute period following severe TBI. It should be noted that Logical Memory I was also a strong baseline predictor of treatment consent capacity in the paper referenced above.[31]

Six Month Cognitive Model

The six month multivariate cognitive model of FC differed from the baseline model. The six month model included a primary predictor of simple executive function (Token Test) and a secondary predictor of mental arithmetic/working memory (WAIS-III Arithmetic). No memory measures entered into the model (see Table 4). Although included as a measure of language comprehension, the Token Test requires aspects of working memory and executive skills (i.e., planning, volition, and purposive action)[38, 39] and in a moderate to severe TBI population seems to function as a measure of basic executive function.[31] As reflected in Table 2, very few of the participants with TBI, even at baseline, performed in the impaired range on the Token Test, indicating that difficulty with language comprehension per se was not a significant factor in this study. Instead, the limited variation in scores was interpreted to reflect the executive aspects of the test, which tap a range of cognitive abilities, including working memory, attention, and praxis. It is notable that in a prior TBI capacity study by our group, utilizing the same subject sample, the Token Test emerged in both the 6 month model and the baseline-6 month cognitive model as a key executive function measure predicting treatment consent capacity.[31]

In addition to executive function, cognitive abilities of mental arithmetic and working memory (WAIS-III Arithmetic) continued to be key predictors of FC at six months post injury. This finding reinforces the results noted above concerning the general relevance of arithmetic abilities and working memory to financial functioning in cognitively impaired populations.

The key difference between the baseline and six month cognitive models was the absence at six months of a memory predictor (although candidate memory predictors emerged at the univariate level) (see Table 4). In the 6 month period after acute TBI, it appears that basic executive functions replace short-term verbal memory abilities as a predictor of FC. As noted in our prior study, this finding may reflect “the broader clinical reality that a patient’s outcome in the year after TBI will be primarily mediated by the patient’s basic executive abilities and overall frontal lobe function, and not by memory per se”[31] (page 494). In support of this contention, in our prior study we found that short-term verbal memory predicted treatment consent capacity during the acute inpatient hospitalization period following TBI, but executive functioning and working memory predicted improved decision-making capacity at 6 month follow-up.[31]

Baseline-Six Month Cognitive Model

The baseline–6 month cognitive model was virtually identical to the 6 month cognitive model, with the order of predictors switched. The primary predictor was mental arithmetic/ working memory (WAIS-III Arithmetic) and the secondary predictor was the basic executive function measure (Tokens Test) (see Table 5). Similar to the 6 month model, this model also reflects the shift from baseline verbal memory predictors to executive function predictors. In keeping with this, a majority of univariate predictors were executive based, including Trails B, EXIT-25, WCST categories and errors, and semantic fluency. These findings again support the proposition that the integrity of frontal lobe processes, rather than memory processes, are critical to recovery of financial skills at six months and beyond in patients with moderate to severe TBI.

In summary, this study represents an initial step towards developing a neurologic model of FC loss and initial recovery in persons with TBI. As reflected in several prior reports,[1, 5, 11] moderate/severe TBI is associated with significant impairment of FC. The present study has extended prior work by finding that in the initial one-month post injury recovery period the FC of patients with moderate/severe TBI was strongly associated with cognitive abilities of mental arithmetic, working memory, and immediate verbal memory. Six months post injury, the predictor model had shifted somewhat and patients' FC was now more strongly associated with simple executive function, and mental arithmetic and working memory, while short-term memory had diminished in importance. Importantly, the same exploratory predictor model of mental arithmetic, working memory, and executive function at baseline predicted patients' FC performance at six month follow-up.

The present study has limitations. First, the clinical and control samples were small and limit the study's generalizability to larger TBI populations, including mild TBI and complicated mild TBI populations. It is possible that different cognitive predictor models of FC impairment and recovery may apply to patients with milder forms of TBI. In addition, although the current TBI predictor models were quite robust (see Tables 3–5), they were exploratory in nature and will require further investigation with larger samples. It may be that with a larger TBI cohort, additional cognitive measures may emerge as significant predictors or the predictor variables of the present models may change. Thus, larger samples are needed to replicate, confirm, and extend the current findings. Second, the use of a psychometric measure of financial capacity has advantages and disadvantages. Performance based evaluations of financial skills enjoy advantages of objectivity, standardization and norm referencing, but have potential problems with ecological validity and do not always replicate closely the financial context and activities of individual TBI patients.

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Table 1

Schematic of the Financial Capacity Instrument-9 (FCI-9): 18 Tasks, 9 Domains, and 2 Global Scores

Domain and Tasks	Task Description	Difficulty
Domain 1 - Basic Monetary Skills		***Simple***
Task 1a Naming coins/currency	Identify specific coins and currency	Simple
Task 1b Coin/currency relationships	Indicate relative monetary values of coins/currency	Simple
Task 1c Counting coins/currency	Accurately count groups of coins and currency	Simple
Domain 2- Financial Conceptual Knowledge		***Complex***
Task 2a Define financial concepts	Define a variety of simple financial concepts	Complex
Task 2b Apply financial concepts	Practical application/computation using concepts	Complex
Domain 3- Cash Transactions		***Simple***
Task 3a 1 item grocery purchase	Enter into simulated 1 item transaction; verify change	Simple
Task 3b 3 item grocery purchase	Enter into simulated 3 item transaction; verify change	Complex
Task 3c Change/vending machine	Obtain change for vending machine use; verify change	Simple
Task 3d Tipping	Understand tipping convention; calculate/identify tips	Complex
Domain 4- Checkbook Management		***Complex***
Task 4a Understand checkbook	Identify and explain parts of check and check register	Complex
Task 4b Use checkbook/register	Enter into simulated transaction; pay by check	Complex
Domain 5- Bank Statement Management		***Complex***
Task 5a Understand bank statement	Identify and explain parts of a bank statement	Complex
Task 5b Use bank statement	Identify specific transactions on bank statement	Complex
Domain 6- Financial Judgment		***Simple***
Task 6a Detect mail fraud risk	Detect and explain risks in mail fraud solicitation	Simple
Task 6b Detect telephone fraud risk	Detect and explain risks in telephone fraud solicitation	Simple
Domain 7- Bill Payment		***Complex***
Task 7a Understand bills	Explain meaning and purpose of bills	Simple
Task 7b Prioritize bills	Identify bills; identify overdue utility bill	Simple
Task 7c Prepare bills for mailing	Prepare simulated bills, checks, envelopes for mailing	Complex
Domain 8- Knowledge of Assets/Estate*	Indicate knowledge of asset ownership, estate arrangements	***Simple***
Domain 9- Investment Decision Making	Understand investment options; determine returns; make decision	***Complex***
Overall Financial Capacity (Domains 1–7)	Overall functioning across tasks and domains	***Complex***
Overall Financial Capacity (Domains 1–7 & 9)	Overall functioning across tasks and domains	***Complex***

* = Experimental domain

Table 2

Control and TBI Group Comparisons on FCI Total Score and Neuropsychological Measures at Baseline (Time 1) and Six-Month Follow-Up (Time 2).

Measures	Controls Time 1 *M (SD)* N=20	Controls Time 2 *M (SD)* N=20	p^1	TBI Patients Time 1 *M (SD)* N=24	TBI Patients Time 2 *M (SD)* N=24	p^2	Group 1 *p*	Group 2 *p*	Group/Time Interaction *p*
FCI Total Score (Domains 1–7) (Max score = 324)	297.1 (16.4)	299.9 (14.0)	.157	229.2 (39.0)	267.4 (32.0)	.001	.001	.001	.001
Orientation									
GOAT	N/A	N/A	—	88.91 (7.35)	93.54 (6.66)	.041	—	—	—
Attention									
WAIS-III Digit Span	16.20 (4.50)	17.15 (4.55)	.342	12.13 (2.94)	14.00 (3.36)	.001	.001	.012	.330
WAIS-III Arithmetic	15.40 (3.38)	15.20 (3.25)	.691	9.92 (2.81)	11.67 (3.24)	.001	.001	.001	.010
Information Processing Speed									
Trail Making Test A	29.40 (11.10)	27.25 (8.79)	.317	80.79 (62.71)	37.71 (17.06)	.001	.001	.017	.001
SDMT (Oral)	58.10 (12.23)	61.45 (12.44)	.120	28.09 (13.31)	49.05 (13.43)	.001	.001	.004	.001
SDMT (Written)	52.95 (9.06)	55.85 (10.36)	.095	25.91 (12.52)	44.23 (15.89)	.001	.001	.008	.001
Short-Term Memory									
WMS-R Logical Memory I	27.05 (6.13)	30.20 (7.27)	.054	18.13 (6.52)	23.13 (7.61)	.002	.001	.003	.993
RAVLT	50.70 (9.39)	51.21 (12.19)	.914	34.09 (12.62)	43.04 (11.76)	.001	.001	.033	.022
7/24 Spatial Recall, Total Avg.	5.92 (1.22)	6.28 (.95)	.226	5.02 (1.30)	5.34 (1.27)	.266	.025	.010	.834
7/24 Spatial Recall, Interference	4.50 (1.43)	5.05 (1.82)	.186	3.22 (1.54)	3.45 (2.26)	.554	.007	.017	.786
7/24 Spatial Recall, Short-Delay	5.95 (1.90)	6.65 (1.57)	.130	4.22 (1.65)	6.09 (1.19)	.001	.003	.198	.211
Delayed Memory									
WMS-R Logical Memory II	24.20 (5.93)	27.25 (6.53)	.012	8.65 (7.38)	18.52 (8.50)	.001	.001	.001	.004
7/24 Spatial Recall, Long-Delay	6.05 (1.79)	6.50 (1.15)	.317	4.35 (1.77)	5.77 (1.72)	.033	.003	.118	.200
Executive Functioning									
WCST (Categories completed)	5.15 (1.35)	5.00 (1.65)	.634	2.17 (2.33)	3.79 (2.52)	.007	.013	.073	.011
Trail Making Test B	74.10 (29.52)	63.35 (20.60)	.106	216.67 (94.58)	109.58 (72.82)	.001	.001	.009	.001
EXIT-25	5.55 (3.00)	4.80 (2.38)	.284	10.25 (3.96)	7.67 (4.04)	.001	.001	.008	.026
COWA–CFL	14.03 (3.21)	14.23 (3.50)	.728	5.60 (2.09)	8.81 (2.94)	.001	.001	.001	.001
Semantic Fluency Composite	19.23 (4.60)	18.92 (4.22)	.648	12.03 (3.60)	14.79 (3.50)	.001	.001	.001	.002
Token Test	43.10 (1.55)	43.90 (.91)	.046	40.77 (3.69)	42.17 (2.52)	.037	.012	.006	.385

Measures	Controls Time 1 *M (SD)* N=20	Controls Time 2 *M (SD)* N=20	p^1	TBI Patients Time 1 *M (SD)* N=24	TBI Patients Time 2 *M (SD)* N=24	p^2	Group 1 *p*	Group 2 *p*	Group/Time Interaction *p*
Visuospatial Skills									
WAIS-R Block Design	29.95 (13.92)	30.30 (12.38)	.871	15.22 (10.39)	23.04 (10.77)	.001	.001	.044	.012
BVDT	29.50 (2.37)	28.70 (3.11)	.245	25.42 (4.94)	28.13 (7.61)	.025	.002	.602	.049
Fine Motor Functioning									
Grooved Pegboard	66.30 (17.68)	59.80 (8.71)	.047	148.88 (79.64)	89.88 (30.33)	.001	.001	.001	.002

Note. p^1 = Within group difference across time for Controls; p^2 = Within group difference across time for TBI participants; Group 1 = Control and TBI group difference at Time 1; Group 2 = Control and TBI group difference at Time 2; N = 24

Legend References: GOAT = Galveston Orientation and Amnesia Test; WAIS-R Digit Span = Wechsler Adult Intelligence Scale-Revised, Digit Span Subtest; WAIS-III = Wechsler Adult Intelligence Scale-Third Edition, Arithmetic Subtest; Trail Making Test A = Trail Making Test A from the Halstead Reitan Battery; SDMT (Oral) = Symbol Digit Modalities Test (Oral); SDMT (Written) = Symbol Digit Modalities (Written); WMS-R Logical Memory I = Wechsler Memory Scale-Revised, Logical Memory I; RAVLT = Rey Auditory Verbal Learning Test; 7/24 Spatial Recall Test, Total; 7/24 Spatial Recall Test, Total Avg. = 7/24 Spatial Recall Test, Total Score Average; 7/24 Spatial Recall Test, Interference; 7/24 Spatial Recall Test, Short-Delay; WMS-R Logical Memory II = Wechsler Memory Scale-Revised, Logical Memory II; 7/24 Spatial Recall Test, Long-Delay; BVDT = Benton Visual Discrimination Test; WCST (categories completed) = Wisconsin Card Sorting Test; Trail Making Test B = Trail Making Test B from the Halstead Reitan Battery; EXIT-25 = Executive Interview; Semantic Fluency Composite = Sum of Animals, Fruits/Vegetables, and Clothing/3; Token Test = Multilingual Aphasia Examination Token Test; WAIS-III Block Design = Wechsler Adult Intelligence Scale-Third Edition, Block Design Subtest.

Note. Table was adapted from our prior work previously published [Dreer et al. 2008. Rehabilitation Psychology, 53 (4): 486–497].

Table 3

Baseline (Time 1) Cognitive Predictors of Baseline FCI Total Score for TBI Group.

	Univariate		Multivariate			
Predictors	**r**	**p**	**β**	**S.E.β**	**R^2cum**	**p**
WAIS-III Arithmetic	.79	.001	9.6	2.2		.001
WMS-R Logical Memory I	.59	.01	3.1	1.0		.007
(constant)			79.8	20.4		
					.72	.001
Tokens Test	.61	.002				
EXIT-25	−.59	.01				
Trail Making Test (part A)	−.44	.01				
WCST Categories	.42	.05				
WAIS-III Block Design	.41	.05				

Table 4

Six-Month Follow-up (Time 2) Cognitive Predictors of Six-Month FCI Total Score for TBI Group (N = 24)

	Univariate		Multivariate			
Predictors	**r**	**p**	**β**	**S.E.β**	**R^2cum**	**p**
Tokens	.74	.001	10.8	2.2		.001
WAIS-III Arithmetic	.70	.001	8.0	1.8		.001
(constant)			−279.1	89.7		
					.79	.001
Trails B	−.66	.001				
Logical Memory II	.56	.007				
Logical Memory I	.52	.01				
EXIT-25	−.51	.01				
Semantic Fluency	.51	.01				
WCST Errors	−.51	.01				
WCST Categories	.50	.01				
Rey AVLT	.49	.02				
WAIS-III Digit Span	.45	.04				

Table 5

Baseline (Time 1) Cognitive Predictors of Six-Month (Time 2) FCI-9 Total Score for the TBI Group (N = 24)

	Univariate		Multivariate			
Predictors	**r**	**p**	**β**	**S.E.β**	**R^2cum**	**p**
WAIS-III Arithmetic	.79	.001	13.9	2.4		.001
Tokens Test	.68	.001	5.2	1.8		.01
(constant)			−52.7	24.8		
					.71	.001
Trails B	−.66	.001				
WMS-R Logical Memory II	.56	.007				
WMS-R Logical Memory I	.52	.01				
EXIT-25	−.51	.01				
Semantic Fluency	.51	.01				
WCST Errors	−.51	.01				
WCST Categories	.50	.01				
Rey AVLT	.49	.02				
WAIS-R Digit Span	.45	.04				