Cognitive, Emotional, and Physical Functioning as Predictors of Paid Employment in People With Stroke, Traumatic Brain Injury, and Spinal Cord Injury

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OBJECTIVE. Our objective was to examine demographic, cognitive, emotional, and physical factors that predict return to paid employment for people after neurological injury.

METHOD. Four hundred eighty adults with stroke ($n = 149$), traumatic brain injury ($n = 155$), and spinal cord injury ($n = 176$) completed an occupational outcome questionnaire and physical, emotional, and cognitive assessments at three rehabilitation facilities.

RESULTS. Odds of employment were predicted by being married or partnered, having more education, requiring fewer prompts for task sequencing, and having higher inhibitory control (but were not predicted by specific type of injury). Participants who returned to work within 3 mo were more likely to work with the same employer and to take a full-time position than those who returned later.

CONCLUSION. Executive functioning, in particular sequencing and inhibitory control, strongly predicts employment and highlights the importance of cognitive strategy training during occupational therapy with people who have sustained neurological injuries.

Employment is a major social determinant of health that is linked with financial, social, and personal well-being (Kirsh et al., 2009). Return to work after a neurological injury, such as stroke, traumatic brain injury (TBI), or spinal cord injury (SCI), is often a focus of rehabilitation interventions (Désiron et al., 2011). Inability to return to work can put people with neurological injuries at risk for financial strain and other adverse psychosocial outcomes, such as problems with housing, social communication, and depression symptoms (Khazaeipour et al., 2014).

Reported employment rates after neurological injuries vary widely, in part because of differences in data collection techniques, sample characteristics, and definitions of employment (Ottomanelli & Lind, 2009). However, paid employment rates after a neurological injury are considerably lower than before injury. Employment rates after SCI are estimated to be about 12% 1 yr postinjury and 34% 20 yr postinjury (National Spinal Cord Injury Statistical Center, 2016). In a prospective cohort study, Grauwmeijer et al. (2012) found that employment rates of 80% before moderate to severe TBI dropped to 15% 3 mo after injury and improved to only 55% 3 yr after injury. In another study of people who were working in paid employment immediately before stroke, Busch et al. (2009) reported much lower employment rates poststroke, with employment rates of 37% for people who had been employed full time and 29% for those who had been employed part time.

Employment after stroke tends to decline considerably in younger stroke survivors. Hackett et al. (2012) reported that 75% of survivors ages 17–65 yr who were employed before stroke returned to work within 1 yr, but 29% of these survivors transitioned from full- to part-time jobs. These data reveal an urgent need to understand the factors that result in reduced likelihood of employment after a neurological injury. Understanding factors that influence employment status

may help clinicians and policymakers identify targets for health services and workplace policies to help improve employment outcomes.

In past studies, researchers examined factors related to employment after a neurological injury. White race, younger age at injury, longer time since injury, less severe injury, and more years of education were associated with higher odds of reemployment post SCI, with years of education being the most important predictor (Krause et al., 1999). In a systematic review, Teodorescu et al. (2017) also found that male gender, younger age at onset of injury, and higher education level and functional independence related to a higher likelihood of return to work after SCI. People ages 17–65 yr who had a stroke were more likely to return to work within 1 yr if they were younger and independent in activities of daily living (ADLs) 28 days after injury (Hackett et al., 2012). Wang et al. (2014) found that stroke severity, time since injury, and ability to plan and self-regulate (viz., executive function abilities) were related to employment after injury. People experiencing symptoms of depression, anxiety, and cognitive deficits after a TBI were at increased risk for long-term unemployment (Grauwmeijer et al., 2012).

In most studies, researchers reported that demographic characteristics and ADL independence were associated with employment outcomes (Grauwmeijer et al., 2012; Hackett et al., 2012; Ottomanelli & Lind, 2009). Two studies indicated that cognitive functioning contributed to prediction of employment status (Benedictus et al., 2010; Wang et al., 2014). In these two studies, the researchers reported a notable relationship between increased odds of return to work and higher cognitive functioning; however, they did not specify which aspects of cognition could be targeted for interventions to improve employment outcomes.

In one study, Ownsworth and Shum (2008) examined the effects of compromised executive function related to productivity outcomes because neurological injuries frequently affect people's abilities to multitask and deal with activities requiring higher level skills. These skills are key demands for many jobs (Koenig, 2011). These authors found that planning, self-regulation, and self-monitoring were related to the level of poststroke productivity and employment outcomes, highlighting the importance of assessing specific aspects of cognitive function, especially executive function, to guide rehabilitation interventions. About 40%–50% of people with SCI have varying degrees of cognitive deficit (Davidoff et al., 1992), reflecting the frequent co-occurrence of SCI and TBI (Hagen et al., 2010). Concurrent TBI worsens patient outcomes, especially in those with impairments in processing speed, memory, and executive function (Cohen et al., 2017; Macclocchi et al., 2013).

In the current study, we had two specific aims. The first was to describe characteristics of participants who obtained employment postinjury, especially those who obtained full-time versus part-time employment, in consideration of whether employment is with the same employer versus a new employer. The second aim was to identify specific aspects of physical, emotional, and cognitive functioning as predictors of postinjury employment. We defined *employment* as either full- or part-time paid work. On the basis of an earlier study (Baum et al., 2017), we characterized cognition in three domains: functional, fluid, and crystallized.

Method

Participants and Procedures

As part of a larger project, 480 community-dwelling adults with neurological disorders (SCI, $n = 176$; TBI, $n = 155$; stroke, $n = 149$) participated in a comprehensive 2-day assessment at three medical institutions in the midwestern United States. We recruited participants via patient registries, outpatient clinics, and affiliated hospital referrals. Eligibility criteria were community residence, at least 1 yr since the most recent neurological injury, ages 18–62 yr (i.e., of typical working age), and the ability to speak English. We chose an upper age of 62 yr because that is the earliest age for Social Security retirement benefits. Although we chose an upper age limit, we recognize that continuing paid employment has psychosocial and financial benefits for many workers who are older than the eligibility age for full Social Security retirement benefits (Fraser et al., 2009).

We reviewed medical records to verify eligibility. TBI eligibility criteria included a diagnosis of complicated mild, moderate, or severe TBI (Traumatic Brain Injury Model Systems National Data Center, 2006). We used emergency department Glasgow Coma Scale (GCS; Teasdale & Jennett, 1974) scores and positive neuroimaging results to confirm TBI severity; we defined *severity* as the lowest GCS score within the first 24 hr of injury not due to intubation, sedation, or intoxication. Fifty-one participants (11%) had mild TBI (GCS score = 13–15), 15 (3%) had moderate injury (GCS score = 9–12), 88 (18%) had severe injury (GCS score $\leq$ 8), and 1 (<1%) had unknown severity. SCI eligibility criteria were an acute traumatic lesion of neural elements in the spinal canal resulting in either temporary or permanent sensory or motor disabilities. We characterized SCI as paraplegia or tetraplegia and as complete or incomplete according to the International Standards for Neurological Classification of SCI (Kirshblum et al., 2011). Forty-eight participants (10%) had complete paraplegia, 36 (8%) had incomplete paraplegia, 41 (9%) had complete tetraplegia, 50 (10%) had incomplete tetraplegia, and 1 (<1%) had unknown classification.

Stroke eligibility criteria were medically documented, rapidly developing clinical signs of focal or global disturbance of cerebral function with symptoms lasting more than 24 hr and with apparent cause of vascular origin (Hatano, 1976). We used the Modified Rankin Scale (van Swieten et al., 1988) to classify stroke severity. Forty-one participants (9%) had mild strokes (score = 0–2), 41 (9%) had moderate strokes (score = 3), 66 (14%) had severe strokes (score = 4), and 1 (<1%) had unknown severity. We coded stroke etiology as either ischemic or hemorrhagic. Forty-three participants (9%) had a hemorrhagic stroke, and 101 (21%) had an ischemic stroke. To ensure sufficient vision, literacy, and communication skills to complete assessments, we added the following inclusion criteria: a Lighthouse Near-Visual Activity Test (Bailey & Lovie, 1976) score of less than 20/100, the ability to read the first 10 words of the Wide Range Achievement Test (Wilkinson & Robertson, 2006), and the ability to communicate some of the main ideas of a story in the Frenchay Aphasia Screening Test (Enderby & Crow, 1996).

Participants completed all measures under the guidance of a trained and certified tester with a graduate degree in psychology or occupational therapy who provided reasonable accommodations as needed. All testers underwent rigorous training procedures to ensure that testers at all sites followed a standard test administration protocol (Tulsky & Heinemann, 2017). We developed a training manual, provided in-person training for administering and scoring tests, and certified testers through direct observation of administration of the test battery to a practice participant. Annually, we maintained quality control through site visits, recertification, and double scoring of protocols by study investigators to ensure adherence and minimize drift from the protocol.

This study received ethics approval from the institutional review boards at each of the three collaborating sites, and all participants provided informed, written consent. Participants received an honorarium to acknowledge their research contribution.

Outcome Measure

We administered an occupational outcome questionnaire including items about return to work, time to return to work, job demands, satisfaction, earnings, and pace at work. It can be downloaded at <https://wustl.box.com/s/3t6rlufhwd23u6q33hfiprrlcjp2pkuc>. This measure was validated to determine work outcomes of people after a stroke (O'Brien & Wolf, 2010; O'Neill & Wolf, 2010). We used two items to operationalize paid employment: (1) "Did you return to work after an injury?" and (2) "Are you currently employed?" Participants who answered no for the first question and chose "employed in a volunteer position" for the second question were defined as not employed.

Physical Function

For mobility, participants indicated whether they used a mobility device and then specified the device they used most often. An occupational therapy practitioner with Assistive Technology Professional certification confirmed their classification as either wheelchair users or ambulators. We found this dichotomous classification to be useful for predicting

participation outcomes of people with stroke, TBI, and SCI (Magasi et al., 2018). For upper extremity functioning, participants completed the Quality of Life in Neurological Disorders—Upper Extremity item bank (Cella et al., 2012), which was computer administered via the National Institutes of Health (NIH) Assessment Center® (<https://www.assessmentcenter.net/>). The Upper Extremity item bank consists of 20 items. We chose it because it assesses one's ability to carry out various activities involving digital, manual, and reach-related functions ranging from fine motor (e.g., "Are you able to turn a key in a lock?") to ADL (e.g., "Are you able to button your shirt?") functioning. Higher scores indicate better functioning. Excellent test–retest reliability (interclass correlation coefficient [ICC] = .88) and internal consistency (Cronbach's α = .82) of this measure for adults with stroke had been established.

Emotional Function

Participants completed the NIH Toolbox (NIHTB) Emotion Battery (Salsman et al., 2013) administered via computer. We administered 15 measures of negative affect (i.e., anger–affect, anger–hostility, anger–physical aggression, fear–affect, fear–somatic, perceived stress, sadness), social satisfaction (i.e., emotional support, friendship, instrumental support, loneliness, perceived rejection), and psychological well-being (i.e., meaning, life satisfaction, positive affect). Higher scores indicate more of the trait.

Cognitive Function

On the basis of an earlier study (Baum et al., 2017), we characterized cognition in three domains: functional, fluid, and crystallized. Participants completed five fluid cognition tests from the NIHTB Cognition Battery (Weintraub et al., 2013): the Dimensional Change Card Sort Test, to measure cognitive flexibility; the Flanker Inhibitory Control and Attention Test, to measure inhibitory control; the Picture Sequence Memory Test, to measure episodic memory; the List Sorting Working Memory Test, to measure working memory; and the Pattern Comparison Processing Speed Test, to measure processing speed. They also completed two tests of crystallized cognition from the NIHTB Cognition Battery, including the Picture Vocabulary Test to measure receptive vocabulary and the Oral Reading Recognition Test to measure decoding skills. For all NIHTB Cognition Battery measures, uncorrected standard scores (mean [M] = 100, standard deviation = 15) were used, with higher scores representing better performance. We chose the NIHTB because it provides a brief, comprehensive assessment of motor, cognitive, emotional, and sensory functions and was normed on a nationally representative sample (Gershon et al., 2010). We reported evidence to support the clinical utility and construct validity of this tool in people with stroke, TBI, and SCI (Carlozzi et al., 2017).

The Executive Function Performance Test (EFPT; Baum et al., 2008) is a performance assessment designed to measure cognitive integration (or functional cognition). It is used to assess which executive function components are impaired as a person completes the following four tasks: simple cooking, telephone use, medication management, and bill payment. We rated the cues that participants needed to complete the tasks successfully while initiating, organizing, sequencing, using judgment and safety, and completing the tasks. Adequate to excellent interrater reliability (ICC range = .79–.94) and adequate internal consistency (Cronbach's α range = .77–.88) were established for survivors with chronic stroke. Moderate correlations between EFPT and NIHTB Cognition Battery scores were found in TBI (r s = $-.42$, $-.50$), suggesting that the EFPT measures similar but distinct cognitive constructs from the NIHTB Cognition Battery (Baum et al., 2017). Higher scores on the EFPT indicate lower levels of executive function.

Data Analysis

We computed descriptive statistics to characterize the total sample (Table 1) and examined any differences in sociodemographic characteristics, physical function, emotion, and cognition between employed and unemployed groups. We used χ^2 tests for categorical variables, independent t tests for variables with a normal distribution, and Mann–Whitney U tests on variables with skewed distributions to test for group differences. To correct for the chance

Table 1. Descriptive Characteristics of Participants by Postinjury Employment Status

Characteristic	Total, <i>N</i> = 480	Employment Status ^a		<i>p</i>
		No, <i>n</i> = 358 (75%)	Yes, <i>n</i> = 122 (25%)	
Demographics				
Gender, <i>n</i> (%)				
Male	308 (64.2)	229 (74.4)	79 (25.6)	.913 ^b
Female	172 (35.8)	129 (75.0)	43 (25.0)	
Race, <i>n</i> (%)				
White	261 (54.4)	174 (66.7)	87 (33.3)	<.001 ^b
Black	152 (31.7)	129 (84.9)	23 (15.1)	
Other	63 (13.1)	52 (82.5)	11 (17.5)	
Marital status, <i>n</i> (%)				
Married or partner	143 (32.3)	88 (61.5)	55 (38.5)	<.001 ^b
Other	301 (67.8)	242 (80.4)	59 (19.6)	
Education, <i>n</i> (%)				
High school or less	163 (34.0)	140 (85.9)	23 (14.1)	<.001 ^b
Some college	183 (38.1)	140 (76.5)	43 (23.5)	
College degree	134 (27.9)	78 (58.2)	56 (41.8)	
Neurological injury, <i>n</i> (%)				
Spinal cord injury	176 (36.7)	134 (76.1)	42 (23.9)	.022 ^b
Traumatic brain injury	155 (32.3)	104 (67.1)	51 (32.9)	
Stroke	149 (31.0)	120 (80.5)	29 (19.5)	
Age, <i>M</i> (<i>SD</i>)	42.4 (13.2)	42.7 (13.1)	41.7 (13.7)	.449 ^c
Years since injury, <i>Mdn</i> (25%–75%)	4.4 (2.3–9.7)	4.2 (2.3–9.6)	4.4 (2.6–10.1)	.413 ^d
Physical functioning				
Mobility, <i>n</i> (%)				
Wheelchair users	209 (44.1)	167 (79.9)	42 (20.1)	.015 ^b
Ambulators	265 (55.9)	185 (69.8)	80 (30.2)	
Upper extremity function, ^e <i>M</i> (<i>SD</i>)	35.8 (7.3)	35.3 (7.4)	37.4 (6.8)	.008 ^c
Emotion ^f				
Negative affect emotion, <i>M</i> (<i>SD</i>)				
Anger–affect	51.5 (10.9)	51.8 (11.3)	50.8 (9.5)	.388 ^c
Anger–hostility	52.4 (10.2)	53.0 (10.4)	50.7 (9.4)	.039 ^c
Anger–physical aggression	54.0 (11.3)	54.4 (11.4)	52.7 (11.2)	.144 ^c
Fear–affect	53.1 (11.2)	53.5 (11.8)	51.8 (9.3)	.111 ^c
Fear–somatic	55.7 (11.6)	56.3 (12.1)	53.9 (9.9)	.030 ^c
Perceived stress	52.4 (10.6)	52.9 (11.0)	51.2 (9.5)	.138 ^c
Sadness	53.7 (11.1)	54.2 (11.8)	52.4 (8.7)	.093 ^c
Social satisfaction emotion, <i>M</i> (<i>SD</i>)				
Emotional support	45.0 (11.5)	44.1 (11.9)	47.5 (10.2)	.005 ^c
Friendship	46.5 (11.0)	45.6 (11.3)	49.1 (9.8)	.003 ^c
Instrumental support	48.7 (9.6)	48.2 (9.9)	50.4 (8.6)	.029 ^c
Loneliness	54.9 (11.8)	55.7 (12.1)	52.5 (10.4)	.005 ^c
Perceived rejection	52.1 (11.3)	53 (11.7)	49.4 (9.5)	.001 ^c
Psychological well-being, <i>M</i> (<i>SD</i>)				
Meaning	45.4 (10.6)	44.7 (10.6)	47.5 (10.6)	.014 ^c
Life satisfaction	43.4 (11.5)	42.5 (11.8)	46 (10.3)	.004 ^c
Positive affect	46.9 (11.7)	47.1 (12.3)	46.6 (9.9)	.656 ^c
Cognition				
Functional cognition, ^g need help, <i>n</i> (%)				
Organization				
No help	320 (68.4)	215 (67.2)	105 (32.8)	<.001 ^b
Help needed	148 (31.6)	133 (89.9)	15 (10.1)	

(Continued)

Table 1. Descriptive Characteristics of Participants by Postinjury Employment Status (Cont.)

Characteristic	Total, <i>N</i> = 480	Employment Status ^a		<i>p</i>
		No, <i>n</i> = 358 (75%)	Yes, <i>n</i> = 122 (25%)	
Sequencing				
No help	89 (19.0)	50 (56.2)	39 (43.8)	<.001 ^b
Help needed	379 (81.0)	298 (78.6)	81 (21.4)	
Judgment and safety				
No help	165 (35.3)	112 (67.9)	53 (32.1)	.020 ^b
Help needed	303 (64.7)	236 (77.9)	67 (22.1)	
Initiation				
No help	415 (88.7)	303 (73)	112 (27)	.067 ^b
Help needed	53 (11.3)	45 (84.9)	8 (15.1)	
Completion				
No help	375 (80.1)	267 (71.2)	108 (28.8)	.001 ^b
Help needed	93 (19.9)	81 (87.1)	12 (12.9)	
Fluid cognition, ^h <i>M</i> (<i>SD</i>)				
DCCS—cognitive flexibility	103.1 (12.8)	101.1 (13.4)	108.7 (8.6)	<.001 ^c
Flanker—inhibitory control	96.3 (12.4)	93.9 (12.9)	103.4 (7.6)	<.001 ^c
List sorting—working memory	97.5 (13.6)	95.9 (14.1)	102 (10.9)	<.001 ^c
Pattern comparison—processing speed	101.8 (15.4)	99.8 (15.6)	107.3 (13.8)	<.001 ^c
Picture sequence—episodic memory	93.2 (14.7)	91.5 (14.4)	98.1 (14.6)	<.001 ^c
Crystallized cognition, ^h <i>M</i> (<i>SD</i>)				
Reading	102.3 (9.0)	101.1 (8.9)	106.0 (8.1)	<.001 ^c
Vocabulary	102.1 (11.5)	100.4 (11.6)	107.1 (9.8)	<.001 ^c

Note. We set α at $p \leq .01$, corrected for multiple comparisons used to compare two groups. Significant comparison results are in **bold**. DCCS = Dimensional Change Card Sort; *M* = mean; *Mdn* = median; *SD* = standard deviation.

^ans used to calculate percentages may not equal the overall column *n*. ^b χ^2 test. ^cIndependent-samples *t* test. ^dMann–Whitney *U* test. ^eQuality of Life in Neurological Disorders, Upper Extremity function scores. ^fCensus-weighted scores (*M* = 50, *SD* = 10) of the National Institutes of Health (NIH) Toolbox Emotion Battery. ^gRaw scores (help needed vs. no help) of the Executive Function Performance Test. ^hUncorrected standard scores (*M* = 100, *SD* = 15) of the NIH Toolbox Cognition Battery. ⁱUncorrected standard scores (*M* = 100, *SD* = 15) of the NIH Toolbox Cognition Battery.

of Type I errors due to our use of multiple *t* tests, we adjusted the α level for each of these analyses from the standard $p < .05$ to $p < .01$. We also reported characteristics of participants who obtained postinjury employment to understand any job characteristics associated with taking full- versus part-time employment and working with same versus new employers postinjury (Table 2). Before regression analyses, we assessed the presence of any outlier by running boxplots. An outlier is considered when any value is larger than 3 times the interquartile range. We assessed the extent of collinearity by examining the variance inflation factor (VIF) to ensure that variables met the assumption of regression analyses. Collinearity is considered high when the VIF is greater than 10 (Kutner et al., 2004).

To account for unique variances in employment explained by physical, emotional, and cognitive domains, we performed a series of logistic regression models by domains in which we forced all sociodemographic variables as covariates in Step 1, and we added predictor variables within each different domain in Step 2. Multivariate odds ratios (ORs) in Table 3 show information on the independent domain (i.e., single-domain models). Recognizing the likely multifactorial nature of employment in people with neurological injuries, we entered variables in all domains into a full model, and we still entered all sociodemographic variables as covariates to account for variance in employment explained by all domains. Because variables in physical, emotional, and cognitive domains could be highly correlated, we chose forward selection because it allowed us to keep covariates that had stronger associations with the employment outcomes retained in the final model. We used IBM SPSS Statistics (Version 20; IBM Corp., Armonk, NY) for statistical analyses and set α at $p < .05$.

Table 2. Characteristics of Participants Who Obtained Postinjury Employment

Characteristic	Total, <i>n</i> = 116	FT Usual, <i>n</i> = 46 ^a (40%)	PT Usual, <i>n</i> = 37 ^a (32%)	FT New, <i>n</i> = 10 ^a (8%)	PT New, <i>n</i> = 23 ^a (20%)	<i>p</i>
Time to return to work postinjury, <i>n</i> (%)						
Within 3 mo	55 (47.4)	30 (54.5)	21 (38.2)	1 (1.8)	3 (5.5)	<.001
6 mo–1 yr	40 (34.5)	14 (35.0)	14 (35.0)	2 (5.0)	10 (25.0)	
>1 yr	21 (18.1)	2 (9.5)	2 (9.5)	7 (33.3)	10 (47.6)	
Ability to meet the job demands after returning to work, <i>n</i> (%)						
Same or better than before injury	34 (28.3)	15 (44.1)	11 (32.4)	4 (11.8)	4 (11.8)	.308
Less than before	86 (71.7)	32 (37.2)	27 (31.4)	5 (5.8)	22 (25.6)	
Satisfaction with job performance after returning to work, <i>n</i> (%)						
Not satisfied	17 (14.5)	9 (52.9)	6 (35.3)	1 (5.9)	1 (5.9)	.314
Satisfied	100 (85.5)	36 (36.0)	32 (32.0)	7 (7.0)	25 (25.0)	
Present earnings, <i>n</i> (%)						
Same or better than before	73 (60.8)	30 (41.1)	27 (37.0)	5 (6.8)	11 (15.1)	.099
Less than before	47 (39.2)	16 (34.0)	11 (23.4)	5 (10.6)	15 (31.9)	
Present pace of work, <i>n</i> (%)						
Same as before	70 (61.4)	27 (38.6)	25 (35.7)	8 (11.4)	10 (14.3)	.071
Less than before	44 (38.6)	15 (34.1)	12 (27.3)	2 (4.5)	15 (34.1)	

Note. Six participants did not complete the entire questionnaire. FT = full time, New = return to work with a new employer; PT = part time; Usual = return to work with usual employer.

^ans used to calculate percentages may not equal the overall column *n*.

Results

By design, we recruited roughly equal numbers of people with the three neurological conditions: SCI (*n* = 176; 37%), TBI (*n* = 155; 32%), and stroke (*n* = 149; 31%). [Table 1](#) shows sociodemographic characteristics of the sample and the results of univariate analyses of study variables between employed and unemployed groups. Employment was more likely for the following groups: White compared with Black (33% vs. 15%) or other race (18%); married or partnered compared with other marital status groups (39% vs. 20%); a college degree compared with some college (42% vs. 24%) or high school or less (14%); having greater upper extremity function (*M* = 37 vs. 35); lower loneliness (*M* = 53 vs. 56) and perceived rejection (*M* = 49 vs. 53); better emotional support (*M* = 48 vs. 44) and friendship (*M* = 49 vs. 46); as well as better functional, fluid, and crystallized cognition, except EFPT initiation.

Characteristics of Participants Who Were Employed Postinjury

Among 480 participants, 122 participants (25%) returned to work after injury; 18% returned to work with their previous employer, including 10% who worked full time and 8% who worked part time with their previous employer. Most participants who were employed within 3 mo of injury returned to their previous employer (see [Table 2](#)): Fifty-five percent worked full time, and 38% worked part time with their previous employer, whereas 7% worked with a new employer. Participants who resumed work more than 1 yr after injury worked mainly with a new employer: 33% worked full time, and 48% worked part time, whereas 19% worked with their previous employer (*p* < .001). No statistical differences were found in other characteristics, such as ability to meet job demands, satisfaction with job performance, earnings, or the pace of work.

Function-Specific Domains Affecting Employment

In the baseline sociodemographic multivariate model (see [Table 3](#)), greater likelihood of employment was predicted by White race, being married or partnered, and having a college education, but it was not predicted by type of neurological

Table 3. Multivariate ORs of Employment by Domains

Characteristic	Multivariate OR (95% CI) ^a	<i>p</i>	Cox–Snell <i>R</i> ² , %
Demographics			11.0
Gender			
Male	1.00		
Female	1.05 (0.64–1.72)	.855	
Race			
White	1.00		
Black	0.60 (0.33–1.09)	.092	
Other	0.47 (0.22–0.99)	.047	
Marital status			
Other	1.00		
Married or partner	2.41 (1.44–4.03)	.001	
Education			
High school or less	1.00		
Some college	1.81 (0.99–3.32)	.054	
College degree	3.25 (1.73–6.09)	<.001	
Neurological injury			
Spinal cord injury	1.00		
Traumatic brain injury	1.52 (0.84–2.74)	.164	
Stroke	0.96 (0.47–1.97)	.916	
Age	0.99 (0.97–1.01)	.286	
Years from injury	1.02 (0.98–1.05)	.371	
Physical functioning			16.5
Mobility			
Wheelchair users	1.00		
Ambulators	1.64 (0.76–3.54)	.210	
Upper extremity function ^b	1.05 (1.02–1.08)	.001	
Emotion ^c			
Negative affect emotion			12.4
Anger–affect	1.02 (0.98–1.06)	.303	
Anger–hostility	0.98 (0.95–1.01)	.124	
Anger–physical aggression	1.00 (0.98–1.03)	.826	
Fear–affect	0.99 (0.95–1.04)	.738	
Fear–somatic	0.99 (0.97–1.02)	.463	
Perceived stress	1.00 (0.97–1.04)	.837	
Sadness	0.99 (0.96–1.03)	.741	
Social satisfaction emotion			12.6
Emotional support	1.00 (0.97–1.03)	.930	
Friendship	1.01 (0.98–1.04)	.575	
Instrumental support	1.02 (0.99–1.05)	.298	
Loneliness	1.00 (0.97–1.03)	.853	
Perceived rejection	0.99 (0.96–1.02)	.606	
Psychological well-being			13.2
Meaning	1.04 (1.00–1.08)	.042	
Life satisfaction	1.02 (0.99–1.05)	.201	
Positive affect	0.96 (0.92–0.99)	.012	
Cognition			
Functional cognition ^d			16.9
Organization	0.35 (0.18–0.71)	.003	
Sequencing	0.43 (0.23–0.80)	.007	
Judgment and safety	0.88 (0.52–1.49)	.634	
Initiation	0.94 (0.37–2.36)	.894	

(Continued)

Table 3. Multivariate ORs of Employment by Domains (Cont.)

Characteristic	Multivariate OR (95% CI) ^a	<i>p</i>	Cox–Snell <i>R</i> ² , %
Completion	0.58 (0.27–1.22)	.149	21.1
Fluid cognition ^e			
DCCS—cognitive flexibility	1.01 (0.97–1.05)	.740	
Flanker—inhibitory control	1.12 (1.06–1.17)	<.001	
List sorting—working memory	1.00 (0.97–1.02)	.674	
Pattern comparison—processing speed	1.00 (0.97–1.02)	.899	
Picture sequence—episodic memory	1.02 (1.00–1.04)	.097	13.3
Crystallized cognition ^e			
Reading	1.02 (0.98–1.06)	.254	
Vocabulary	1.03 (1.00–1.06)	.062	

Note. CI = confidence interval; DCCS = Dimensional Change Card Sort; OR = odds ratio.

^aOnly information on the independent domain is shown, although we forced all sociodemographic variables as covariates in Step 1 and added predictor variables in each different domain in Step 2. ^bQuality of Life in Neurological Disorders, Upper Extremity function scores. ^cCensus-weighted scores ($M = 50$, $SD = 10$) of the National Institutes of Health (NIH) Toolbox Emotion Battery. ^dRaw scores (help needed vs. no help) of the Executive Function Performance Test. ^eUncorrected standard scores ($M = 100$, $SD = 15$) of the NIH Toolbox Cognition Battery.

injury, age, or number of years since injury. This baseline model explained 11% of the variance in employment. When demographic variables were entered as covariates, better upper extremity function predicted employment; these variables explained an additional 6% (total 17%) of the variance. For emotion domains, individual variables in the negative affect and social satisfaction domains did not predict employment; however, meaning and positive affect within the psychological well-being domain explained an additional 2% (total 13%) of the variance when demographic variables were entered as covariates.

Next, we evaluated three domains of cognition independent of physical and emotional function by entering demographic variables as covariates. Fluid cognition explained the greatest variance in employment (total $R^2 = 21\%$), followed by functional (total $R^2 = 17\%$) and crystallized (total $R^2 = 13\%$) cognition when demographic variables were entered as covariates. Organization and sequencing scores measured by the EFPT and inhibitory control measured by the NIHTB Flanker Inhibitory Control and Attention Test were significant predictors of employment.

Multifactorial Model of Employment

Table 4 shows results for the full model. Variables did not violate the assumption of collinearity because VIFs were less than 1.8. Greater likelihood of employment was predicted by being married or having a partner ($OR = 2.21$, $p = .018$) and having a college degree ($OR = 2.64$, $p = .018$). Cognition remained statistically significant, even after multifactorial adjustment. Participants requiring less assistance on sequencing tasks ($OR = 0.48$, $p = .05$) and demonstrating better inhibitory control ($OR = 1.10$, $p < .001$) predicted a greater chance of employment, whereas crystallized cognition was not statistically significant; it explained 25% of the variance in employment.

To ensure that we achieved enough power to run the regression, we used G*Power (Version 3.1.9.2; Heinrich Heine University Düsseldorf, Düsseldorf, Germany) for the power calculation, including 39 variables in the final regression model (Faul et al., 2009). Given our sample size ($N = 480$) and a medium effect size ($f^2 = 0.15$), the study has 99.9% power to detect predictors at $\alpha = .05$, suggesting that the sample size provides sufficient power for the analysis.

Discussion

We aimed to identify physical, emotional, and cognitive factors that predict employment after neurological injury to guide health care and policy interventions. The final model revealed significant predictors of employment, including marital status, education, and fluid and functional cognition; specifically, sequencing and inhibitory control significantly predicted employment after injury. Although tests of both functions measure a similar construct of executive function,

Table 4. Multivariate ORs of Employment With All Domains

Characteristic	Multivariate OR (95% CI)	p	Cox–Snell R^2 , %
Demographics			24.9
Gender			
Male	1.00		
Female	0.96 (0.52–1.80)	.906	
Race			
White	1.00		
Black	0.88 (0.40–1.97)	.763	
Other	0.84 (0.31–2.24)	.719	
Marital status			
Other	1.00		
Married or partner	2.21 (1.15–4.27)	.018	
Education			
High school or less	1.00		
Some college	1.19 (0.55–2.59)	.659	
College degree	2.64 (1.18–5.88)	.018	
Neurological injury			
Spinal cord injury	1.00		
Traumatic brain injury	1.73 (0.76–3.94)	.195	
Stroke	1.25 (0.49–3.20)	.640	
Age	1.02 (0.99–1.05)	.141	
Years from injury	1.03 (0.98–1.08)	.264	
Physical functioning			
Mobility			
Wheelchair users	—	—	
Ambulators	—	—	
Upper extremity function ^a	1.04 (1.00–1.07)	.060	
Emotion ^b			
Negative affect emotion			
Anger–affect	—	—	
Anger–hostility	—	—	
Anger–physical aggression	—	—	
Fear–affect	—	—	
Fear–somatic	—	—	
Perceived stress	—	—	
Sadness	—	—	
Social satisfaction emotion			
Emotional support	—	—	
Friendship	—	—	
Instrumental support	1.03 (1.00–1.07)	.065	
Loneliness	—	—	
Perceived rejection	—	—	
Psychological well-being			
Meaning	—	—	
Life satisfaction	—	—	
Positive affect	—	—	
Cognition			
Functional cognition ^c			
Organization	0.48 (0.21–1.10)	.082	
Sequencing	0.48 (0.23–1.00)	.050	
Judgment and safety	—	—	
Initiation	—	—	
Completion	—	—	

(Continued)

Table 4. Multivariate ORs of Employment With All Domains (Cont.)

Characteristic	Multivariate OR (95% CI)	<i>p</i>	Cox–Snell <i>R</i> ² , %
Fluid cognition ^d			
DCCS—cognitive flexibility	—	—	
Flanker—inhibitory control	1.10 (1.05–1.15)	<.001	
List sorting—working memory	—	—	
Pattern comparison—processing speed	—	—	
Picture sequence—episodic memory	—	—	
Crystallized cognition ^d			
Reading	—	—	
Vocabulary	—	—	

Note. All demographic variables were entered as covariates in the final multivariate model. Only significant variables of physical functioning, emotion, and cognition domains are presented. Dashes indicate covariates that were not statistically associated with employment outcomes and are not presented. CI = confidence interval; DCCS = Dimensional Change Card Sort; OR = odds ratio.

^aQuality of Life in Neurological Disorders, Upper Extremity function scores. ^bCensus-weighted scores ($M = 50$, $SD = 10$) of the National Institutes of Health (NIH) Toolbox Emotion Battery. ^cRaw scores (help needed vs. no help) of the Executive Function Performance Test. ^dUncorrected standard scores ($M = 100$, $SD = 15$) of the NIH Toolbox Cognition Battery.

sequencing as measured by the EFPT reflects the capacity to use executive control skills to order steps correctly while performing a functional task (Baum et al., 2008), whereas inhibitory control measured by the NIHTB Flanker Inhibitory Control and Attention Test reflects the ability to inhibit automatic responses that interfere with task completion (Weintraub et al., 2013).

Our results underscore the importance of cognitive functioning, especially executive functioning, in employment outcomes. They are consistent with prior studies supporting the importance of executive function on employment for people with neurological disorders (Grauwmeijer et al., 2012; Wang et al., 2014). In studies of people who received supported employment services, researchers have reported executive function to be an important predictor of employment outcomes (e.g., McGurk et al., 2005). Education and marital status were identified as predictors of employment for people after neurological injury (Kreutzer et al., 2003). Emotion domains were not predictors of employment, contrary to research in which depression and anxiety were found to be predictors of employment after TBI (Grauwmeijer et al., 2012). However, univariate models revealed significant relationships between employment status and emotional functions such as loneliness and perceived rejection. Because this study is cross-sectional, these associations could reflect emotional responses to unemployment instead of factors that may contribute to difficulties resuming employment.

Recommendations for Future Research

These findings provide valuable information about the employment characteristics of people postinjury. Participants who return to work 3 mo postinjury are more likely to work with the same employer, and more than half of them tend to work full time. Early entry into return-to-work rehabilitation programs may improve employment outcomes, although randomized controlled trials are needed to confirm this finding. Tasks such as site visits, worksite assessments, and employer education regarding job modification and Americans With Disabilities Act of 1990 (Pub. L. 101-336) requirements may assist employers and employees to develop early return-to-work plans (U.S. Equal Employment Opportunity Commission, 2005). More research is needed to study the effectiveness of similar programs for adults with neurological injuries. Future research regarding predictors of part- versus full-time employment, and of success at a previously held job, would guide priorities for treatment of neurological populations.

Our results inform the need for cognitive training, especially in executive function, when preparing people to succeed in employment postinjury. The significant prediction of employment with executive function is noteworthy because cognition may be underaddressed in therapeutic interventions. Early cognitive rehabilitation may be neglected after an

injury in favor of motor and sensory interventions (Johansson, 2011). These results support identifying and increasing the use of effective cognitive rehabilitation strategies for people with neurological disorders. Metacognitive strategies, including interventions aimed at building self-monitoring and self-regulation skills, are effective at improving self-awareness and executive deficits after moderate to severe TBI. The Cognitive Orientation to Occupational Performance (CO-OP; Dawson et al., 2009) uses problem solving, guided discovery, and verbal self-instruction to help people internalize the strategies they use to deal with the cognitive challenges while they perform activities that demand multitasking. A randomized controlled trial supported the early use of CO-OP to improve performance and remediate cognitive and upper extremity impairment for adults poststroke (Wolf et al., 2016). These strategies may be beneficial in improving employment outcomes because most jobs demand problem-solving and self-regulating skills (Koenig, 2011).

Although the findings suggest targeting executive function to prepare for employment, more research is needed to investigate the efficacy of CO-OP in improving employment outcomes for people with neurological injuries. Of course, the requirements of the job and the nature and severity of cognitive deficits are important. Future studies should include people who have varied neurological injuries. The EFPT and NIHTB Cognition Battery should be helpful in identifying cognitive skill level. In addition to therapies restoring cognitive function, environmental supports may be considered to help people compensate for any cognitive deficits. These supports could include the use of smartphones and personal data assistants to compensate for cognitive deficits postinjury (Cicerone et al., 2011). In this study, notable additions include our *t* test result indicating a significant difference between participants with and without employment postinjury in upper extremity function as well as our single-domain regression result showing that upper extremity function was a significant predictor of employment. Occupational therapy practitioners play a critical role in helping people with stroke, TBI, and SCI reach their highest potential with regard to their arm and hand functioning. Integrative interventions that include both cognitive and motor enhancement may help prepare them for return to work.

Limitations

The cross-sectional nature of the study design limits our ability to draw causal inferences. We do not know whether physical, emotional, and cognitive functions affect work functioning, or vice versa (especially for emotional function). The design of this study did not permit us to examine how employment changes over time or whether employment predictors change with time since injury. We did not collect information such as discharge location or receipt of work or therapy programs. We also did not examine other physical function factors such as balance, pain, or work tolerance, which may influence the return to work. We did not examine the effect of injury severity on paid employment. In future studies, researchers should examine this factor to learn whether findings can be generalized to people with different severity levels of stroke, TBI, and SCI. Moreover, we used self-reported measures to assess work status and physical functioning. Thus, in future studies researchers should consider using a work performance test and other ecologically validated physical functioning tests to understand people's capacities in real life.

Implications for Occupational Therapy Practice

The results of this study have the following implications for occupational therapy practice:

- Executive function is related to paid employment for people with stroke, TBI, and SCI.
- Employment is likely related to higher functions in task sequencing, inhibitory control, marital status, and higher education.
- Interventions directed to develop cognitive skills may support the return to paid employment for people with stroke, TBI, and SCI.

Conclusion

This study expands knowledge regarding predictors of employment after neurological injury and supports an increased focus on enhancing executive function and healthy relationships to improve employment outcomes. In future studies, researchers should examine the relationships between cognitive interventions and employment outcomes to determine the fluid and functional cognition mechanisms that are involved in employment preparation. ■

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