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Neuropsychological Predictors Of Engagement In Rehabilitation Therapy And Functional Independence In Individuals With Acquired Brain Injuries

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NEUROPSYCHOLOGICAL PREDICTORS OF ENGAGEMENT IN REHABILITATION THERAPY AND FUNCTIONAL INDEPENDENCE IN INDIVIDUALS WITH ACQUIRED BRAIN INJURIES

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DEDICATION

This work is dedicated to my family and friends.

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CHAPTER 1

INTRODUCTION

Acquired brain injury (ABI) is a very common clinical condition, which may lead to residual deficits requiring rehabilitation for activities of daily living (Chau, Ng, Yap, & Bok, 2007). Occupational therapy after ABI is important part of a rehabilitation program, as it is designed to assess and aid patients in regaining independent functioning with activities of daily living (Steultjens, Dekker, Bouter, Leemrijse, & van den Ende, 2005). Engagement in therapy is a patient factor that can limit or enhance the benefits of occupational therapy (Adams, 2010). It has been shown that patients with high levels of engagement and awareness of deficit demonstrate greater gains in therapy than those who have low engagement (Barello, Graffigna, & Vegni, 2012; Fleming & Ownsworth, 2006). Conversely, low engagement and failure to maximize therapy is associated with increased health costs and disability (Barello et al., 2012). Brain injury can disrupt cognition and emotions, resulting in apathy and low engagement (Bach & David, 2006; Bright, Kayes, Worrall, & McPherson, 2015; Clarke, Ko, Kuhl, van Reekum, Salvador, & Marin, 2011; Lane-Brown & Tate, 2011). Unfortunately, very little research has examined the link between specific cognitive impairments and engagement in therapy; fewer still have examined this link with ultimate endpoints of functional outcome. An important gap in the knowledge base concerns how cognitive impairments associated with ABI disrupt engagement in therapy, and the extent to which this disruption undermines the benefits of rehabilitation therapy. Accordingly, this study will examine the relationships among cognitive impairment, engagement in rehabilitation therapy, and functional outcomes.

Therapy Engagement

Rehabilitation therapies are not passive endeavors; they require patients' participation to be effective (Adams, 2010). Therapy engagement captures patient participation in rehabilitation

activities, which includes attendance, completion of prescribed exercises, and so on. Research has demonstrated that engagement and awareness of deficit are positively associated with gains in therapy, whereas low engagement and poor self-awareness of impairments predict poor therapy outcomes (Fleming & Ownsworth, 2006; Ownsworth & Clare, 2006: Barello et al., 2012). In turn, outcomes of rehabilitation therapy impact health costs and long-term disability (Barello et al., 2012). Cohen-Mansfield et al. (2012) described engagement to reference the act of being occupied or involved with an external stimulus. Cohen-Mansfield and colleagues (2012) attended to individuals in nursing homes diagnosed with dementia given that most of these individuals' time is spent not engaged in stimulating activity. This sets the stage for low engagement, which is associated with apathy, depression, and loneliness influencing behavioral manifestations of these negative emotions (Cohen-Mansfield et al., 2012). According to Lequerica et al. (2006), therapy engagement is defined as a deliberate effort and commitment to working toward the goals of rehabilitation. Lequerica and Kortte (2010) provided a model of therapeutic engagement in rehabilitation that involves a large cognitive portion: perceived need for rehabilitation and self-efficacy, as well as rehabilitation outcome expectancies comprising willingness to engage in rehabilitation. Behavioral portions of the model indicate the linear process of preparation for rehabilitation, initiation of rehabilitation activity, and active engagement. There is an analysis of the experience and outcome, which may lead to disengagement (unpleasant experience without a purpose or goal attainment) or maintenance (pleasant experience with a purpose and/ or goal not attained) of engagement. This model of therapy engagement is strong given that it includes belief and attitudes as well as behavioral indicators in addition to a feedback loop on active engagement after initiation.

Rehabilitation Therapies

Occupational Therapy Post ABI

A large portion of the research supporting the effectiveness of occupational therapy post brain injury is based on case studies (Trombly, Radomski, Trexel, & Burnett-Smith, 2002). There has been a shift in the medical rehabilitation model to reduce costs and demonstrated maximum benefits of patient services. The major shift is the new increased focus on cost and time leading to more constraints on provision services. In light of this paradigm shift, therapy has become increasingly goal oriented toward independence, which requires the patient be involved in the goal setting and treatment planning process and that outcomes and progress are tracked (Trombly et al., 2002). The concept of engagement encapsulates patient involvement in therapy throughout all stages including home practice and exercises. Understanding that the training exercises and activities for occupational therapy are uniquely designed to fit individual patients' needs, it is important that patients be engaged in the entire process for maximum benefit. Task-specific training has emerged as a prominent treatment model in an attempt to optimize the benefits from therapy to increase efficiency of treatment with consideration to cost-benefit analysis. Hubbard, Parsons, Neilson, and Carey (2009) highlight the increasing research literature supporting the use of task-specific training in rehabilitation therapy. Task-specific training works to improve functional performance of patients through goal-directed practice and repetition, which is based upon learning theory and neuroplasticity (Hubbard et al., 2009). They put forth a framework for occupational therapy using five recommendations to increase application of task-specific training in therapy using the "five Rs": relevant, randomly, repetitive, reconstruction, and reinforced. The training should be relevant to the patient through involvement of activities to the patient. The training sequences should be randomly ordered to

increase generalization of learning to novel activities. The training should be repetitive to foster skill building and mastery. The training must also work toward reconstruction of the complete activity. Lastly, the patient in training should be positively reinforced in a strategic manner to provide encouragement without creating dependency. These recommendations reflect this new circumscribed, goal-oriented perspective that requires patient engagement based upon theory and research conclusions to enhance occupational therapy practice. As such, therapy engagement is more important than ever in the rehabilitative process and should be accounted for during the process of therapy. Unfortunately, there is a lack of process assessment in rehabilitation therapy, which includes the patient's engagement in the therapy. There are strategies and techniques specific to enhancing therapy engagement, which could be utilized to bolster those with lower levels of engagement. Thus, knowing about the patient's level of engagement in this current model of patient-centered, goal-oriented therapy could save a significant amount of money in terms of medical costs and faster return to productive activity.

Acquired Brain Injury

The term ABI encompasses all brain injuries that occur after birth, which includes stroke, traumatic brain injury, brain tumors, cerebral hypoxia/anoxia, and the like. These are acquired insults or injuries to the brain that typically follow a course of recovery over time from acute to chronic states. There are also ABIs that are neurodegenerative such as multiple sclerosis, Parkinson's disease, etc., which are not the focus in this study due to progressive worsening of functioning and abilities. Impairments and disabilities following an ABI cover the range of human behavior and functioning, including cognitive, physical, emotional, and behavioral sequelae. Every person experiences an ABI differently, as the location and severity of brain damage influences residual deficits in addition to premorbid factors and person/environmental

interaction. For example, age and education at time of injury are very important to consider in the person's prognosis. Advanced age at time of injury is associated with poorer outcomes post brain injury (Hukkelhoven et al., 2003). This may be understood with the theory of cognitive reserve brain reserve capacity (passive model), larger brain size or greater specific neuroanatomical-functional relations allows for neuroprotection against brain insult (Satz, 1993; Stern, 2002). Advanced education serves as a protective factor from cognitive decline post brain injury, as postulated in the active model of the cognitive reserve theory (Kesler, Adams, Blasey, & Bigler, 2003). Physical impairments could consist of muscle weakness in specific body parts or inability to control body movements. Also, there are possible sensorimotor deficits like loss of vision, visual field cuts, and so on subsequent to an ABI. The residual deficits of an anoxic/ hypoxic brain injury for survivors vary based upon severity of injury like other ABIs, but unlike other ABIs there are key areas in the brain that are sensitive to oxygen deprivation and associated with typical deficits. Significant memory and cognitive deficits are likely following an anoxic/ hypoxic event due to oxygen deprivation sensitivity of the hippocampi and cortex (Kwasnica, Brown, Elovic, Kothari, & Flanagan, 2008). The basal ganglia and cerebellum are also sensitive areas and deprivation typically causes motor dysfunction or a movement disorder such as tics, ataxia, and more (Kwasnica et al., 2008). Brain tumors are very dangerous injuries to experience as the 5-year life expectancy rose to about 31% in 2001. Moreover, the most malignant and common type of brain tumor, glioblastoma multiforme, has maintained a steady 1-year survival rate at 32% since the 1980s despite the indication of a rise in incidence rate to 2.8 per 100,000 (Kwasnica et al., 2008). Of the varying etiologies of ABI, traumatic brain injury and stroke are the most common events (Kwasnica et al., 2008).

In the United States, there are roughly 1.7 million individuals who sustain a traumatic

brain injury (TBI) annually. Although TBI contributes to approximately 30% of injury-related death, the majority of people who experience a TBI survive: 275,000 are hospitalized and 1.4 million do not have severe enough injuries to warrant hospitalization as determined in the emergency department (Faul, Xu, Wald, & Coronado, 2010). TBI is damage to brain tissue caused by an external mechanical force as indicated by loss of consciousness subsequent to brain trauma, or post traumatic confusion (PTC), or skull fracture, or other objective neurological findings that can be reasonably attributed to TBI on the initial physical examination or mental status examination (Thurman, Alverson, Dunn, Guerrero, & Sniezek, 1999). The economic burden of TBI in the United States alone is upwards of 60 billion dollars (Brown, Elovic, Kothari, Flanagan, & Kwasnica, 2008). This number includes estimations of lost wages and productivity, medical expenses, and rehabilitation costs. The advancements in standards of care and medical science for those with brain injuries have improved the survival rate, increasing the number of individuals living with impairment (Brown et al., 2008). At least 5.3 million Americans are currently living with residual deficits stemming from a TBI (Faul et al. 2010). It is also important to mention that individuals who sustain a TBI often have associated injuries, like bone fractures, spinal cord injuries, polytrauma, and limb amputations, which exacerbate psychosocial and economic burden (Chau et al., 2007).

Strokes can be delineated into two categories, ischemic and hemorrhagic. Ischemic stroke is the occlusion of blood flow in the brain, whereas hemorrhagic stroke is the loss of blood flow in the brain as a result of a blood vessel, vein, or artery in the brain bursting (Go et al., 2013). Hemorrhagic stroke can be intracerebral or subarachnoid. Most strokes tend to be ischemic, 87%. Annually in the United States, approximately 795,000 individuals have a stroke, of which more than 75% are experiencing their first stroke (Go et al., 2013). Also, hemiplegia occurs within

about 80% of people during their first stroke (Dobkins, 2004). About 20% of individuals who sustain a stroke are referred for inpatient rehabilitation (Skidmore et al., 2010). Higher stroke prevalence has been found among Blacks, older adults, people with lower levels of education, and those residing in the southeastern part of the United States (Go et al., 2013).

Neuropsychology of Engagement

Individuals with an ABI are left with a host of impairments that increase the difficulty in fully participating in all of the rehabilitation strategies. Brain injury can disrupt emotions leading to apathy and low engagement in rehabilitation therapies (Bach & David, 2006; Clarke, Ko, Kuhl, van Reekum, Salvador, & Marin, 2011; Lane-Brown & Tate, 2011). Cognitive deficits are commonly associated with ABI also can reduce patients' abilities to learn new information, retain new information, and engage in other behaviors that promote self-management, which may also limit ability to participate in therapy (Kortte, Falk, Castillo, Johnson-Greene, & Wegner, 2007).

Apathy is a deficit in motivation exemplified by diminished goal-directed behavior (e.g., lack of effort) and cognition (e.g., lack of interest) in addition to diminished emotional reactions (e.g., flat affect) linked with goal-directed behaviors. It is commonly associated with neurological insult to the frontal lobes bilaterally, subcortical damage, and right hemisphere infarction, particularly the anterior portion (Andersson, Krogstad, & Finset, 1999; Kant &Smith-Seemiller, 2002). Apathy is distinct from depression, which may also result from brain injury, in that a depressed individual may express some concern about their inactivity whereas the apathetic person may portray indifference or lack of sufficient concerns. Apathy is a common condition post TBI, anoxic/hypoxic event, and stroke (Kant & Smith-Seemiller, 2002; Matsuzaki et al., 2015). Pre-frontal and temporal lobes are especially vulnerable and likely to be damaged

post TBI due to the design of the skull and movement of the brain. Diffuse axonal injuries can also follow TBI causing shearing and tearing of neuroconnective tissue in subcortical areas, which has been associated with apathy (Andersson et. al., 1999). Most importantly, damage to structures along the frontal subcortical circuits (i.e., basal ganglia, limbic structures, anterior thalamus, etc.) have been linked with apathy (Andersson et al., 1999; Carota, Staub, & Bogousslavsky, 2002). It is more likely for individuals post brain injury to have apathy and depression than it is for them to have either apathy or depression alone (Andersson et al., 1999; Matsuzuki et al., 2015). Depression and apathy do share some overlap in that the negative symptoms of depression are similar in presentation to apathy. Unlike apathy, depression has been associated with damage to the subcortical networks presenting as a negative bias and potential withdrawal and reduced activity level and interest (Andersson et al., 1999). It is important to accurately understand and detect apathy as well as determine the etiology (organic versus psychological) separately from depression, as the intervention might differ in addition to the need for appropriate environmental feedback (Kant & Smith-Seemiller, 2002; Matsuzuki et al., 2015).

Anosognosia, like apathy, can interfere with the rehabilitation treatment. Anosognosia refers to an inability to recognize one's own impairments or appreciate the severity of their deficits, which can be demonstrated through denial of impairments, confabulations about deficits, and other manifestations (Heilman, Barrett, & Adair, 1998; Carota et al., 2002; Orfei et al., 2007).

Anosodiaphoria may be conceptualized as a less severe case of anosognosia in that one acknowledges their deficits and yet is unconcerned about their deficits (Heilman et al., 1998). Anosognosia or anosodiaphoria, both terms coined by Babinski (Prigatano, 2010), could lead to

lack of engagement in therapy and potential undertaking of relatively dangerous tasks given the individual's particular deficit (Flashman & McAllister, 2002; Hartman-Maeir, Soroker, Ring, & Katz, 2002). Potential mechanisms of increased risk include that underappreciation of deficits can undermine the recognition of need to learn and/or invoke appropriate compensatory strategies (Rapport et al., 1993, 2008; Ryan et al., 2009). Most importantly, individuals with anosognosia and anosodiaphoria tend to have worse outcomes than do individuals who appreciate the nature of their deficits, because they may not fully engage in therapies designed to ameliorate their impairments or continually exhibit unsafe behaviors leading to the need for supervision (Flashman & McAllister, 2002).

Other cognitive deficits may also limit an individual's ability to engage in therapies post ABI. Commonly with TBI, processing speed and sustain attention abilities are diminished (Rao & Lyketsos, 2000; McDonald, Flashman, & Saykin, 2002). Poor attention may manifest as increased distractibility and inability to follow instructions or maintain focus on task demands during therapy, reducing intended effectiveness of rehabilitation. It also reduces opportunity for information to be adequately processed for long-term storage, which may require additional time spent on repeating instructions and coaching causing the rehabilitation process to be slowed. Other neurocognitive problems include impaired memory and executive functioning, which may interfere with rehabilitation (McDonald et al., 2002). Reduced memory functioning may lead to poor retention of strategies and techniques learned in therapy. Executive functioning deals with planning, cognitive flexibility, purposeful action, and behavioral control (Andersson et al., 1999; McDonald et al., 2002). FMRI studies indicate the dorsolateral prefrontal cortexes are activated during completion of a task assessing executive functioning, the Stroop (Moering, Schinka, Mortimer, & Graves, 2004). Other common measures of executive functioning that are

purportedly linked to frontal activation include Wisconsin Card Sorting Test, and the Trail Making Test (McDonald et al., 2002). Another measure of executive functioning is cognitive initiation, which tends to be impaired with frontal lobe damage (McDonald, et al. 2002; Lezak, Howieson, & Loring, 2004). It is important to note that impairment in cognitive initiation is also positively correlated with injury severity and linked to diffuse axonal injury (Lezak et al., 2004). Thus, people with TBI and stroke, both of which very commonly involve damage to frontal regions, are at high risk for disrupted engagement in rehabilitation therapies.

Measurement of Therapy Engagement

Researchers have recently begun to examine rehabilitation therapy engagement independent of other constructs like depression, motivation, etc. There have been a few measures developed to assess patient engagement in rehabilitation based on the therapist's perception using short surveys. Lenze and colleagues (2004a) developed a 1-item scale called the Rehabilitation Participation Scale to measure engagement in physical and occupational therapy to explore depression and cognitive impairments as predictors of rehabilitation outcome among elderly patients with an orthopedic injury. They reported "because no instrument was available in the scientific literature, we created the [RPS]." The Pittsburg Rehabilitation Participation Scale (PRPS; Lenze et al., 2004b) was a revised version of the RPS with a wider set of response options to reduce ceiling effect but still a single-item measure. Temporal administration was used per study procedure over 20 session of inpatient rehabilitation for elderly patients recovering from a stroke, orthopedic injury or surgery, or other debility from medical etiology (e.g., cardiopulmonary) to demonstrate reliability and validity. Although PRPS ratings were taken at each session, a mean PRPS score was used in correlation and regression analyses. Interestingly, PRPS score was more predictive for patient with stroke than those with orthopedic injuries. It

was mentioned that this might be a result of greater variability in engagement among those with stroke, as those with orthopedic injuries had generally good PRPS scores (Lenze et al., 2004b). A major drawback of the PRPS is that it consists of only one item, missing many intricacies that are commonly a part of conceptualizations in engagement. Also, it was based upon elderly patients in an inpatient rehabilitation setting, which may limit generalizability to outpatient rehabilitation populations.

The Hopkins Rehabilitation Engagement Rating Scale (HRERS; Kortte et al., 2007) was developed to include consideration of multiple elements associated with engagement. This is a 5-item survey based upon research literature with final item selection determined by expert opinion. Although Kortte and colleagues (2007) collected a good sample of individuals (206) from three inpatient rehabilitation facilities, they excluded patients with more than mild cognitive impairment. This exclusion markedly limits generalizability, as it is unknown whether the scale would be useful with patients with more severe cognitive impairments.

The Rehabilitation Therapy Engagement Scale (RTES; Lequerica et al. 2006) is a 15-item therapist rated measure of patient engagement in rehabilitation therapies. The RTES was validated on an inpatient rehabilitation setting with patients of varying injury severity based on physical and occupational therapies. Lequerica et al. (2006) found internal consistency of .97 and .99 for physical and occupational therapies, respectively. Also, RTES scores were negatively associated with injury severity and predicted rehabilitation progress across inpatient stay. The RTES covers an array of facets that comprise engagement, more specifically: initiation, interest, persistence, enthusiasm, concentration, motivation, attentiveness to task demands, effort, eagerness to learn, determination, redirection, encouragement, cooperation, proactive, and participation. Although the RTES is longer than both the PRPS and HRERS, it has greater

breadth and is still relatively quick without additional burden on the patient. Also, the RTES provides more information for therapists to adjust treatment to address areas of weakness. The utility of the RTES has been demonstrated in rehabilitation patients with varying injury severity allowing a broad range of use.

Relationship between Engagement and Cognitive Impairments

Understanding patients' expected level of engagement would allow for more nuanced, individualized treatments aimed at improving best chances for maximum benefit from occupational therapy (Adams, 2010; Barello et al., 2012). Low engagement is associated with increased hospital costs (Barello et al., 2012). There are not many studies that examine therapy engagement for individuals with acquired brain injuries (Skidmore et al. 2010).

Lenze and colleagues (2004a) explored the adverse effects of depression and cognitive impairment on rehabilitation participation and functional recovery in 56 elderly participants who sustained a hip fracture. Depression was measured using the Hamilton Rating Scale for Depression (HRSD), and it was associated with the FIM™ motor efficiency score: change in FIM™ motor score from admission to discharge divided by the length of stay, a measure of recovery. Cognitive impairment was assessed using the Mini Mental State Examination (MMSE) and positively related to the FIM™ motor efficiency score. The authors found that more cognitive impairment is linked with lower functional recovery. Rehabilitation participation was appraised and quantified using the Rehabilitation Participation Scale, a therapist-rated single question regarding the patient's level of participation on a scale of 1 (refused / no participation) to 4 (maximum effort in most or all activities). The researchers, with a limited sample size of 56, demonstrated that level of participation mediated the relationship between depression and functional recovery as well as the relationship between cognitive impairment and functional

recovery (Lenze et al., 2004a). This study offered some promising findings in terms of the importance of rehabilitation participation serving as a mediator of functional recovery; however, it is limited by the use of screener instruments that are not sufficiently informative to offer much guidance in the way of adapting and developing new interventions. For example, the MMSE does not afford examination of separate cognitive domains that might drive an association between cognitive functioning and functional outcome (Dick et al., 1984). There was no reason to suspect cognitive impairment given the purpose of rehabilitation was for orthopedic recovery. Poor scores may not be accurate to the participant's true cognitive status. Another limitation of this study is the modest sample size and number of analyses conducted likely increasing family-wise error increasing probability of Type 1 error, false positive. Also, the design of the study likely violated some model assumptions. For example, given that these elderly participants were not identified with cognitive impairment, the MMSE is likely not a good representation of cognitive abilities. The mean and standard deviation scores were not reported for the MMSE. However, the MMSE score plot appears to be negatively skewed (most participants with high scores) and a few outliers with low scores may account for the correlation between MMSE and outcome. In term of the HRSD, 79% of the participants were below the cut off for a significant number of symptoms endorsed. Also, the degree of participation across participants was positively skewed as the authors admit that the "vast majority of therapy scores were '4' (Lenze et al., 2004). Thus, model assumptions such as normality and linearity in the predictor variable may have been violated. The findings need to be replicated in a larger sample with a more detailed assessment of cognitive functioning.

Lenze et al. (2012) extended their work in an investigation of 26 older adults undergoing inpatient postacute rehabilitation, some of which were randomized to an "Enhanced Medical

Rehabilitation" intervention designed to increase patient engagement in rehabilitation therapies. They assessed therapy intensity via "active time" spent by patients during therapy sessions and therapy engagement using the Rehabilitation Participation Scale, with functional and performance outcomes including the Barthel Index, gait speed, and a walking task. Among many findings, they concluded that patients in the treatment group showed higher intensity and were more engaged in their rehabilitation therapy sessions as compared to standard care, and that both enhanced intensity and patient engagement in rehabilitation therapy were associated with enhanced functional outcomes for older adults. These findings are especially important because the study employed a true experimental design (with a control group), which in turn provides evidence for the causal links between engagement, rehabilitation therapy, and functional outcomes. Importantly, however, generalizability of findings from people without cognitive impairment to people with ABI cannot be assumed.

Katz and colleagues (2005) examined the differences of engagement in *drug abuse treatment* based upon participants' cognitive abilities. They separated individuals into groups of high and low cognitive abilities based upon comparative estimates of Wechsler Adult Intelligence Scale-Revised full scale IQ. It was concluded that individuals with higher cognitive abilities were more likely to achieve better treatment outcomes and engagement in treatment. This study did not measure engagement from the therapist's perspective of effort in therapy; instead, it used a survey scale, Treatment Readiness, to assess treatment engagement, based on research correlating scores on that scale with therapy engagement. Comparison of Treatment Readiness scores yielded differences favoring those with higher cognitive abilities; however, there was no difference in treatment retention, an objective outcome measure of engagement, based upon cognitive groupings. Also, Katz et al. did not report any objective outcome measure

of treatment benefit. They used differences in Treatment Readiness scores between cognitive groups to infer potentially better outcomes for those with higher cognitive abilities, which included individuals with average IQ scores.

Skidmore et al. (2010) studied the relationship between cognitive and affective deficits and rehabilitation participation post ischemic stroke. They assessed cognitive domains including memory, attention, and executive functioning. Participation was measured using the PRPS, in which all scores were averaged across therapy sessions, including physical and occupational therapies. Depression and apathy levels were assessed for affective status. Of note, individuals who endorsed high level of depressive symptoms ($\geq$ 16) on the HRSD were considered as potentially having Major Depressive Disorder and were excluded from the study. Apathy, as measured with the Apathy Evaluation Scale, was not significantly correlated with participation, and it was not included in the regression analysis. It was determined based upon multiple linear regressions that executive functioning abilities and baseline disability were predictive of participation. Also, depressive symptoms were predictive of participation (Skidmore et al., 2010); this latter finding seems remarkable particularly because the authors' exclusion of cases with significant depressive symptoms restricted range in the sample. Consistent with other research, Skidmore and colleagues (2010) found that participation was related to functional status at 12 weeks. This study supports the general notion that neuropsychological function plays an important role in participation, which in turn predicts long-term functional status. Weaknesses of the study design involve aspects assessing the role of emotional and motivational impairments to participation and functional outcome. First, the PRPS is a single-item measure of participation, and limitations in reliability of the scale limit potential validity (outcome) results. Second, exclusion of participants on the basis of depressive symptoms restricted the range of depressive

symptoms, which also influences effect size. Also, the test battery in this study did not assess a comprehensive set of cognitive domains; only attention, memory, and executive functioning were assessed using a single test for each. The assessment of memory did not include a delay. It was merely the fourth consecutive trial of immediate recall on a list-learning task. The sample size only included 44 participants and part of the inclusion criteria stated that cognitive impairment had to be demonstrated in attention, memory, or executive functioning. The exclusion criteria removed individuals with HRSD score >16 and those considered to have severe aphasia determined based upon lesion location, Token Test Part I score ≤ 8, or a Boston Naming Test score greater than one standard deviation below age-adjusted norms. The selective characteristics of this sample may limit generalizability of these results. Importantly, this study did not conduct a meditational analysis to determine relative importance of participation.

Summary and Purpose

The literature examining the value of neuropsychological assessment in predicting therapy engagement among individuals with acquired brain injuries is sparse. This study examined the relationships among cognitive impairment, engagement in rehabilitation therapy, and functional outcome among persons with ABI. The aims of this study included: (a) learn more about assessing and developing prognosis of therapy for individuals with acquired brain injuries, (b) understand patient factors related to therapy engagement, (c) explore the extent to which cognitive testing predicts therapy engagement, (d) assess the relationship between engagement and functional gains in rehabilitation therapy, and (e) determine the extent to which therapy engagement mediates the relationship between cognitive testing and functional gains in therapy. It was expected that cognitive testing would be related to therapy engagement (Katz et al., 2005; Krpan, Levine, Stuss, & Dawson, 2007). It was also expected that cognitive testing would be

related to functional gains in therapy (Katz et al., 2005). Additionally, it was predicted that there would be a positive relationship between engagement in therapy and functional gains in therapy (Barello et al., 2012; Skidmore et al., 2010). Lastly, it was expected that therapy engagement would mediate the relationship between cognitive impairment and functional gains in rehabilitation therapy (Lenze et al., 2004).

CHAPTER 2

METHOD

Participants

Participants were 98 adults recruited from the Rehabilitation Institute of Michigan Brain Injury Outpatient locations: Novi Center, Brasza Outpatient Center, and Sterling Heights Center. The inclusion criteria included: (a) medically documented acquired brain impairment; (b) at least 18 years of age; (c) and provision of informed consent. The exclusion criteria included: (a) non-English speaking; (b) sensory or motor impairments that would preclude valid cognitive testing; (c) and individuals whose ABI is caused by progressive neurologic diseases.

Table 1 presents participant demographics (n = 94) and clinical characteristics. The majority of participants were men (56%), had a stroke (78%), and African American (52%). Forty-two percent of the participants identified as Caucasian. In terms of educational background, most participants completed at least 1 year of post-secondary education (54%), whereas 27% earned a high school diploma. Median time since onset of ABI was 5.5 months (M = 21.6, SD = 38.4 months). For 61% of the sample this was the first course of OT, whereas 13% of the sample had completed one course of OT prior to this study, and the remaining participants (26%) had completed more than one course of OT. Average length of treatment was 19.9 days (SD = 8.3 days).

Measures

Demographic characteristics. The demographic characteristics included in this study were: age, sex, years of education, type of ABI (TBI, stroke, etc.), and time since injury.

Predictors. The *Neuropsychological Battery* included Test of Premorbid Functioning, Repeatable Battery for Assessment of Neurological Symptoms-Form A, Trail Making Test-Part

A and B, Controlled Oral Word Association (FAS), Stroop Color and Word (Golden version), and Boston Diagnostic Aphasia Examination Complex Ideational Material. Battery described below in order of administration.

The Test of Premorbid Functioning (TOPF; The Psychological Corporation, 2009) was included as both a screen to ensure that participants have requisite reading ability to complete the self-report surveys validly, and also as an estimate of premorbid intellectual functioning. Recognition reading vocabulary is relatively robust to neurologic impairment and has been shown to be an excellent estimate of Full Scale IQ (Johnstone, Hexum, & Ashkanazi, 1995; Green, Melo, Christensen, Ngo, Monette, & Bradbury, 2008). Examinees are presented with 70 words to pronounce aloud.

The Repeatable Battery for Assessment of Neurological Symptoms-Form A (RBANS; Randolph, Tierney, Mohr, & Chase, 1998) is a neuropsychological screening battery that taps the following cognitive domains: Immediate Memory, Visuospatial Constructional, Language, Attention, and Delayed Memory. Immediate Memory abilities are assessed with a List Learning and Story Memory task. Visuospatial/ Constructional abilities are measured using a Figure Copy task and Line Orientation task. Language abilities are determined based upon a Picture Naming task and Semantic Fluency task. Attention is assessed using a test of ability to recall a span of digits (Digit Span) and ability to quickly decode lexical symbols and record the correct number associated with each lexical symbol (Coding). Delayed Memory is comprised of performances on List Recall, List Recognition, Story Memory, and Figure Recall. The RBANS also yields a total score representative of neuropsychological status.

The Trail Making Test (Reitan &Wolfson 1985) provides a measure of psychomotor processing speed (Part A) and executive functioning (Part B). Part A requires examinee to

connect numbers randomly positioned on a page in numerical order as quickly as possible. Part B has both number and letter randomly positioned on a page, and the examinee is instructed to connect them shifting between numerical and alphabetical symbols in ascending order (e.g., 1 to A, A to 2, 2 to B, etc.). The set shifting and executive control to inhibit prepotent responses of either numerical or alphabetical order is demonstrative of executive functioning.

The Word Generation Task (FAS; Heaton, Miller, Taylor, & Grant, 2004) was used to examine language functioning and, more importantly, executive functioning. This test requires examinees to verbally generate as many words as they can in 1 minute constrained by the starting letter of the words: F, A, and S. This task demonstrates how well the examinee organizes their thoughts and plans responses (Lezak, 2004).

The Stroop Color and Word Test (Golden, 1978) was used to assess processing speed and executive functioning. The Stroop has three 45-second trials: 1) Word reading-read aloud words of color names, 2) Color naming-name the color of the ink aloud without distraction of words, and 3) Color-Word-name the color of the ink while ignoring the words printed with the ink. The Word reading and Color reading trials measure processing speed. The Color-Word trial measures executive functioning due to the need to inhibit reading the words while naming the ink.

The Boston Diagnostic Aphasia Examination (BDAE) Complex Ideational Material subtest (Kaplan, Goodglass, & Weintraub, 1983) assesses language comprehension. The task requires examinees to use gestures to agree or disagree with factual questions that increase in complexity and difficulty.

The *Positive Affectivity and Negative Affectivity Schedule* (PANAS; Watson, Clark, & Tellegen, 1988) is a 20-item self-report scale assessing the rater's experience of 10 positive affective states and 10 negative affective states using a 5-point Likert-type scale. Participants

selected ratings from 1 (very slightly) to 5 (extremely). The PANAS provides two scores, positive affectivity (α = .89) and negative affectivity (α = .88), that are considered to be independent of one another.

The Brief Symptom Inventory-18 (BSI-18; Derogatis, 2001) is an 18-item self-report scale that assesses psychiatric symptoms. The scale is an abbreviated version of the Symptom Checklist-90 (Derogatis, 1977). Respondents rate their level of distress over the past 7 days using a 5-point Likert-type scale, with response alternatives ranging from 0 (*Not at All*) to 4 (*Extremely*). The BSI-18 provides three scales that assess Somatization, Depression, and Anxiety. The Global Severity Index (GSI) is a composite score that reflects overall level of distress. The BSI-18 has shown excellent reliability and validity in medical and community samples (Derogatis, 2001), including adults with TBI (Meachen et al., 2008). Internal consistency reliabilities (coefficient alpha) of the BSI-18 as used in the present sample were α = .91 (GSI), α = .75 (Somatization), α = .88 (Depression), and α = .85 (Anxiety).

The *Pain Anxiety Symptoms Scale-20* (PASS-20; McCracken & Dhinga, 2002) is a 20-item self-report measure assessing fear and anxiety related to pain. In addition to a total score, it provides four subscale scores including: Cognitive Anxiety, Fear of Pain, Escape/Avoidance behaviors, and Physiological Anxiety. The total score ranges from 0 (none) to 100 (high pain anxiety). Internal consistency reliabilities (coefficient alpha) of the PASS-20 as used in the present sample were α = .96 (Total), α = .88 (Physiological), α = .93 (Cognitive Anxiety), α = .91 (Fear of Pain), and α = .83 (Avoidance).

The *Apathy Evaluation Scale* (AES; Marin, Biedrzycki, & Firinciogullari, 1991) is an 18-item measure of apathy. There are three versions: self, informant, and clinician rated. The total score ranges from 18-72 with higher scores representing more apathy. In this study, the AES

clinician-rated version was administered using an interview format. The clinician version provides the best predictive validity of the three versions for time involved with activity and difficulty level of activity (Marin et al., 1991). The AES-clinician version also has demonstrated good ability to discriminate between depression and apathy. The clinician-rated scale was used in the present study because apathy observed following brain damage is frequently associated with impaired self-awareness or insight. Thus, the AES self-rated version may not yield the most accurate picture of the participant's level of apathy. The internal consistency reliability of the AES-Clinician as used in the present sample was $\alpha = .89$.

The *Modified Cumulative Illness Rating Scale* (MCIRS) is a 14-item survey that assesses health status across 14 domains: cardiac, hypertension, vascular, respiratory, EENT (eyes, ears, nose, and throat), upper gastrointestinal, lower gastrointestinal, hepatic, renal, other gastrourinary, musculo-skeletal-integumentary, neurological, endocrine-metabolic, and psychiatric/behavioral. Researchers completed the MCIRS based upon interview and known medical history.

Outcome measures. Therapy engagement was assessed using the *Rehabilitation Therapy Engagement Scale* (RTES; Lequerica et al., 2006). This is a 15-item *therapist-rated* scale to assess engagement in occupational therapy. Each item assesses an aspect of engagement and is rated on a 4-point Likert-type scale. Low scores reflect maladaptive expression of the characteristic being rated, whereas high scores reflect adaptive expressions of the characteristic being rated. The total score ranges from 0 (low engagement) to 45 (high engagement). The scale has showed excellent reliability and validity when used with adults with acquired brain injury (Lequerica et al., 2006; Lequerica, Rapport, Loeher, Axelrod, & Vangel Jr., 2007). The internal consistency reliability of the RTES as used in the present sample was $\alpha = .97$.

Basic activities of daily living (ADL) were assessed using the *Barthel Index* (Mahoney & Barthel 1965), a 10-item *clinician-rated* inventory that covers feeding, bathing, grooming, dressing, bowel control, bladder control, toilet use, bed transfers, mobility, and stairs. The total score ranges from 0 (dependent) to 100 (independent). Internal consistency reliability of the Barthel in the present study was $\alpha = .90$.

The *Lawton Instrumental Activities of Daily Living Scale* (Lawton & Brody, 1969) was also completed to capture complex ADL abilities. It is an 8-item *clinician-rated* inventory regarding the patient's highest level of functioning across eight domains: Ability to Use Telephone, Shopping, Food Preparation, Housekeeping, Laundry, Mode of Transportation, Responsibility for Own Medications, Ability to Handle Finances. The scale items assess level of independence for each item using trichotomous classification: dependent, needs assistance, and independent. Standard scoring for the Lawton collapses items into dichotomous (dependent vs. independent) scoring; thus, the total score ranges from 0 (low function) to 8 (high function). The present study used the full range of trichotomous item scores in analyses to capture the range of independence exhibited (i.e., represent individuals who can complete some tasks with assistance) and maximize the psychometric sensitivity of the scale. In support of this decision is the observation that internal consistency reliability for the trichotomous-scored Lawton (Time 1 = .92 and Time 2 = .94) exceeded that observed for the standard scoring (Time 1 = .86, Time 2 = .86).

Design and Procedures

This study received approval from Wayne State University Institutional Review Board and adhered to their guidelines regarding human investigation research. Participants were recruited and enrolled in the study at the beginning of occupational therapy. The initial intake

including collection of demographic information, completion of surveys, and neuropsychological assessment occurred within 1 week of enrollment in this study. The treating occupational therapists completed the Barthel Index and Lawton IADL as part of their initial treatment intake assessment and completed the Rehabilitation Therapy Engagement Scale at the end of the sixth therapy session along with a follow-up Barthel Index and Lawton IADL.

CHAPTER 3

STATISTICAL ANALYSES

Prior to analysis, the data were screened for violations of the assumptions associated with the parametric model using procedures as recommended by Tabachnick and Fidell (2006). One case identified was as an outlier on multiple variables and as an outlier on a multivariate test ($p <$ .001 criterion) and was deleted from the analyses. Three participants completed neuropsychological testing but did not complete OT treatment beyond baseline assessment. Therefore, a total of 4 participants were excluded from the analyses.

Neuropsychological test scores were converted to a uniform metric (z scores), unadjusted for demographic characteristics, to facilitate meaningful comparison across tests and to combine the indices into a neuropsychological composite score. The composite z score was used as an index of global neurocognitive function when the ratio of variables to cases in a multivariate model could not support the seven individual neuropsychological indices. Predictive validity models were examined using hierarchical multiple regressions for outcomes expressed with continuous data (i.e., Barthel Index and Lawton IADL Scale).

Mediation hypothesis was tested using the statistical method recommended by Baron and Kenny (1986). A *mediator* refers to the variable through which the relationship between two different and unique variables are related. In this study, the hypothesized mediator was therapy engagement. Evidence to support this hypothesis would show significant relationships (a) between neuropsychological testing and therapy engagement, (b) between therapy engagement and functional outcome, and (c) between neuropsychological testing and functional outcome, conducted in using regressions. A final regression analysis with neuropsychological testing and therapy engagement predicting functional outcome should show a null or reduced (partial

mediation) relationship between neuropsychological testing and functional outcome in therapy. The theoretical reason for the null or reduced relationship in the final regression analysis would be that therapy engagement mediates the relationship between neuropsychological testing and functional outcome in therapy; thereby, the correlation from neuropsychological testing to functional outcomes in therapy would be linked by way of therapy engagement. The squared semi-partial correlations were used to indicate the amount of unique variance attributable to each variable in the model. Two sets of regressions were conducted to assess for mediation: a basic model with only education as an additional predictor, and an enhanced model with comorbid health conditions, emotional distress, and clinician-rated apathy.

CHAPTER 4

RESULTS

Table 2 presents descriptive statistics for the neuropsychological test data, outcomes, and therapy engagement. The neuropsychological composite score represents the average *z* score across the participants' neuropsychological performance. As shown in Table 2, average cognitive functioning for the sample ranged from mild impairment (language composite, 11th percentile) to moderately-severe impairment (Processing Speed, < 1st percentile; Attention, 2nd percentile).

As shown in Table 2, on average, participants made functional gains during treatment time. At baseline, 47.9% of the sample were unable or dependent (lowest score) on least one domain of the Barthel. At follow-up, 37.2% had one or more Barthel items rated as unable or dependent. Repeated-measures ANOVA indicated that change on the Barthel from baseline to follow-up was significant, showing medium effect, $F(1, 93) = 24.28$, $p < .001$, $\eta_p^2 = .21$ (medium effect; Cohen, 1988). The significant gain is especially noteworthy because 26.6% ($n = 25$) of the sample initially scored at the maximum on the Barthel therefore limiting the number of participants who could show gain on the Barthel. At follow-up, 35.1% ($n = 33$) scored the maximum on the Barthel. Similarly for the Lawton, a repeated-measures ANOVA indicated significant change from baseline to follow-up, $F(1, 93) = 25.55$, $p < .001$, $\eta_p^2 = .22$ (medium effect; Cohen, 1988). At baseline, 81.9% ($n = 77$) of participants had one or more Lawton domain rated as unable or dependent (i.e., item score = 0), with 18.1% ($n = 17$) scoring at maximum. At follow up, 80.9% ($n = 76$) had one or more domains rated as unable or dependent, whereas 19.1% ($n = 18$) obtained the maximum Lawton score.

Table 3 presents the correlations for cognitive, psychosocial, and demographic characteristics with the two functional outcomes (Barthel and Lawton) and therapy engagement.

Age was not correlated with any of the outcome measures. Education showed small (Barthel T1 and T2, Lawton T2, r = .20) to modest (Lawton T1 r = .31) correlations with the functional outcomes, and no relationship to therapy engagement. Of note, baseline and follow-up outcome measures were very highly correlated (i.e., Barthel, r = .90; Lawton, r = .84). Therefore, outcome measures taken at follow up (T2) were used as the dependent variables.

Correlations from Table 4 show that the Neuropsychological Composite ranked as the highest correlate of all predictors with the outcome measures and engagement, except for Barthel at Time 2, in which case it ranked second behind Processing Speed composite. The Language composite generally showed the weakest correlations with the outcomes and therapy engagement. Among the psychosocial measures, Apathy Evaluation Scale–Clinician-rated version (AES-C) showed the strongest correlations with the outcomes and therapy engagement, which were modest (r -.31 to -.39). Brief Symptom Inventory – 18 (BSI), Somatization scale had the next highest correlation with therapy engagement although small. Also, BSI – Somatization showed small (Lawton T1 and T2) to modest (Barthel T1 and T2) correlations with the functional outcomes (r -.22 to -.33). The other psychosocial predictors did not show significant correlations with therapy engagement (rs < -.17). Pain Anxiety Symptom Scale (PASS) Total score was not significantly related to functional outcomes; however, PASS Fearful Thinking and Physiological Response content scales had small, significant relationships with Barthel Index (r -.19 to -.23). The Positive and Negative Affective Schedule (PANAS) Positive Affectivity only showed small correlation with Lawton T1 and T2. The PANAS Negative Affectivity showed small correlations with all functional outcomes. The BSI-Global Severity Index (GSI) showed small (Barthel T1 and Lawton T1) to modest (Barthel T2 and Lawton T2) correlations with the functional outcomes.

Of special note, the PANAS-NA, BSI Anxiety, BSI Depression, and BSI-GSI scales were all strongly intercorrelated (r = .70 to r = .91). The BSI-GSI showed the strongest relationship with the functional outcomes, and thus selected as the representative for emotional distress in subsequent analyses. The Modified Cumulative Illness Rating Scale (MCIRS) had modest correlations with the Barthel T1 and T2; however, there was not a significant relationship with engagement, Lawton T1 or T2.

Prerequisite Criteria for Mediation

As can be seen in Table 3, the three prerequisite criteria for mediation were met for both the Barthel and Lawton as functional outcomes. Significant relationships ($p < .001$) were observed (a) between neuropsychological performance and therapy engagement (r = .40); (b) between therapy engagement and functional outcome (Barthel r = .62; Lawton r = .58); and (c) between neuropsychological performance and functional outcome (Barthel r = .40; Lawton r = .36). Neuropsychological performance accounted for 16% of the variance in therapy engagement, $F(1, 92) = 17.21$, $p < .001$, $R^2 = .16$.

Basic Activities of Daily Living Mediation

Hierarchical multiple regressions were conducted to assess for mediation by therapy engagement in the relationship between neuropsychological performance and the Barthel Index at follow-up. Table 5 presents the results of the multiple regression assessing the mediated predictive relationship of neuropsychological performance to Barthel Index. On Step 1, with self-reported years of formal education, $F(1, 92) = 3.96$, $p < .05$, $R^2 = .04$. Addition of the neuropsychological composite on Step 2 increased R^2 by 13%, which improved the model, $F_{change}(1, 91) = 14.43$, $p < .001$. On Step 3, therapy engagement added to the model significantly, increasing R^2 by 26%, $F_{change}(1, 90) = 40.24$, $p < .001$. Importantly, when engagement was added

to the model on Step 3, neuropsychological composite was no longer a significant predictor (p = .090), and in the presence of therapy engagement, it accounted for only 2% unique variance. Thus, the criteria were met for full mediation. The total model accounted for 43% of variance in the Barthel index at follow-up, $F(3, 90) = 22.46$, $p < .001$.

Enhanced Models. Table 6 presents the results of the multiple regression assessing the mediated predictive relationship of neuropsychological performance to Barthel Index with the addition of comorbid health conditions, emotional distress, and apathy included in the model. On Step 1, with self-reported years of formal education and comorbid health conditions $F(2, 82) = 5.49$, $p < .01$, $R^2 = .12$. Addition of emotional distress and apathy on Step 2 increased R^2 by 8%, which improved the model, $F_{change}(2, 80) = 4.22$, $p < .05$. Addition of neuropsychological performance on Step 3 increased R^2 by 7%, which improved the model, $F_{change}(1, 79) = 8.12$, $p < .01$. Addition of therapy engagement on Step 4 increased R^2 by 23%, which improved the model, $F_{change}(1, 78) = 35.15$, $p < .001$. When engagement was added to the model on Step 4, neuropsychological composite was no longer a significant predictor (p = .110) and the sr^2 for the variable dropped to 2% unique variance. Therefore, this enhanced model also met all criteria for full mediation. The total model accounted for 50% of variance in the Barthel index, $F(6, 78) = 13.07$, $p < .001$.

Instrumental Activities of Daily Living Mediation

Hierarchical multiple regressions were conducted to assess for mediation by therapy engagement in the relationship between neuropsychological performance and the Lawton IADL Scale at follow-up. Table 7 presents the results of the multiple regression assessing the mediated predictive relationship of neuropsychological performance to Lawton IADL Scale. On Step 1, with self-reported years of formal education $F(1, 92) = 4.12$, $p < .05$, $R^2 = .04$. Addition of the

neuropsychological performance on Step 2 increased R^2 by 10%, which improved the model, $F_{change}(1, 91) = 11.00$, $p < .001$. On Step 3, therapy engagement added to the model significantly, increasing R^2 by 23%, which improved the model, $F_{change}(1, 91) = 32.27$, $p < .001$. The results assessing the mediated predictive relationship of neuropsychological performance to Lawton IADL Scale were consistent with mediation by therapy engagement: Neuropsychological performance was no longer significant in the model ($p = .188$) and accounted for only 1% unique variance in the presence of therapy engagement. The total model accounted for 37% of variance in the Lawton IADL Scale, $F(3, 90) = 17.73$, $p < .001$.

Enhanced Models. Table 8 presents the results of the multiple regression assessing the mediated predictive relationship of neuropsychological performance to Lawton IADL Scale with the addition of comorbid health conditions, emotional distress, and apathy included in the model. On Step 1, with self-reported years of formal education and comorbid health conditions $F(2, 82) = 2.19$, $p = .118$. Addition of emotional distress and apathy on Step 2 increased R^2 by 9%, which improved the model, $F_{change}(2, 80) = 4.36$, $p < .05$. Apathy was the only significant predictor accounting for 5% of the variance. Addition of neuropsychological performance on Step 3 increased R^2 by 6%, which improved the model, $F_{change}(1, 79) = 5.68$, $p < .05$. On Step 4, addition of therapy engagement increased R^2 by 20%, which improved the model, $F_{change}(1, 78) = 26.01$, $p < .001$. Addition of therapy engagement caused neuropsychological performance on Step 4 to decrease in unique variance to 1%, and become no longer significant in the model ($p = .235$). This model also met the conditions for full mediation. The total model accounted for 40% of variance in the Lawton IADL Scale, $F(6, 78) = 8.71$, $p < .001$.

Nature of Therapy Engagement

Given that engagement is a unique predictor of outcome, the nature of engagement is of

interest. As seen in Table 4, it shows modest relationship to neuropsychological performance broadly across cognitive domains. The strongest relationship (r = .40) was observed with the neuropsychological performance composite. Although the global composite was the best predictor, among the individual domains, Executive Functioning (r = .36), Delayed Memory (r = .36), and Processing Speed (r = .35) showed stronger relationships with therapy engagement (RTES) than did Immediate Memory (r = .21) or Visuospatial (r = .18). Attention (r = .30) and Language (r = .29) also had modest relationships with therapy engagement.

Fischer's r-to-z transformations testing differences between dependent correlations indicate that the correlation of the Executive Function composite to therapy engagement is significantly stronger than the correlation for therapy engagement and Immediate Memory composite (Hotelling William t[91] = 1.67, p = .049), with a similar, strong trend noted for Visuospatial composite (Hotelling William t[91] = 1.67, p = .0506). Similarly, the Delayed Memory composite showed significantly stronger correlation to therapy engagement than Immediate Memory (t[91] = 2.19, p = .016), with a notable trend for Visuospatial (t[91] = 1.48, p = .071). Processing speed showed substantial overlap with Executive Function (r = .78) and therefore it showed a similar pattern; however, the comparisons for correlations of RTES with Processing Speed versus Immediate Memory (p = .067) and Visuospatial (p = .059) were not significant.

Therapy engagement was not significantly related to race (r = -.04), age (r = .05), current comorbid health status (r = -.06), sex (r = -.11), education (r = .08), or estimated premorbid IQ (r = .15). Race was binary between White and Black participants (n = 88) for this correlation. The absence of significant correlations with participant demographics and comorbid health status shows that therapy engagement is independent of these characteristics. Therapy engagement was

also independent of trait affectivity, although relationships with positive and negative affectivity were in the expected directions. In addition, there was a small yet significant relationship with self-reported somatic complaints (BSI-18 Somatization) and therapy engagement, although health comorbidities (MCIRS) were not correlated. Most importantly, therapy engagement showed a modest inverse relationship with clinician-rated apathy (AES-C), which supports a conceptual link. However, the modest relationship between the two (r = -.35) indicates that therapy engagement is more complex than just the counterpart of apathy.

Table 9 shows a multiple regression of therapy engagement with constructs of theoretical interest: neuropsychological performance, apathy (AES-C), emotional distress (BSI-18 GSI), objective health status (MCIRS), education, age, positive and negative affectivity, and pain-related anxiety. This theoretical model accounted for 24% of variance in therapy engagement, $F(9, 75) = 2.56$, $p = .013$. Of note, neuropsychological functioning ($sr^2 = .05$) and apathy ($sr^2 = .05$) were the only significant predictors of therapy engagement.

CHAPTER 5

DISCUSSION

Engagement is a powerful factor in the context of rehabilitation therapy. This study demonstrates that patient engagement in therapy is a crucial characteristic in successful rehabilitation outcomes. In addition, the findings of this study support the hypothesis that cognitive deficits associated with ABI undermine full engagement in rehabilitation therapy, which in turn diminishes potential gains made in therapy as well as functional recovery. Even with consideration of demographic characteristics, psychosocial qualities, and comorbid health status, therapy engagement explained unique information about the relationship between neuropsychological performance and functional outcomes. This finding is novel and contributes to the growing body of literature regarding engagement in rehabilitation therapies post ABI. Notably, this study extends previous research by examining the role of engagement in rehabilitation therapies among persons who had cognitive impairments, a unique factor that other researchers have not addressed. Despite cognitive impairments, patients were able to engage in treatment as ultimately related to their functional outcomes. Uniquely, the study findings indicate that cognition is related to, and predictive of, patient engagement in rehabilitation therapies. This is no small matter when considering the complex recovery for those with brain injuries. Of note, a global composite representing neuropsychological functioning was most useful in explicating the influence of cognition on functional outcomes and therapy engagement, as compared to specific domains of cognitive function.

Overall, these findings are consistent with previous research, supporting the crucial role of patient engagement in rehabilitation therapies for maximum functional recovery (Kortte et al., 2007; Lenze et al., 2004a, 2004b; Lequerica et al., 2006; Skidmore et al., 2010). The findings of

this study regarding basic activities of daily living were as hypothesized. Neuropsychological functioning and patient engagement were strong predictors of basic ADL functioning at follow-up. Yet, the findings support the hypothesis that therapy engagement mediates the relationship between cognitive impairment and functional outcomes for basic ADLs. Possible mechanisms for the mediating relationship are that impairments in executive functioning and processing speed limit engagement by disrupting the capacity to integrate information presented during therapy, which in turn undermines maximum functional recovery. Deficits in executive functioning (i.e., cognitive flexibility and control) may be related to patients' acquisition and use of adaptive skills from therapy. Impairment in processing speed could leave some patients overwhelmed and also disrupt learning process in rehabilitation. Delayed memory also demonstrated a modest relationship with therapy engagement, which may be related to patients completing homework assignments and maintaining exercises between sessions.

Previous research demonstrated similar findings that therapy engagement is an important patient characteristic that influences realized benefits from therapy. Skidmore et al. (2010) examined emotional and cognitive factors related to engagement and found a significant influence on participation, which is consistent with the findings of this study. However, Skidmore et al. (2010) reported that apathy (assessed with the AES, the same scale employed in this current study) was not related to participation. In the present study, apathy and emotional distress were key emotional factors that adversely influenced patient engagement in rehabilitation therapy. The difference in the role of apathy in engagement between the two studies may reflect several issues. First, the relatively modest sample size in Skidmore and colleagues limited statistical power; in fact, their findings indicated a meaningful association between apathy and engagement (r = -.27), which compares well with the observation of medium

effect in the present study (r = -.35). Furthermore, the observation of a stronger association between apathy and engagement in this study as compared Skidmore et al. could be attributed to differences in the sensitivities of the engagement scales: the 15-item RTES versus one-item PRPS. The restricted range of a one-item measure probably attenuated the observed relationship to apathy. Additionally, the selected sample from a larger pharmacological intervention study used for secondary analyses by Skidmore and colleagues (2010) may have restricted range on engagement. Thus, although Skidmore and colleagues did not report a relationship between apathy and engagement, the findings are generally consistent with those of this study, which support a meaningful association of those characteristics.

There were similar findings in support of the hypothesis regarding instrumental ADLs (iADL) at follow-up in this study. Therapy engagement remained a critical component in the rehabilitation process for ABI, even when considering subjective emotional distress and clinician-rated apathy. Furthermore, evidence was consistent with the role of engagement mediating the predictive relationship of neuropsychological functioning to iADLs. These findings further highlight the importance of patient involvement in their recovery process as not only helpful but necessary. Also, patient engagement is not a binary phenomenon (engaged or not); instead, it likely has multiple aspects (i.e., homework completion, attendance, and task persistence) with gradients (e.g., absent, low, moderate, and high) of each aspect. As iADLs are more complex than basic ADLs and cover activities that are required for individuals to live independently without supervision, this study provides evidence that patient engagement can limit ability for people to regain full independence in living post brain injury due to diminished engagement, even in an outpatient setting. Previous research has examined patient engagement in inpatient rehabilitation therapies, which also demonstrates that engagement is valuable (Kortte et

al., 2007; Lenze et al., 2004a, 2004b; Lequerica et al., 2006; Skidmore et al., 2010). The inpatient setting is likely to be associated with a faster rate and wider range of functional recovery than the outpatient setting. It is powerful and quite inspiring to see that patient engagement remains a strong predictor of functional outcomes in the outpatient setting.

Therapy Engagement appears to be a unique characteristic that functions independent of trait affectivity, current emotional distress, and premorbid demographic characteristics. This study demonstrated that it could reliably be assessed in patients with ABI using the RTES, which is a relatively brief measure of engagement. The RTES is a detailed assessment tool that could facilitate clinicians identifying and targeting weak aspects of patients' engagement in their therapies. Single-item measures of engagement do not allow for clinicians to collect useful information regarding individuals' specific weaknesses and strengths with therapy engagement. This rationale is based on understanding that therapy engagement is complex, including consideration of aspects such as perceived effort exerted in therapy, enthusiasm, initiation, and openness to learning.

The pattern of constructs that were and were not related to engagement help to elucidate the nature of this unique patient-related attribute. Age and education has shown consistent relationships with TBI outcomes (Hukkelhoven et al., 2003; Kesler et al., 2003; Luerssen, Klauber, & Marshall, 1988; Mosenthal et al., 2002). Neither age nor education were associated with level of engagement, however. Other demographic factors, such as gender and race also did not influence patient engagement. These findings are especially heartening, because they indicate that patient engagement is not limited by demographic characteristics.

Engagement was associated with emotional characteristics of the patient. Consistent with theory about the nature of engagement (Bach & David, 2006; Bright et al., 2015; Clarke, Ko,

Kuhl, van Reekum, Salvador, & Marin, 2011; Lane-Brown & Tate, 2011; Lequerica & Kortte, 2010), it showed meaningful association with apathy, and those two characteristics showed similar pattern of associations to neuropsychological functioning and rehabilitation outcomes. However, apathy only had a modest inverse relationship with therapy engagement. One might easily expect that apathy and engagement would be complete opposites and exhibit a strong inverse relationship. However, the modest association between these constructs indicates that therapy engagement is more than the absence of apathy in a patient. Given prior knowledge that apathy can be a neurobiological consequence of brain injury, this observation provides additional support that aspects of engagement are resilient to brain injury.

Consideration of patient-rated emotional factors adds to understanding patient engagement. Among these adults with ABI, there was no relationship between therapy engagement and trait affectivity (positive or negative), despite modest association of trait affectivity to neuropsychological function and strong association of trait affectivity with apathy. Consistent with a large literature on the adverse effects of negative affectivity on physical and mental health, as well as recovery from illness (Krantz & McCerney, 2002; Smith & MacKenzie, 2006; Votruba, Rapport, Whitman, Johnson, & Langenecker, 2013), the present study found that negative affectivity predicts worse functional outcomes. Therapy engagement was found to be independent of patients' symptoms of anxiety and depression. However, patients' symptoms of depression were related to functional outcomes. Although research has shown that it is important to assess depressive symptoms, because it negatively influences successful recovery (Hackett, Yapa, Parag, & Anderson, 2005; Matsuzaki et al., 2015), therapy engagement must also be assessed independently. The findings of this study demonstrate that apathy and depression are related, but inadequate proxies for patient engagement in rehabilitation. Rehabilitation therapists

should remain acutely aware of patients' level of engagement and monitor it throughout treatment. Psychologists in rehabilitation and medical settings can assist with screening and intervention for emotional and cognitive characteristics likely to hamper successful rehabilitation.

Although patient emotional characteristics appeared largely independent of therapy engagement, cognitive characteristics were not independent of engagement. Patient neuropsychological functioning across cognitive domains had small to modest relationships with therapy engagement, and global neuropsychological functioning had the strongest association. This relationship between cognitive functioning and therapy engagement may be based upon a cognitive-behavioral aspect of engagement, such as learning and initiation. A model with all cognitive domains as related to engagement was not tenable due to high intercorrelation among domains. However, examination of individual domains demonstrated that executive functioning and delayed memory had the strongest relationships with therapy engagement, as compared to the other domains. Executive functioning can likely be linked to behavioral initiation and cognitive flexibility and control (Lezak et al., 2004). Therapy engagement may be most sensitive to these cognitive faculties. The findings of this study suggest that interventions for therapy engagement should include assessment of cognitive functioning and attend to cognitive deficits in developing resultant strategies, because emotional support will likely miss these significant barriers presented by impairments in patients' cognition.

Limitations

This study would have benefited from a larger sample size. The sample was well representative in terms of range of age and education, as well as racial diversity; however, a larger sample would have made possible analyses by distinct injury type (i.e., stroke versus

traumatic brain injury). Examining the influence of therapy engagement by injury type would allow for nuanced assessment given hallmark injury sequelae. Although a larger sample would also have afforded nuanced models with additional characteristics without overfitting, the problem of collinearity among the predictors would likely have precluded this benefit. In general, the RTES measure of engagement performed well; however, with large samples of the scale, detailed measurement analyses should be conducted to critique item fit/ordering, dimensionality, etc.

An important limitation is the brief period from baseline assessment to follow-up. Ideally, participants would be followed for a longer period than an average of 20 days treatment time, which would likely yield greater improvement from baseline and a larger range of functioning. Following patients through their full treatment regimen would have allowed for a complete picture of their outpatient rehabilitation progress and for analyses to account for baseline disability in predictive models. However, it is quite remarkable that the rehabilitation therapists were able to facilitate functional improvements in the context of this brief time period and ceiling effects on the functional outcome measures.

The mild to moderate ceiling effects observed in the functional outcome measures also was an important issue. Ceiling effects observed in the functional outcome measures likely further attenuated the observed relationships. Given that there was no room to increase scores for some participants on the functional measures, there was less potential variance to account for in the predictive models. Thus, with use of functional measures that capture subtler differences in higher-level functioning, stronger relationships than those observed in this study could be found. The outcome measures employed in this study are among the most widely used, and the individuals who participated were deemed appropriate for rehabilitation and noted to have

deficits by healthcare professionals and insurance companies. The limited sensitivity of these outcome measures to characterize deficits among these outpatients limited the range of potential gains from baseline to follow-up assessment. Therefore, using measures that are more sensitive to patient deficits and limitations would facilitate assessing change among higher-functioning patients. For example, rather than gross measurements indicating only dependence versus independence on tasks, it might be fruitful to have standard measures that would assess fine-grained improvements in common rehabilitation therapy interventions, such as increasing range of motion, strength/endurance training, and instruction and practice in modification of vocational or avocational activities.

Future directions

It is remarkable that psychological traits and other psychosocial characteristics showed such little relationship to engagement, although they predict outcomes. Thus, additional research would be useful to help elucidate the construct of engagement, which appears partly robust to brain injury, demographics, and psychological characteristics. Size and location of brain lesion may be an important consideration in this context. Some prior research suggests that hemispheric differences in lesion location that could be important and interesting to consider in this context. For example, damage to the left anterior frontal lobe is commonly associated with depression during acute recovery from stroke, whereas damage to the right hemisphere is associated with anosognosia (Bhogal Teasell, Foley, & Speechley, 2004; Orfei et al., 2007). Consideration of potential associations between lesion location and engagement might be a fruitful area to enhance effectiveness of rehabilitation therapies and rehabilitation outcomes.Subsequent to this developed understanding of engagement, a more in-depth study of engagement, subsequent research could look to methods for enhancing engagement.

In addition, future research should continue to assess and explore the concept of patient engagement in both inpatient and outpatient settings. Tracking patient engagement from the start at inpatient rehabilitation and following patients' level of engagement through outpatient rehabilitation therapies may help identify critical periods where therapy engagement can disproportionately influence rehabilitation outcomes. Having evidence to suggest a critical period would provide guidance for timing future intervention strategies with those patients who exhibit inadequate engagement in rehabilitation. As Lenze and colleagues (2012) demonstrated, benefit from "Enhanced Medical Rehabilitation" (EMR), an intervention tactic employed by occupational and physical therapists with older adults undergoing inpatient post-acute rehabilitation, coupling this tactic with appropriate timing would conserve and maximize resources. However, research showing a benefit of EMR and similar evidenced-based interventions among patients with cognitive impairments is required, given that Lenze and colleagues (2012) excluded many patients with cognitive impairment.

Conclusions

The significance of this study is in the demonstration that therapy engagement is an important pathway by which neuropsychological impairment predicts functional outcomes after ABI. Patient engagement, a unique and crucial patient characteristic resilient to brain injury and independent of trait personality and symptoms of depression and anxiety, should be routinely assessed in rehabilitation, as diminished patient engagement can have a costly impact on the rehabilitation process and time lost from reduced personal productivity and community involvement. In addition, neuropsychological assessment can enhance rehabilitation outcomes by identifying cognitive characteristics that underlie therapy engagement, which can ultimately be used to maximize effectiveness of individualized treatment plans to mitigate diminished therapy

engagement. This study highlights the need for interdisciplinary team care of patients in a rehabilitation setting.

APPENDIX A: TABLES 1 – 9

Table 1. *Demographic Statistics for Participants with Acquired Brain Injury (N = 94).*

Variable	*Percent*	*M*	*(SD)*	*Range*
Age (years)		52.7	(15.0)	18 – 82
Sex				
Men	56.4			
Women	43.6			
Race				
Caucasian	41.5			
African American	52.1			
Hispanic	1.1			
Asian	1.1			
Other	4.3			
Education (years)		13.1	(3.0)	4 – 20
< High School	19.1			
High School	26.6			
Some College +	54.3			
Vocational status (prior to injury)				
Employed	51.1			
Retired	24.5			
Unemployed	24.5			
Injury Type				
Traumatic Brain Injury	20.2			
Stroke	77.7			
Other	2.1			
Premorbid Intellectual Functioning		85.8	(15.2)	57 – 124

Table 2. *Descriptive Statistics for Neuropsychological Indices and Outcome Measures.*

Variable	*M*	*(SD)*	*Range*
Outcome Measures			
Barthel Index – Time 1	77.50	(22.88)	10 – 100
Barthel Index – Time 2	82.50	(21.39)	10 – 100
Lawton IADL Scale[1] – Time 1	7.90	(4.66)	0 – 16
Lawton IADL Scale[1] – Time 2	9.18	(4.46)	1 – 16
Neuropsychological Indices[2]			
Executive Functions Composite[3]	-1.86	(1.20)	-3.90 – 1.40
Processing Speed Composite[4]	-2.43	(1.14)	-4.00 – 0.80
Attention Composite[5]	-2.02	(0.70)	-3.00 – 0.33
Immediate Memory Composite[6]	-1.80	(0.85)	-3.00 – 0.00
Delayed Memory Composite[7]	-1.47	(0.77)	-2.53 – 0.42
Language Composite[8]	-1.25	(1.00)	-3.12 – 0.67
Visuospatial Composite[9]	-1.59	(0.82)	-2.53 – 0.69
Neuropsychological Performance Composite[10]	-1.75	(0.73)	-3.07 – -0.18
Therapy Engagement			
Rehabilitation Therapy Engagement Scale (RTES)	37.27	(8.50)	12 – 45

1. Lawton Instrumental Activities of Daily Living Scale.
2. Neuropsychological indices are presented in standard scores (*z* score).
3. Trail Making Test Part B, Control Oral Word Association (FAS), and Stroop Color-Word.
4. Trail Making Test Part A, Stroop Color, and Stroop Word.
5. Repeatable Battery for Assessment of Neuropsychological Status (RBANS) – Digit Span and Coding.
6. RBANS – List Learning and Story Memory.
7. RBANS – List Recall, List Recognition, Story Recall, and Figure Recall.
8. RBANS – Picture Naming and Semantic Fluency, and Complex Ideation.
9. RBANS – Figure Copy and Line Orientation.
10. Average *z* score of the neuropsychological indices.

Table 3. *Descriptive Statistics for health comorbidity and psychosocial measures.*

Variable	*M*	*(SD)*	*Range*
Modified Cumulative Illness Rating Scale (MCIRS)	21.7	(5.7)	13 – 38
Apathy Evaluation Scale (AES-Clinician)	30.0	(9.0)	18 – 56
Positive and Negative Affect Schedule (PANAS)			
PANAS – Positive Affectivity	34.3	(8.7)	10 – 50
PANAS – Negative Affectivity	19.8	(8.0)	10 – 44
Pain Anxiety Symptoms Scale-20 (PASS)			
PASS – Avoidance	9.9	(7.0)	0 – 25
PASS – Fearful Thinking	6.2	(6.9)	0 – 24
PASS – Cognitive Anxiety	8.9	(7.6)	0 – 25
PASS – Physiological Response	6.0	(6.4)	0 – 24
PASS – Total	30.9	(25.4)	0 – 97
Brief Symptom Inventory-18 (BSI)			
BSI – Anxiety	3.8	(4.3)	0 – 22
BSI – Depression	4.3	(5.2)	0 – 23
BSI – Somatization	4.3	(4.3)	0 – 16
BSI – Global Severity Index	12.4	(11.8)	0 – 59

Table 4. *Descriptive Correlations: Cognitive, Psychosocial, and Demographic Characteristics with Functional Outcomes and Therapy Engagement.*

	Barthel Index T1	Barthel Index T2	Lawton IADL Scale[1] T1	Lawton IADL Scale[1] T2	Therapy Engagement
1. Barthel Index T1	--				
2. Barthel Index T2	.90**	--			
3. Lawton IADL Scale T1	.73**	.66**	--		
4. Lawton IADL Scale T2	.73**	.73**	.84**	--	
5. Therapy Engagement	.64**	.62**	.56**	.58**	--
6. Neuropsychological Composite[1]	.46**	.40**	.50**	.36**	.40**
7. Executive Functions Composite[2]	.44*	.40**	.47**	.35**	.36**
8. Processing Speed Composite[3]	.44**	.44**	.46**	.35**	.35**
9. Attention Composite[4]	.36**	.32**	.39**	.31**	.30**
10. Immediate Memory Composite[5]	.28**	.21*	.33**	.20*	.21*
11. Delayed Memory Composite[6]	.36**	.31**	.39**	.27**	.36**
12. Language Composite[7]	.20*	.13	.31**	.19*	.29**
13. Visuospatial Composite[8]	.35**	.25**	.28**	.23*	.19*
14. MCIRS	-.31**	-.32**	-.14	-.13	-.06
15. AES – Clinician	-.39**	-.34**	-.39**	-.31**	-.35**
16. PANAS – Positive Affectivity	.16	.16	.22*	.17*	.09
17. PANAS – Negative Affectivity	-.19*	-.22*	-.18*	-.22*	-.16
18. PASS – Avoidance	-.07	-.04	-.04	-.06	-.08

19. PASS – Fearful Thinking	-.22*	-.23*	-.14	-.15	-.16
20. PASS – Cognitive Anxiety	-.07	-.09	-.01	-.04	-.09
21. PASS – Physiological Response	-.21*	-.19*	-.12	-.14	-.17
22. PASS – Total	-.15	-.15	-.08	-.10	-.14
23. BSI – Anxiety	-.09	-.14	-.10	-.18*	.01
24. BSI – Depression	-.17	-.21*	-.15	-.26**	-.12
25. BSI – Somatization	-.29**	-.33**	-.22*	-.25**	-.19*
26. BSI – Global Severity Index	-.21*	-.27**	-.18*	-.27**	-.12
27. Education (years)	.20*	.20*	.31**	.21*	.08
28. Age	-.10	-.10	.03	.110	.05

Note. T1 = Time 1, Baseline; T2= Time 2, Follow up; Lawton IADL Scale = Lawton Instrumental Activities of Daily Living Scale; MCIRS = Modified Cumulative Illness Rating Scale; AES – Clinician = Apathy Evaluation Scale- Clinician rated version; PANAS = Positive And Negative Affective Schedule; PASS = Pain Anxiety Symptoms Scale; BSI = Brief Symptom Inventory- 18 Items.

*$p < .05$, **$p < .01$.

1. Average *z* score of the neuropsychological test battery.
2. Trail Making Test Part B, Control Oral Word Association (FAS), and Stroop Color-Word.
3. Trail Making Test Part A, Stroop Color, and Stroop Word.
4. Repeatable Battery for Assessment of Neuropsychological Status (RBANS)- Digit Span and Coding.
5. RBANS- List Learning and Story Memory.
6. RBANS- List Recall, List Recognition, Story Recall, and Figure Recall.
7. RBANS- Picture Naming and Semantic Fluency & Complex Ideation.
8. RBANS- Figure Copy and Line Orientation.

Table 5. *Hierarchical Multiple Regression: Barthel Mediation Model.*

Variables	sr^2	β	*df* Change	*F* Change	R^2 Change	*t*
Step 1			1, 92	3.96*	.04	
Education	.04	.20				1.99*
Step 2			1, 91	14.43***	.13	
Education	.01	.12				1.27
Neuropsychological Composite	.13	.37				3.80***
Step 3			1, 90	40.24***	.26	
Education	.02	.13				1.54
Neuropsychological Composite	.02	.15				1.71
RTES	.26	.55				6.34***

Note. Barthel = Barthel Activities of Daily Living Index; RTES = Rehabilitation Therapy Engagement Scale.

Total model, $F(3, 90) = 22.46$, $p < .001$, $R^2 = .43$.
*$p < .05$, **$p < .01$, ***$p < .001$.

Table 6. *Hierarchical Multiple Regression: Enhanced Barthel Mediation Model.*

Variables	sr^2	β	*df* Change	*F* Change	R^2 Change	*t*
Step 1			2, 82	5.49**	.12	
Education	.02	.14				1.30
MCIRS	.08	-.29				-2.67**
Step 2			2, 80	4.22*	.08	
Education	.00	.06				0.54
MCIRS	.04	-.23				-2.08*
BSI – GSI	.01	-.10				-0.84
AES – Clinician	.07	-.27				-2.59*
Step 3			1, 79	8.12**	.07	
Education	.00	.02				0.24
MCIRS	.05	-.24				-2.27*
BSI – GSI	.01	-.12				-1.07
AES – Clinician	.01	-.11				-0.99
Neuropsychological Composite	.07	.32				2.85**
Step 4			1, 78	35.15***	.23	
Education	.00	.05				0.58
MCIRS	.05	-.24				-2.67**
BSI – GSI	.01	-.08				-0.92
AES – Clinician	.00	-.01				-0.13
Neuropsychological Composite	.02	.53				1.62
RTES	.22	.16				5.93***

Note. Barthel = Barthel Activities of Daily Living Index; MCIRS = Modified Cumulative Illness Rating Scale; BSI = Brief Symptom Inventory- 18 Items; AES – Clinician = Apathy Evaluation Scale- Clinician rated version; RTES = Rehabilitation Therapy Engagement Scale.

Total model, $F(6, 78) = 13.07$, $p < .001$, $R^2 = .50$.
*$p < .05$, **$p < .01$, ***$p < .001$.

Table 7. *Hierarchical Multiple Regression: Lawton Mediation Model.*

Variables	sr^2	β	*df* Change	*F* Change	R^2 Change	*t*
Step 1			1, 92	4.12*	.04	
Education	.04	.21				2.03*
Step 2			1, 91	11.00**	.10	
Education	.02	.14				1.38
Neuropsychological Composite	.10	.33				3.32***
Step 3			1, 90	32.37***	.23	
Education	.02	.14				1.62
Neuropsychological Composite	.01	.12				1.33
RTES	.23	.52				5.68***

Note. Lawton = Lawton Instrumental Activities of Daily Living Scale; RTES = Rehabilitation Therapy Engagement Scale.

Total model, $F(3, 90) = 17.73$, $p < .001$, $R^2 = .37$.
*$p < .05$, **$p < .01$, ***$p < .001$.

Table 8. *Hierarchical Multiple Regression: Enhanced Lawton Mediation Model.*

Variables	sr^2	β	*df* Change	*F* Change	R^2 Change	*t*
Step 1			2, 82	2.19	.05	
Education	.03	.19				1.68
MCIRS	.01	-.09				-.83
Step 2			2, 80	4.36*	.09	
Education	.01	.10				0.92
MCIRS	.00	-.01				-0.05
BSI – GSI	.03	-.19				-1.60
AES – Clinician	.05	-.24				-2.16*
Step 3			1, 79	5.68*	.06	
Education	.00	.07				0.67
MCIRS	.00	-.02				-0.13
BSI – GSI	.03	-.20				-1.81
AES – Clinician	.01	-.10				-0.79
Neuropsychological composite	.06	.28				2.38*
Step 4			1, 78	26.01***	.20	
Education	.01	.10				1.02
MCIRS	.00	-.01				-0.12
BSI.GSI	.02	-.17				-1.76
AES – Clinician	.00	-.00				-0.01
Neuropsychological composite	.01	.13				1.20
RTES	.20	.50				5.10***

Note. Lawton = Lawton Instrumental Activities of Daily Living Scale; MCIRS = Modified Cumulative Illness Rating Scale; BSI = Brief Symptom Inventory- 18 Items; AES – Clinician = Apathy Evaluation Scale- Clinician rated version; RTES = Rehabilitation Therapy Engagement Scale.

Total model, $F(6, 78) = 8.71$, $p < .001$, $R^2 = .40$.
*$p < .05$, **$p < .01$, ***$p < .001$.

Table 9. *Hierarchical Multiple Regression: Engagement Model.*

Variables	sr^2	β	*df* Change	*F* Change	R^2 Change	*t*
Step 1			9, 75	2.56*	.24	
Neuropsychological composite	.05	.28				2.29*
AES – Clinician	.05	-.32				-2.28
BSI – Global Severity Index	.00	.10				-0.53
MCIRS	.00	-.06				-0.47
Education	.00	-.05				-0.46
Age	.01	.11				0.89
PANAS – Positive Affectivity	.01	-.13				-1.02
PANAS – Negative Affectivity	.02	-.21				-1.29
PASS – Total	.00	.02				0.15

Note. AES – Clinician = Apathy Evaluation Scale- Clinician rated version; BSI = Brief Symptom Inventory- 18 Items; MCIRS = Modified Cumulative Illness Rating Scale; PANAS = Positive And Negative Affective Schedule; PASS = Pain Anxiety Symptoms Scale.

Total model, $F(9, 75) = 2.56$, $p = .013$, $R^2 = .24$.
*$p < .05$, **$p < .01$, ***$p < .001$.

APPENDIX B: HIC Approvals

WAYNE STATE UNIVERSITY

IRB Administration Office
87 East Canfield, Second Floor
Detroit, Michigan 48201
Phone: (313) 577-1628
FAX: (313) 993-7122
http://irb.wayne.edu

NOTICE OF EXPEDITED APPROVAL

To: Michael Williams
Psychology
5057 Woodward, 7th Flr.

From: Dr. Deborah Ellis C. Zalondek
for Chairperson, Behavioral Institutional Review Board (B3)

Date: January 14, 2014

RE: IRB #: 117113B3E

Protocol Title: Neuropsychological Predictors of Engagement in Rehabilitation Therapy and Functional Independence in Individuals with Acquired Brain Injuries

Funding Source: Unit: Psychology

Protocol #: 1311012578

Expiration Date: January 13, 2015

Risk Level / Category: Research not involving greater than minimal risk

The above-referenced protocol and items listed below (if applicable) were **APPROVED** following *Expedited Review* Category (#5 #7)* by the Chairperson/designee *for* the Wayne State University Institutional Review Board (B3) for the period of 01/14/2014 through 01/13/2015. This approval does not replace any departmental or other approvals that may be required.

- Revised Protocol Summary Form (received in the IRB Office 1/14/2014)
- Protocol (received in the IRB Office 11/18/2013)
- Revised HIPAA Summary Form (received in the IRB Office 1/14/2014)
- Behavioral Research Informed Consent with HIPAA Authorization (dated 1/14/2014)
- Behavioral Research Informed Consent - Occupational Therapist (dated 11/14/2013)
- Data Collection Tools: Positive and Negative Affect Schedule (PANAS) Questionnaire, PASS-20, Apathy Evaluation Scale - Clinical Version, Modified Cumulative Illness Rating Scale (MCIRS), Rehabilitation Therapy Engagement Scale, Barthel Index, and Lawton Instrumental Activities of Daily Living Scale

- Federal regulations require that all research be reviewed at least annually. You *may* receive a *"Continuation Renewal Reminder"* approximately two months prior to the expiration date; however, it is the Principal Investigator's responsibility to obtain review and continued approval ***before*** the expiration date. Data collected during a period of lapsed approval is unapproved research and can never be reported or published as research data.
- All changes or amendments to the above-referenced protocol require review and approval by the IRB **BEFORE** implementation.
- Adverse Reactions/Unexpected Events (AR/UE) must be submitted on the appropriate form within the timeframe specified in the IRB Administration Office Policy (http://www.irb.wayne.edu//policies-human-research.php).

NOTE:

1. Upon notification of an impending regulatory site visit, hold notification, and/or external audit the IRB Administration Office must be contacted immediately.
2. Forms should be downloaded from the IRB website at **each** use.

*Based on the Expedited Review List, revised November 1998

WAYNE STATE UNIVERSITY

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NOTICE OF EXPEDITED CONTINUATION APPROVAL

To: Michael Williams
Psychology
5057 Woodward, 7th Flr.

From: Dr. Deborah Ellis or designee For A. Jacobs IMB
Chairperson, Behavioral Institutional Review Board (B3)

Date: December 12, 2014

RE: IRB #: 117113B3E

Protocol Title: Neuropsychological Predictors of Engagement in Rehabilitation Therapy and Functional Independence in Individuals with Acquired Brain Injuries

Funding Source: Unit: Psychology

Protocol #: 1311012578

Expiration Date: December 11, 2015

Risk Level / Category: Research not involving greater than minimal risk

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Continuation for the above-referenced protocol and items listed below (if applicable) were APPROVED following Expedited Review by the Chairperson/designee of the Wayne State University Institutional Review Board (B3) for the period of **12/12/2014 through 12/11/2015**. This approval does not replace any departmental or other approvals that may be required.

- Actively accruing participants
- Behavioral Research Informed Consent with HIPAA Authorization (dated 1/14/2014)
- Behavioral Research Informed Consent - Occupational Therapist (dated 11/14/2013)

- Federal regulations require that all research be reviewed at least annually. You *may* receive a *"Continuation Renewal Reminder"* approximately two months prior to the expiration date; however, it is the Principal Investigator's responsibility to obtain review and continued approval ***before*** the expiration date. Data collected during a period of lapsed approval is unapproved research and can never be reported or published as research data.
- All changes or amendments to the above-referenced protocol require review and approval by the IRB **BEFORE** implementation.
- Adverse Reactions/Unexpected Events (AR/UE) must be submitted on the appropriate form within the timeframe specified in the IRB Administration Office Policy (http://www.irb.wayne.edu//policies-human-research.php).

NOTE:

1. Upon notification of an impending regulatory site visit, hold notification, and/or external audit the IRB Administration Office must be contacted immediately.
2. Forms should be downloaded from the IRB website at **each** use.

*Based on the Expedited Review List, revised November 1998

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ABSTRACT

NEUROPSYCHOLOGICAL PREDICTORS OF ENGAGEMENT IN REHABILITATION THERAPY AND FUNCTIONAL INDEPENDENCE IN INDIVIDUALS WITH ACQUIRED BRAIN INJURIES

by

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Occupational therapy after acquired brain injury (ABI) is an important part of a rehabilitation program, as it is designed to assess and aid patients in regaining independent functioning with activities of daily living (ADL; eating, toileting, etc.) and instrumental ADL (IADL). Engagement in therapy is a patient factor that can limit or enhance the benefits of occupational therapy. Therapy engagement refers to deliberate effort and commitment to working toward the goals of rehabilitation (Lequerica et al., 2006); it encompasses patient participation in rehabilitation activities, such as attendance and completion of prescribed exercises. Low engagement and failure to maximize therapy are associated with increased health costs and disability (Barello et al., 2012). Brain injury can disrupt cognition and emotions, resulting in apathy and low engagement (Lane-Brown & Tate, 2011). Unfortunately, few studies have examined the link between cognitive impairments and engagement in therapy; fewer still have examined this link with endpoints of functional outcome. An important gap in the knowledge base concerns how cognitive impairments associated with ABI disrupt engagement in therapy, and the extent to which this disruption undermines the benefits of rehabilitation therapy.

Accordingly, this dissertation study examined neuropsychological predictors of functional outcomes after ABI, and the role of therapy engagement as a potential mediator for the relationship between neuropsychological performance and functional outcomes.

Method: Participants were 94 adults with medically-documented ABI recruited from three outpatient brain injury clinics at the beginning of occupational therapy. The participants (57% men) ranged from 18 to 82 in age with the majority (81%) having completed 12 or more years of education. Participants completed a comprehensive neuropsychological assessment at baseline. It included self-report surveys of emotional functioning and clinician-rated apathy. Occupational therapists (OTs) assessed functional independence and disability with the Barthel Index of ADLs (Mahoney & Barthel, 1965) and Lawton Instrumental Activities of Daily Living Scale (Lawton & Brody, 1969) at the initial intake and after the sixth session. OTs also rated the participants' level of engagement in therapy after the sixth session using the Rehabilitation Therapy Engagement Scale (Lequerica et al., 2006).

Results: Education was related to functional outcomes (ADL and IADL), whereas age, gender, and estimated premorbid IQ were not. Multiple linear regressions demonstrated that neuropsychological performance was a significant predictor of functional outcomes and therapy engagement. Therapy engagement predicted functional outcomes and was found to mediate the relationship between neuropsychological performance and outcomes. An additional set of regressions showed that therapy engagement accounted for unique variance and served as a mediator for neuropsychological performance predicting outcomes, even after accounting for education, comorbid physical health status, emotional functioning, and apathy.

Conclusions: Engagement in therapy is a crucial characteristic in successful rehabilitation

outcome. The findings support the hypothesis that cognitive deficits associated with ABI undermine full engagement in rehabilitation therapy, which in turn diminishes potential gains made in therapy and functional recovery. Neuropsychological assessment can enhance rehabilitation outcomes by identifying characteristics that underlie therapy engagement, which can ultimately be used to maximize the effectiveness of individualized treatment plans.

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