

**Caregiver Traits, Attachment Styles, and Patient Outcomes in a Brain Injury  
Rehabilitation Program**

by  
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## Abstract

**Background:** Acquired brain injuries (ABI) are a critical health concern, as they disrupt brain activity and impact individual functioning. Presentations vary, and injuries are inherently unpredictable. Injured persons can experience an array of significant impairments and difficulties in physical, cognitive, behavioral, emotional, and social functioning, as well as activities of daily living. Following injury, patients can achieve improvements in functioning across domains through evidence-based comprehensive post-acute brain injury rehabilitation programs (PABIR) which specialize in community integration. Family members and caregivers are essential to this recovery process by providing necessary social and emotional support. **Purpose:** Previous research suggests that caregiver mental health and functioning influence the quality of care and mood of the brain injured individual. Caregiver engagement promotes better quality of life and buoy of mood, but little research has investigated the caregiver factors which promote or inhibit functioning and rehabilitation progress in brain injured persons. Personality traits, which shape affect, cognition, and behavior, may account for differences in individual caregiving and thereby patient functioning. Furthermore, attachment styles drive variability in relationship closeness and security. Because caregiving represents an essential relationship in recovery, differences in caregiver attachment styles may impact patient progress. This study aims to examine the influence of caregiver personality traits and attachment styles on patient trajectories and outcomes. It is hypothesized: (1) that caregiver agreeableness will promote increased functioning and treatment gains and (2) that patients with caregivers who have an insecure attachment style will see limited treatment gains compared to patients with securely attached caregivers. **Methods:** Data

was collected at a post-acute brain injury rehabilitation programs in the state of Texas. Fifty-nine pairs of caregivers and ABI patients were assessed. Caregivers completed demographic questionnaires, and self-report measures of personality factors and attachment styles. Rehabilitation staff assessed patient ability, adjustment, and participation at the beginning and end of treatment to measure patient trajectories.

**Results:** Pearson's correlation and a hierarchal multiple linear regression analysis were used to examine the relationships between caregiver personality factors and attachment styles and patient rehabilitation gains. Secure attachment and anxious attachment styles, as well as caregiver intensity and duration of rehabilitation were significantly correlated with patient rehabilitation gains. However, attachment styles and personality traits did not predict patient outcomes over caregiver intensity and duration of rehabilitation.

**Conclusion:** Caregiver intensity was the best predictor of rehabilitation followed by duration of rehabilitation treatment. Caregiver intensity also correlated with agreeableness, conscientiousness, and direct in-person contact hours. Limitations, future directions, and clinical implications are discussed.

*Keywords:* acquired brain injury, rehabilitation outcomes, families, caregivers

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## **Chapter I**

### **Introduction**

In the United States, approximately 3.5 million people will experience an acquired brain injury (ABI) each year (Brain Injury Association of America [BIAA], 2014; Parker et al., 2017). Brain injuries disturb the physical integrity of the brain and alter functioning, resulting in cognitive, physical, behavioral, or emotional impairments (Wilson, Winegardner, Van Heugten & Ownsworth, 2017; World Health Organization [WHO], 1996). Globally, ABIs are expected to exceed other diseases as a major cause of death and disability by 2020 (Humphreys, Wood, Phillips, & Macey, 2013). While most ABIs are temporary, some can cause permanent damage leading to significant and costly health concerns (Centers for Disease Control and Prevention [CDC], 2015; Finkelstein, Corso & Miller, 2006). Over \$70 billion dollars a year are spent on total acute costs for ABI care, and this condition is costly to individuals and families: \$1.5 to 2.2 million may be required per individual in the first six years of care (Leisbson, et al., 2012).

An acquired brain injury is defined as cerebral damage that occurs after birth and which is characterized by a disruption of neural activity and functioning (Giustini, Pistarini, & Pisoni, 2013). Injuries are not related to hereditary, congenital, or degenerative diseases and disorders (Byrne, & Coetzer, 2016). They may either be nontraumatic or traumatic (TBI). Nontraumatic brain injuries include interruptions in oxygen and blood supply to the brain, brain tumors and subsequent surgeries, as well as infections and high-dose toxic exposures (Dimancescu, 2007; Mar et al., 2011). The most common nontraumatic injuries often result from ischemic strokes caused by a blocked

artery or blood clot inside the blood vessels in the brain, hemorrhagic strokes caused by blood clots that develop in arteries supplying blood to the brain, or ruptured aneurysms that result in spontaneous hemorrhages (Dimancescu, 2007; Mar et al., 2011). Risk factors include smoking, excessive alcohol intake, high blood pressure, high cholesterol, diabetes, sleep apnea, and atrial fibrillation (AFib) (American Heart Association [AHA], 2017).

Traumatic brain injuries are the result of external forces inflicting a bump, blow, jolt, penetration or blast to the head (CDC, 2015; CDC, 2013). Common forces that result in TBIs include injuries from falls (e.g. falling down stairs, off of a bicycle, blast from improvised explosive device, etc.), physical assaults (e.g. attacked by an assailant with the use of leverage object), motor vehicle accidents (e.g. cars, motorcycles, and boats), or penetrating injuries (e.g. bullets or shards of metal) (Cifu & Caruso, 2010; Dimancescu, 2007). Risk factors for TBIs include military service, contact sports, accelerated driving, and sleep deprivation (CDC, 2015). The Center for Disease Control and Prevention estimates approximately 5.3 million Americans live with long-term impairments because of TBI.

Brain injuries are also defined by their severity. Initial categorization is based on verbal and motor responses and eye contact using the Glasgow Coma Scale (GCS; Teasdale & Jennett, 1974), but later estimates can be based on the duration of post traumatic amnesia, loss of consciousness, or subsequent neuropsychological assessment (Coetzer, Daisley, Newby, & Weatherhead, 2013). Glasgow scores ranging from 13 to 15 indicate a mild injury, between 9 to 12 a moderate injury, and between 3 to 8 a severe injury. Studies examining severity using the GCS found severity predicted outcome and

functioning following ABI, such that lower scores and increased severity predict greater cognitive impairment and poorer occupational outcomes (Elbaum & Benson, 2007; Jourdan et al., 2013; Ponsford, 2013). Post traumatic amnesia (PTA) is a state of confusion that is characterized by behavioral agitation, as well as cognitive deficits in memory, attention, and executive functioning (Marshman et al., 2013). For PTA, a duration of less than 24 hours defines a mild injury, 24 hours to 7 days is moderate, and more than 7 days is severe. Research has found that PTA severity predicts functioning and impairment in activities of daily living, cognitive functioning, opportunities for employment, and relationship satisfaction from 6 months to 10 years post-injury (Hart et al., 2016; Ponsford, 2013). Loss of consciousness (LOC) represents length of unconscious state (O'Neil, et al., 2013) such that an unconscious state between 0 to 30 minutes is mild, 31 minutes to 24 hours is moderate, and over 24 hours is severe. Alteration of consciousness (AOC) or any alteration in mental state at the time of the injury, which includes confusion, disorientation, and reduced speed of thinking (O'Neil, et al., 2013). For AOC, a duration of seconds to 24 hours is considered mild and anything over 24 hours is considered moderate to severe with the use of other criteria, such as an abnormal finding on structural imaging (O'Neil, et al., 2013).

While most individuals with mild brain injuries may resume work and family roles, individuals with moderate to severe injuries may not be successful in their attempts to return home. Damage caused to the brain can create mild to severe impairments in cognition, behavior, and motor functioning and can ultimately alter the injured person's level of independence and need for support (Elbaum & Benson, 2007; Leisbson, et al., 2012).

Following a moderate to severe brain injury, patients go through a process of becoming medically stable. This typically involves a phase of acute rehabilitation where 24-hour medical staff is available, and patients will begin receiving services such as speech and physical therapy (Giustini, Pistarini, & Pisoni, 2013; Wilson et al., 2007). Once discharged, patients are then referred to further specialized treatment to increase functional outcomes (Coetzer et al., 2013; Elbaum & Benson, 2007). Comprehensive residential post-acute brain injury rehabilitation programs offer individualized treatment in physical therapy, occupational therapy, speech therapy, recreational therapy, neurology, nursing, counseling, cognitive rehabilitation and neuropsychology, and 24-hour support staff to assist in skill training that will help the patient increase independent functioning and meaningful engagement (Giustini, Pistarini, & Pisoni, 2013).

Community-integrated models of rehabilitation encompass a variety of settings but focus on the successful transition of patients back into their homes and communities by providing a residential form of skill training that is easily translated to family homes (Coetzer et al., 2013; Malec & Basford, 1996; Malec & Ponsford, 2000). The World Health Organization outlines goals for rehabilitation to include increased cognitive and functional abilities, subjective wellbeing, health condition, mobility, meaningful participation, activities, life satisfaction, and individual goals (Bilbao et al., 2003). Residential programs have demonstrated increased gains compared to home-based models (Glenn et al., 2005), and in a randomized controlled trial comparing outreach treatments, community integration programs were linked to greater psychological wellbeing (Powell, Heslin, & Greenwood, 2002).

However, the effects of ABI go beyond the patient. The impact of the injury on his or her family can be overwhelming, as they grapple with changes in their loved one and must begin to provide extended financial, physical, emotional, and social support. Recovery from injury can be long and can cause chronic changes in the injured person. Thus, the need for social support and other resources can also have immediate and long-term effects on the family and their social network (Hassan, Wan-Fei, Abd Raman, Jamaludin, & Riji, 2012; Las Hayas, Arroyabe, & Calvete, 2015).

Previous studies have suggested that emotional support is vital to recovery. Family members, spouses, and close friends who invest in the betterment of the injured person, also referred to as caregivers, can have a tremendous influence on the injured person's progress after the injury. Family support is associated with better outcomes, and poor social support can negatively affect the wellbeing of the injured individual (McCarthy et al., 2006). Initial social support has also been found to correlate with emotional wellbeing one year after TBI. Changes in social support affect the ability of the injured person to successfully balance positive and negative affective states (Laird et al., 2018).

Still, caregivers have their own strengths and weaknesses. Some families may find it easy to provide social support and resources, while others may not have the emotional, cognitive, or physical means. Additionally, the acute- to post-acute period after a brain injury can be a difficult time for family members fraught with emotional distress (Norup et al., 2013). Due to the sudden onset of brain injuries, caregivers are not prepared for their new role. It has been established that TBI caregivers experience a reduction in quality of life and are at greater risk for depression, anxiety, and stress

(Doser & Norup, 2016; Livingston et al., 2010; Manskow et al., 2014; Norup et al., 2013; Perrin et al., 2013; Ponsford, Olver, Ponsford, & Nelms, 2003). Yet, the mental health functioning of the caregiver influences the emotional support and quality of care the person with a TBI receives (Vangel, Rapport, & Hanks, 2011). Alway, McKay, Ponsford, and Schonberger (2012) found that family member interactions and ability to express emotion significantly predicted the injured individual's emotional adjustment. In particular, caregivers' criticism and over-involvement predicted depression and anxiety in injured individuals. Conversely, Maggio et al. (2018) found that patients with ABI have better treatment compliance and increased functional gains when his or her family is engaged and active in their care.

Given the influence that caregivers can have on adjustment, and their vital role to the injured person, it is crucial to investigate caregiver factors that promote or inhibit progress in rehabilitation and post-injury functioning. Lehan et al. (2012) found that reduction of caregiver burden increased neuropsychological functioning, and Sander et al. (2002) found that TBI patients' progress in post-acute rehabilitation was related to strength of family functioning. Yet despite the effects of these relationships, few researchers have studied how caregivers influence brain injury recovery and rehabilitation.

## **Chapter II**

### **Literature Review**

#### **Recovery and Predictors of Outcome**

Recovery from ABI is complex. Patients may present with a variety of difficulties including: physical disabilities; cognitive deficits in attention, memory, and executive functioning; impairments in self-awareness; changes in behavior and self-regulation; poor initiation; and changes in personality and mood (Malec & Ponsford, 2000). Initial score on the GCS, duration of PTA, and duration of loss of consciousness predict impairments and gains achieved in rehabilitation treatment (Hart et al., 2016; O'Neil, et al., 2013; Ponsford, 2013; Ponsford, Sloan, & Snow, 2013). One study examining TBI outcome 10 to 15 years after injury found that age, premorbid personality, family stability, and pre-injury occupation predicted outcomes related to social participation, speech production, memory, emotional adjustment, fatigue, concentration, sensitivity to stress, and anhedonia (Thomsen, 1984).

However, once patients are medically stable, the nervous system begins to repair itself. While this is a process of natural or spontaneous recovery (Nudo, 2013), environmental stimulation and directed therapies can help target desired areas of skill acquisition (Nudo, 2013; Ponsford, Sloan & Snow, 2013), such as use of language, speech production, and motor ability. The term neuroplasticity refers to the brain's ability to change and reorganize neural pathways where healthy neurons sprout and grow outwards to reconnect with other undamaged neurons (Nudo, 2013; Wilson et al., 2017).

Environmental stimulation and directed therapies which promote neuroplasticity and axonal sprouting are central to comprehensive post-acute rehabilitation.

Since residential rehabilitation programs focus on providing comprehensive treatment and therapies lasting from weeks to months (Glenn, 2005), it is difficult to isolate the individual factors which contribute to patient gains and progress. However, such rehabilitation programs have been shown to improve psychological wellbeing, depression, anxiety, and quality of life in ABI patients compared to waitlisted controls (Holleman, Vink, Nijland, & Schmand, 2018). Cognitive rehabilitation has also been found to be effective in improving divided attention in stroke patients and activities of daily living for individuals with severe ABI (De Luca, Calabro, & Bramanti, 2018). A meta-analysis by Cicerone et al. (2008) found that cognitive rehabilitation improved community integration, activities of daily living, initiation and productivity for brain injured patients including patients whose initial injury occurred years earlier. Further, family and caregiver engagement in rehabilitation programs has also been shown to influence recovery trajectories (Foster et al., 2012; Maggio, 2018).

### **Five Factor Model of Personality**

Contemporary theorists describe personality as the individual traits that define a person's pattern of thinking, feeling, and behaving (John, Robins, & Pervin, 2008). The Five-Factor Model of Personality, also known as the Big Five for the 5 dimensions of personality (Extraversion, Openness, Agreeableness, Conscientiousness, and Neuroticism), has been replicated across cultures and is one of the most widely accepted models (Schmitt, 2004). This model is based on lexical and statistical approaches to personality taxonomy. It was pioneered by Allport and Odbert (1936) who identified



17,953 dictionary terms for personality traits and divided these into classifications (Larsen & Buss, 2014). Since then, further lexical analysis has been used to ultimately identify the five factors and their facets (Cattell, 1943; Fiske, 1949; Tupes & Chritsal, 1961). Each of the five factors bands together these smaller facets which provide scope and nuance to descriptions of personality. These have been replicated across cultures as well and represent the greatest consensus in personality psychology to date (Larsen & Buss, 2014; Rammsterd et al., 2010).

Extraversion refers to the quality and intensity of social interactions and activity, with facets related to warmth, gregariousness, assertiveness, activity, excitement-seeking, and positive emotions (Kajonius & Johnson, 2018; Larsen & Buss, 2014). Research has shown that extraverts tend to assume leadership positions, be more cooperative and have a greater influence on social environments than introverts (Jensen-Campbell & Graziano, 2001; Tolea et al., 2012). Agreeableness refers to the interactions related to cooperation versus individual power, with facets related to trust, straightforwardness, altruism, modesty, morality, and sympathy (Kajonius & Johnson, 2018; Larsen & Buss, 2014). Individuals high on agreeableness tend to be prosocial and empathetic, and they enjoy helping others (Caprara et al., 2010). Conscientiousness refers to industriousness or goal-motivated behaviors, with facets related to self-efficacy, orderliness, dutifulness, achievement, self-discipline, and cautiousness (Kajonius & Johnson, 2018; Larsen & Buss, 2014). Individuals high on conscientiousness demonstrate reliable behavior and more positive and committed social relationships (Langford, 2003). Neuroticism refers to individual emotional adjustment and ability to cope with stressors, with facets related to anxiety, hostility, depression, self-consciousness, impulsivity, and vulnerability (Kajonius

& Johnson, 2018; Larsen & Buss, 2014). Individuals high on neuroticism tend to be emotionally unstable which leads to greater fatigue during the day, and greater experiences of negative emotions (De Vries & van Heck, 2002). Further, they have been found to experience greater levels of distress, depression, and health problems related to providing care for relatives with dementia and cancer (Kim, Duberstein, Sörensen, & Larson, 2005). Open-Mindedness refers to experimentation and appreciation of different experiences, with facets related to imagination, artistry, feelings, adventurousness, intellect/ideas, and values (Kajonius & Johnson, 2018; Larsen & Buss, 2014). Individuals high in open-mindedness are more “open” to receiving information and feedback, and are less likely to discriminate against others (Flynn, 2005).

### **Caregiver Personality**

McClendon and Smyth (2013) found that caregiver personality factors were related to quality of care given to relatives with dementia; specifically, agreeableness, openness, conscientiousness, and neuroticism were related to greater quality of care, while extraversion was related to poorer quality of care. Caregivers with higher neuroticism have shown poorer adjustment to a relative’s brain injury and increased rates of anxiety and depression, whereas caregivers with high agreeableness and low conscientiousness may have better social adjustment and mental health over time (Trujillo, Perris, Doser, & Norup, 2016). In a study examining positive gains from caregiving experiences for older relatives, Koerner, Kenyon, and Shirai (2009) found that caregivers high on agreeableness and extraversion saw increased benefits and gains in satisfaction and gratification from their caregiver role, while caregivers high on

neuroticism and conscientiousness did not experience secondary benefits from providing care.

There is only one known study to investigate how caregiver personality influences brain injury recovery. Pointedly, Haller (2017) investigated caregiver personality in severe TBI trajectories and found that relatives high on neuroticism negatively impacted patients' neurological and emotional functioning. Caregivers high on extraversion also negatively influenced emotional functioning and health-related quality of life in the injured person initially for younger TBI participants, but caregiver extraversion eventually yielded an increase in total functioning for TBI individuals. Despite these contributions, very little research has been published on how caregiver traits influence brain injury rehabilitation. Therefore, a closer look at caregiver influence is warranted.

### **Attachment Theory and Relationship Styles**

Attachment theory (Bowlby, 1973, 1982) is a psychological model that describes the emotional bonds between people and the individual attachment behavior that promotes or inhibits the closeness of that bond. Work by Ainsworth (1970, 1978) found that patterns of communication between a caregiver and child represented a secure or insecure base for child exploration. Children with secure attachment demonstrated confidence when their mother left the room and were happy upon her return. Two insecure bases were also identified. One group of children appeared detached from their mothers from departure and return, and a second group of children became anxious when their mothers left and angry and ambivalent about desired closeness to their mother upon return. These three groups are now identified as secure, avoidant (or dismissing), and ambivalent (or anxious-preoccupied) attachment styles. Additionally, Ainsworth found

that mothers' receptiveness to their child's needs predicted secure and insecure attachment. Securely attached children had mothers who were attentive and receptive, while mothers of insecure children were inattentive and less responsive. Hazen and Phillips (1987) found that child-parent attachment styles translate to later relationship styles in adult attachment. Adults with the secure relationship attachment style have an easier time developing trust and satisfying relationships, while adults with an avoidant relationship style have a more difficult time trusting others or making commitments. Adults with an anxious relationship style tend to become dependent in their relationships while remaining uncertain about its security. Later work by Bartholomew and Horowitz (1991) identified a fourth attachment style, fearful, representing someone who was endorse high rates of both ambivalence and avoidance.

### **Caregiver Attachment Styles**

Examining caregiver attachment, one recent study found that insecurely attached caregivers saw increased rates of caregiver burden and poorer behavioral symptoms in dementia patients (Lee et al., 2018). Increased rates of aggression and agitation in dementia patients were also linked to avoidant partners (Perren, Schmid, Herrmann, & Wettstein, 2007). Another study examining TBI in Vietnam veterans found greater cognitive decline associated with caregivers displaying a fearful attachment style (Guevara et al., 2015). While attachment theory has been well researched over the years, no known studies have examined how caregiver attachment style influences brain injury outcomes. Caregiving in its nature requires a close relationship between two people, where the caregiver must be attentive and responsive to the injured person in order to

provide adequate care. Therefore, it is reasonable to examine caregiver attachment to further our understanding and provide caregiver support.

### **Hypotheses**

The proposed study aims to examine whether caregiver personality traits and attachment styles predict brain injury rehabilitation course and outcomes. Specifically, it is predicted that (1) high caregiver agreeableness will have a positive effect on patient treatment outcomes and (2) it is further predicted that there will be increased rehabilitation gains when caregivers are securely attached and limited gains from treatment when caregivers are insecurely attached. This study will advance our understanding of the relationships between caregiver personality traits and attachment style on rehabilitation outcomes for individuals with an acquired brain injury. This research is crucial for understanding the drivers of treatment outcomes following brain insult and providing guided intervention for family members.

## **Chapter III**

### **Materials and Methods**

#### **Procedures**

Both patients and their family members were asked to participate in the proposed study. Participants were recruited during admission and discharge procedures for a residential post-acute brain injury rehabilitation (PABIR) program in Texas. Participants were also recruited during breaks and downtime between and after therapies. No patient or caregiver subject was recruited during the delivery of rehabilitation services.

Participants were recruited by researchers and by referrals from case workers and by self from flyers around the campus.

Participants were informed that their participation in the study was optional and that neither the patient or family member would be penalized or denied benefits for refusal or withdrawal from the study. It was understood that participants with moderate to severe brain injury may experience significant cognitive impairment and may be unable to consent. Thus, when the patient was unable to consent independently, their legally authorized representative provided consent.

Additionally, patient information that is collected on site to monitor patient progress in order to report to insurance and social agencies was made available for use in this study. Thus, for available archival patient data, caregiver participants were identified from case files and contacted for telephone interviews. Patients and caregivers are regularly sent follow-up questionnaires after discharge by the rehabilitation facility, so researcher questionnaires were perceived well. If caregivers consented to participation,

they were also given the option of completing questionnaires via email or mail depending on caregiver preference.

Upon completion of the survey, participants were given the opportunity to submit their email address to be entered into a drawing for a fifty-dollar Visa gift card. The data was then obtained by an affiliated researcher of a large university located in the southern United States for further analysis. The affiliate received approval to conduct research projects using direct data collection and archival data from the University's Institutional Review Board of Human Subjects.

### **Participants**

Inclusion criteria included: an acquired brain injury that occurred after birth as the result of physical trauma (e.g. TBI following a car accident) or non-traumatic brain injury (e.g. stroke, brain tumor); client must have been seeking services as an inpatient or outpatient at the PABIR program. The client must have been able to provide consent, or consent from an individual with power of attorney must be obtained. Clients must have been 18 to 65 years of age. Exclusion criteria included: degenerative diseases, epilepsy, autoimmune disorders, and brain malformation.

Inclusion criteria for caregivers included: (1) relationship to patient participant that received rehabilitation services at the PABIR program, (2) English comprehension and (3) both client and family member consent to participation. Caregivers must have been at least 18 years old.

Information regarding client progress was collected by PABIR program staff, such as case workers, psychologists, and occupational therapists, as part of standard procedures for rehabilitation progress monitoring and outcome. Rehabilitation staff

provide informant ratings of client performance at the beginning and end of treatment. Currently, informant ratings are collected as standard practice to help measure and track progress.

### **Assessment and Measures**

Basic demographic features of study patients were collected by the researcher from available medical charts. Patient Demographics included education, age, gender, ethnicity, categorization of injury, severity of injury, duration of loss of consciousness, duration of posttraumatic amnesia, time since injury, and duration of rehabilitation. Basic demographics were collected separately from caregivers, such as education, age, gender, ethnicity, socioeconomic status, and occupation. Caregivers also reported basic data regarding the nature of the patient-caregiver relationship. This included the type of relationship, length of relationship, amount of time spent in communication with the patient during the week, number of days spent with the patient, whether the patient and caregiver lived together before and after the injury, if the caregiver is responsible for the care of any other individuals besides the patient, and if there are any other caregivers providing ongoing support. Caregiver intensity, defined as the total number of weekly patient-caregiver contact hours, was estimated by caregivers. This included direct time spent in-person, time spent communicating on the phone, and/or time spent communicating via video chat platforms.

### ***Mayo-Portland Adaptability Inventory***

The Mayo-Portland Adaptability Inventory (MPAI-4; Lezack & Malec, 2008) was originally developed by Lezack and Malec (2008) as a measure of outcome following brain injury. The MPAI-4 is a 29-item scale that can be administered to the person with



brain injury, to a caregiver, or to professionals working with the client. There are an additional 6 questions that are not used in the MPAI-4 score or subscales that examine relevant pre- and post-injury history and demographics. The MPAI-4 has 3 subscales that assess ability, adjustment, and participation. These have been found to correlate with the physical, emotional, and behavioral problems that brain injured individuals experience (Lezack & Malec, 2008). Each item is rated on a 5-point Likert scale from 0 (none) to 4 (severe), indicating the level at which the injured individual is currently experiencing that problem. Lower scores suggest greater integration while higher scores suggest greater functional impairments. The ability index examines sensory, motor, and cognitive abilities. For example, one ability subscale sample item covers, “verbal communication: problems expressing or understanding language”. The adjustment index examines interpersonal and family interactions, and mood. One adjustment sample item includes, “inappropriate social interactions: acting childish, silly, rude, behavior not fitting for time and place”. The participation index examines social connection, initiation, money management, and residence. One participation sample item includes, “initiation: problems getting started on activities without prompting”. Previous research (Malec et al., 2003) has demonstrated good internal consistency (.89) for the MPAI-4 total score and ranges from acceptable to good for the subscales (.76 -.83). It was also found to have good predictive validity for treatment outcomes (Malec, Moessner, Kragness, & Lezak, 2000; Testa, J Malec, Moessner, & Brown, 2005).

### ***The Big Five Inventory- 2***

The Big Five Inventory- 2 (BFI-2; Soto & John, 2016) was developed to look at the Big Five personality domains. As a recent update to the original Big Five Inventory

(BFI; John, Donahue, & Kentle, 1991), the BFI-2 improves item acquiescence and the overall fidelity and robustness of each domain. The BFI-2 is a 60-item self-report questionnaire that uses short descriptive phrases on a 5-point Likert scale. All items start with the stem, “I am someone who...” and sample items include “tends to be disorganized” and “is outgoing, sociable”; the scale is anchored from 1 (disagree strongly) to 5 (agree strongly). The scale has 5 subscales that load onto each of the personality domains. Subscales include Extraversion, Agreeableness, Conscientiousness, Negative emotionality, and Open-Mindedness. Soto and John (2016) reported an excellent convergent validity (.92) with the original BFI and ranged from .72 to .82 when compared to the Big Five Mini-Markers, the Big Five Aspect Scales, the NEO Personality Inventory—Revised, and the NEO Five-Factor Inventory. Good internal consistency was found for each of the subscales – Extraversion (.88), Agreeableness (.85), Conscientiousness (.86), Negative Emotionality (.90), and Open-Mindedness (.85).

### ***The Revised Adult Attachment Scale***

The Revised Adult Attachment Scale (RAAS; Collins, 1996) was developed to assess adult attachment styles with regard to any close relationship. The RAAS is an 18-item self-report questionnaire that uses a 5-point Likert scale. Sample items include, “I find it relatively easy to get close to people” and “I am comfortable with others”; the scale is anchored from 1 (not at all characteristic of me) to 5 (very characteristic of me). This scale has three subscales examining the participant’s comfort with emotional closeness and intimacy (Close), comfort with trust and depending on others (Depend), and feelings of worry and abandonment. Anxious attachment is correlated with Anxiety, while avoidant attachment is generated using the Close and Depend subscales. Secure

attachment correlates with low avoidance and low anxiety scores. The RAAS has been used extensively since 1996 and has consistently demonstrated good reliability and excellent validity (Ravitz, Maunder, Hunter, Sthankiya, Lancee, 2010). Collins reported Cronbach's alpha as .77, .78, and .85 for the Close, Depend, and Anxiety subscales, respectively.

## **Data Screening and Analytic Plan**

### ***Preliminary Analyses***

First, an a priori power analysis was conducted using G\*Power (version 3.1.9.2; Faul, Erdfelder, Buchner, & Lang, 2009), to find the minimum sample size required for 80% power and alpha of .05 in a regression model with 5 tested predictors. This analysis indicated sample sizes of 647, 92, and 43 pairs of caregivers and brain injured clients were needed to detect small, medium, or large effect sizes, respectively. A medium effect has been found to be preferential in behavioral sciences over a small effect, what Cohen (1988) calls "noisy" data in behavioral sciences and in the attachment literature (Karantzas, Evans, & Foddy, 2010). Thus, the current study aimed to collect 92 participants.

A total of 69 pairs of patients and caregivers were collected. Data were reviewed for study exclusion criteria (i.e. pre-existing brain malformations) and missingness of key data. Since the current study was conducting a complete case analysis, 11 pairs of caregivers and patients (17% of total sample) were excluded due to missing data on key variables. Four patient-caregiver pairs could not participate due to non- English comprehension and one patient declined participation after consent and thus, caregiver data was removed from the dataset. Further, recruitment had to be cut short due to

research restrictions due to COVID-19. The final dataset included 53 pairs of patients and caregivers.

### *Data screening*

Data screening was performed through descriptive statistics (e.g., means, standard deviation, and examinations of skewness and kurtosis). Given that Both personality variables included in the final regression (i.e., Agreeableness and Conscientiousness) had skewness and kurtosis values of less than 1 (Bulmer, 1979). Other key variables (i.e., weekly talking hours, differences in MPAI scores, and attachment style) all had skewness and kurtosis values of less than 3 (Kline, 2016). Given that Kline (2016) suggests that Kline (2016) suggests that absolute values of skewness over 3 and kurtosis over 10 indicate serious problems with non-normality, overall, there were no serious deviation from univariate normality for the key study variables except for TLC Time which had a kurtosis value of 25.7.

### *Data analysis*

Preliminary analysis was conducted using the Statistical Package for the Social Sciences (SPSS; version 26). Next, the study used Pearson's correlation analysis to explore the relationship between main study variables to determine which might be the best predictors of improvement scores for a set of controls (e.g., demographics), and both caregiver personality traits and attachment style.

After, key variables were selected, a two-step hierarchical regression model was used to determine to the extent to which caregiver personality and attachment styles influence the ABI patient's rehabilitation gains. Prior to the hierarchical multiple regression analysis, relevant assumptions were tested including independence of residuals, ruling out multicollinearity among independent variables, showing

homoscedasticity, ruling out significant outliers, and ascertaining that the residuals (errors) are approximately normal distributed. In the first step, weekly talking hours and TLC time were entered to predict changes in MPAI scores. In the second step, personality traits of Agreeableness and Conscientiousness were added as well as attachment style (i.e., secure vs. insecure).

## **Chapter IV**

### **Results**

The first task was to explore the pooled data using preliminary descriptive statistics and frequency analyses. Pearson's correlation estimates are provided between key study variables, which were then used to assess which variables might best predict improvement scores for a set of controls (e.g., demographics), as well as assessing both caregiver personality traits and attachment style. A hierarchical regression model was used to determine to the extent to which caregiver personality and attachment styles influence the ABI patient's rehabilitation gains.

#### **Descriptive Statistics for Study Variables**

Participants included 53 patient-caregiver pairs (N = 106 participants). The majority of participants were White/Caucasian (64.2%). Patients were, on average, 37.6 years old (SD = 13.3 years) and mostly male (75.5%), while caregivers were, on average, 45.5 years (SD = 13.9 years) and mostly female (79.2%; see Table 1 for additional demographics). The average number of days for rehabilitation treatment or the total time spent at post-acute rehabilitation was 122 days, with a range of 42 to 244 days.

#### **Key Correlations for Study Variables**

The study first explored the correlations between main study variables to determine which might be the best predictors of improvement scores for a set of controls (e.g., demographics), and both caregiver personality traits and attachment style. Potential personality-based predictor variables included extroversion, agreeableness, conscientiousness, neuroticism, and open-mindedness. Variables for adult attachment

**Table 1**  
*Demographic Characteristics (N = 53 patient-caregiver pairs)*

	Patients	Caregivers
<u>Age in years <i>M (SD)</i></u>	37.6 (13.3)	45.5 (13.9)
<u>Ethnicity (%)</u>		
White/Caucasian	34 (64.2)	34 (64.2)
Black/African American	7 (13.2)	7 (13.2)
Asian	2 (3.8)	2 (3.8)
Hispanic	10 (18.9)	10 (18.9)
<u>Gender n (%)</u>		
Male	40 (75.5)	11 (20.8)
Female		42 (79.2)
<u>Years of Education <i>M (SD)</i></u>	14.0 (1.9)	13.3 (2.6)
<u>Brain Injury Severity (%)</u>		
Moderate	14 (24%)	-
Severe	39 (66%)	-

included secure, avoidant, and anxious styles. Demographic variables included patient gender, caregiver gender, caregiver education, caregiver intensity, the number of days of direct in-person patient-caregiver contact during the week, and whether the patient and caregiver were living together prior to the injury. Caregiver intensity, defined as the total number of weekly patient-caregiver contact hours, was estimated by caregivers. This included direct time spent in-person, time spent communicating on the phone, and/or time spent communicating via video chat platforms.

Patients gains (change from start to end of rehabilitation treatment) using the MPAI-4 total score was used as the criterion variable. Malec, Kean, and Monahan (2017) demonstrated that a meaningful change or the minimal clinically important difference (MCID) can be shown with a 5-point increase in T-scores on the MPAI-4. Further, interpretation is strengthened by using standardized T- scores for main effect and

potential interactions by putting variables on a common scale (Gelman, 2007; Gelman & Pardoe, 2007). On average, study participants saw a 6.51-point increase in total MPAI-4 T-score for patient gains.

Pearson's correlational analysis revealed several statistically significant relationships. Improvements in MPAI-4 scores were significantly correlated with caregiver intensity ( $r = .36, p = .008$ ), treatment duration or amount of time the patient spent at the rehabilitation center in days ( $r = .33, p = .017$ ), caregiver agreeableness ( $r = .23, p = .048$ ), caregiver conscientiousness ( $r = .31, p = .024$ ), and whether the caregiver had a secure or insecure attachment style ( $r = .32, p = .021$ ). Additional correlations between variables can be found in Table 2. These five variables were then used in the main regression analysis to identify caregiver traits that predict patient progress while controlling for the time spent at the rehabilitation facility (duration of treatment) and caregiver intensity. Correlation coefficients provide support for the first and second hypotheses.

Hierarchical regression was used to regress the predictor variables mentioned above to the dependent variable (MPAI-4 total pre-post change score) to determine if caregiver personality (i.e., Agreeableness and Conscientiousness) and attachment styles (i.e., secure vs. insecure) influence patient trajectories. In this analysis candidate variables were identified from the Pearson's correlational analysis. Variables that were found to be significantly correlated with the dependent variable were then selected and entered into the model. The accuracy of the model can be confirmed through an analysis of the  $R^2$  value and adjusted  $R^2$ , such that higher  $R^2$  values account for greater variance in the model (Gelman, & Hill, 2007). Decades of research and clinical observation have



demonstrated that brain injury severity should also influence treatment outcomes (Ponsford, Sloan, & Snow; 2013). Notably, injury severity was not significant in the preliminary correlation analysis of this sample and thus was left out of the hierarchical regression.

### **Hierarchical Regression Analysis**

Prior to the hierarchical multiple regression analysis, relevant assumptions were tested including independence of residuals, ruling out multicollinearity among independent variables, showing homoscedasticity, ruling out significant outliers, and ascertaining that the residuals (errors) are approximately normal distributed. No significant violations of these assumptions were identified.

There was evidence of linearity and homoscedasticity, as assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values. There appears to be independence of residuals, as assessed by a Durbin-Watson statistic of .96. There was no evidence of collinearity problems as all VIF values (ranging from 1.0 – 5.1) were less than 10 (Hair et al., 2014). Agreeableness and Conscientiousness had VIF values right about 5.1 each. The assumption of normality was met as assessed by visual inspection of a Q-Q plot of studentized residuals.

As shown in Table 3, the hierarchical multiple regression analysis revealed that at Step 1, the caregiver intensity and time spent at the rehabilitation center (control variables) significantly contributed to the model ( $F(2, 50) = 6.33, p = .004$ ) and accounted for 20% of the variation in participants' MPAI-4 improvement scores. Inspection of the beta coefficients indicated that greater weekly patient-caregiver talking time ( $\beta = .31, p = .018$ ) and a longer time spent in rehab ( $\beta = .27, p = .039$ ) were

positively associated with greater MPAI-4 score improvements. The variables added in Step 2 (i.e., caregiver personality traits and attachment style) explained an additional 6% of variation in MPAI improvement scores; however results indicated that the change in  $R^2$  from Step 1 to Step 2 was not statistically significant ( $\Delta R^2 = .06$ ,  $F(3,47) = 1.17$ ,  $p = .333$ ). Therefore, these additional variables did not significantly predict MPAI-4 improvement over and above caregiver intensity and time spent at the rehabilitation program. Unlike the Pearson's correlational coefficients, the hierarchical regression analysis did not provide support for either study hypotheses.

## **Chapter IV**

### **Discussion**

#### **Study Overview**

This study addresses gaps in the existing literature around caregiver influence on acquired brain injury rehabilitation outcomes. Specifically, this study adds to the literature by examining the influences of caregiver personality, using the Five-Factor Model of Personality, as well as caregiver attachment styles, using Bowlby's attachment theory and relationship styles, on rehabilitation integration. Associations between caregiver demographics, patient demographics, caregiver attachment, and caregiver personality were examined for their effects on patient rehabilitation outcomes as assessed using the Mayo-Portland Adaptability Inventory

Positive associations were observed between caregiver agreeableness and rehabilitation gains as well as secure caregiver attachment style and rehabilitation gains. Caregiver intensity and treatment duration also demonstrated positive associations. However, both study hypotheses were only partially supported, as only caregiver intensity and duration of treatment explained a statistically significant amount of variance in the overall hierarchical regression model. Overall, this is the first known study examining caregiver attachment on brain injury rehabilitation outcomes, and it is only the second known study to examine caregiver personality effects on the same. It is also the first study of acquired brain injury and caregiver attachment in American patients and caregivers.

#### **Rehabilitation Gains**

Examining the effects of caregiver personality on ABI outcomes, Haller (2017) found that increased agreeableness of close relatives was associated with worse interpersonal functioning for TBI patients over 50 years old and not associated with patient outcomes for TBI patients under 50 (Haller, 2017). Although we did not confirm our hypotheses in analyzing the correlation coefficients between study variables to determine which variables to include in the hierarchical the current study found a significant correlation between patient functioning and caregiver agreeableness, but the participant population was younger ( $M = 37.6$  years,  $SD = 13.3$ ). Taken together, these findings suggest that the effect of caregiver agreeableness may be moderated by age or other demographic factors and should be investigated further.

Separately, Haller (2017) found that caregiver conscientiousness was linked to improved physical quality of life outcomes for TBI patients over 50 years old. These findings are consistent with the current study, as conscientious caregivers showed a positive relationship with improvements in total functioning ( $r = .31$ ,  $p = .024$ ). Caregiver agreeableness and conscientiousness have both been associated with greater quality of care for dementia patients (McClendon & Smyth, 2013), suggesting a mechanism by which caregiver personality may influence the quality of care and thereby outcomes observed in TBI patients. Although the main analysis did not support the hypotheses, the correlation findings may suggest associations between caregiver agreeableness, conscientiousness, and improved functioning which were observed in this study.

In this study, improved functioning was also positively correlated with securely attached caregivers did not significantly predict patient outcomes over treatment duration and caregiver intensity. While attachment styles have been heavily researched, there are only three known studies examining caregiver attachment and neurological patient

outcomes, and there is little information regarding caregiver attachment on patient outcomes in ABI. Perren et al. (2007) found that dementia patients had higher rates of aggression and agitation when their partners had an avoidant attachment style, and Guevara et al. (2015) showed that Vietnam veterans with a history of TBI demonstrated greater cognitive decline when their caregivers were fearfully attached. Insecure caregivers have also been found to have high rates of caregiver burden and worse behavioral functioning observed in their dementia patients (Lee et al., 2018). No published studies have examined how caregiver attachment influences rehabilitation gains for recent brain injuries, and it is notable that, while attachment style was associated with patient outcomes, it was not significantly predictive over treatment duration and caregiver intensity in the current investigation.

In this investigation, treatment duration and caregiver intensity were ultimately the best predictors of improved patient functioning. Within our sample, the average time of treatment was 122 days, and longer treatment durations were related to improvements in overall functioning for ABI patients. Duration accounted for significant variance in brain injury rehabilitation gains, and this finding is consistent with previous analyses and models of rehabilitation that have consistently found improved patient outcomes related to treatment duration and intensity (Cullen et al., 2018; O’Neil, 2013). Overall, this is consistent with previous findings and adds the existing literature.

An additional statistically significant amount of variance in gains was contributed by caregivers who spent more time connecting with ABI patients, via direct in-person contact and/or telephone and video communication. Total time in contact with the patient proved more valuable than direct in-person contact, as assessed by the number of days

caregivers visited with patients in the rehabilitation facility, although caregiver intensity was also positively associated with the number of days spent visiting the patient. Further, caregiver agreeableness and conscientiousness demonstrated positive associations with caregiver intensity. Future studies may want to examine conscientiousness and agreeableness as moderators in caregiving contact and support.

Research has found caregiver intensity is often associated with improved outcomes for neurological populations (Fredman et al., 2019), but, caregiver intensity and quality of life may vary significantly by ethnicity, gender, and age (Cook et al., 2018). White and older caregivers have been found more likely to experience negative emotions and social burden, whereas Black caregivers are more likely to experience positive emotions associated with caregiving. Further, over time, high caregiver intensity may also be associated with high rates of caregiver burden and poor neurobehavioral outcomes (Griffin, et al., 2017). This change is marked for individuals caring for TBI and polytrauma family members several years post-injury. Taken together, these findings suggest that caregiver intensity may be beneficial in the early stages of caring but may have negative outcomes for both the caregiver and patient in the long-term; However, this may vary across patient-caregiver demographics.

### **Implications for Future Studies**

Burden was not assessed in the current study given the limited planned period of follow-up; however, it remains an important aspect of patient and caregiver success. It is unclear which personality, attachment, cultural, or community factors may modify these associations, suggesting the need for further research in this area for caregivers of individuals with ABI. For example, other studies have found that family agreeableness

was associated with improved social functioning for TBI caregivers (Trujillo, et al., 2016) and higher rates of coping and resilience (Skinner, Pitzer, & Steele, 2013). It is possible that communities beyond direct caregivers may need to be assessed for their influence on caregiver burden and, by proxy, for positive effects on the patient-caregiver dyad. The dyads included in this study were predominantly white, and the sample size was insufficient to further investigate associations between race, gender, socioeconomic status, and personality or attachment style factors. However, in future research, caregiver intensity, burden, and communities may be important factors to assess and monitor for changes in brain injury outcomes as well as a possible area of intervention for caregivers.

### **Incidental Findings**

Caregiver extraversion was positively associated with the number of in-person visiting days, secure attachment style, agreeableness, conscientiousness, and open mindedness. Haller (2017) found caregiver extraversion to have a positive relationship with quality of life and health outcomes for TBI patients. However, caregiver extraversion was related to poorer quality of care for dementia patients (McClendon & Smyth, 2013). These conflicting findings suggest caregiver extraversion could be moderated by other caregiver demographics, and future research should continue to examine these relationships (Cook et al., 2018). Caregiver agreeableness was positively correlated with caregiver intensity and number of in-person visiting days, and caregiver conscientiousness was positively correlated with caregiver intensity, visiting days, extraversion, and agreeableness.

Secure attachment was positively correlated with extraversion, agreeableness, conscientiousness, and had a negative relationship with negative emotionality, while

anxious attachment was positively correlated with negative emotionality and had a negative relationship with secure attachment. These findings are consistent with working models of attachment and personality. Haller (2017) found that caregivers high on neuroticism had a negative impact on the emotional and neurological functioning of TBI patients, which suggested that interventions may be best applied to caregivers who demonstrate high neuroticism and are insecurely attached.

### **Limitations and Future Directions**

The current sample is expected to reflect the demographic characteristics and profiles found in community-based residential treatment settings, but these findings may not generalize to neurobehavioral, outpatient, holistic or home-based rehabilitation settings. Due to the nature of comprehensive treatments, and the many individuals that provide care, it is unrealistic to assess personality, attachment styles, and duration of exposure to all rehabilitation staff who may contribute to or influence caregiving. Measures used to collect data from caregivers are also self-report, and caregivers may not be aware of or openly report negative traits, especially in a rehabilitation setting where patients, caregivers, and staff are focused on treatment progress and overall improvement.

Surprisingly, brain injury severity did not correlate with rehabilitation gains in this investigation. Previous research has demonstrated brain injury severity influences treatment outcomes (O'Neil et al., 2013; Ponsford, Sloan, & Snow; 2013), as may be expected. This finding therefore represents a limitation in study generalizability. However, this finding may be due to the selection of cases included. Based on the nature of residential inpatient rehabilitation itself, individuals with worse functioning and greater rehabilitation needs are more likely to participate in a residential rehabilitation



program. Additionally, individuals with moderate TBI in this study were clustered towards the lower functioning end of moderate range. For example, the moderate range on the GCS is between 9-12, and 39% of study participants with a moderate injury had a score of 9 or 10. Of moderate cases, 26% also had a PTA period greater than 4 days. Thus, the sample within this study may over-represent a particularly severe level of injury within the moderate brain injury range, weakening statistical interpretation.

While the number of days caregivers visited was predictive of gains, these activities were also positively correlated with caregiver extraversion, agreeableness, conscientiousness, and open-mindedness. This may suggest there is an overrepresentation of high prosocial personality traits in our sample. This may also indicate that caregivers with high rates of prosocial personality traits were more likely to visit the facility and/or select to participate in the study, while caregivers with negative emotionality and avoidant attachment may be less likely to participate in the study and may be underrepresented.

Lastly, but most critically, this research was underpowered for a multiple linear regression analysis to identify moderate effect sizes. While positive associations of caregiver personality factors and attachment styles were observed and accounted for an additional 6% of variation in hierarchical regression on MPAI scores beyond caregiver intensity and treatment duration, these effects did not reach statistical significance. It is unclear whether this is due to the posited effect size or observed sample. Unfortunately, due to the changing circumstances surrounding COVID-19 and the need to limit access to the facility, the full proposed sample of cases could not be collected at the site.

If data could be collected, caregiver and patient relationships would be inherently different. This would be likely to confound comparative or integrated analyses. For example, prior to COVID-19 family members and friends were allowed on campus between patient arousal from and return to bed. Caregivers were allowed to support their loved ones by watching them complete therapy treatments, assist in rehabilitation therapies as appropriate, participating in family counseling sessions, and/or assisting in morning and nighttime routines. Caregivers also spent time socializing with patients during meals and downtime. Caregiver access is now limited to evenings, weekends, and only when necessary to promote social distancing and prevent a COVID-19 outbreak on campus. Caregivers and patients are also likely facing additional stress due to the nature of the pandemic. In the future, a similar study or related investigations should be conducted once facilities have established new norms in treatment and visitation. This may better assess the validity of the observed associations and effect size.

Future research should examine the effects of caregiver intensity, demographics, attachment, and personality longitudinally in order to delineate if there are changes in these relationships over time and whether or which demographic factors may influence or moderate them. Future research should also be carried out across various inpatient and outpatient rehabilitation settings. Studies could expand on attachment styles and patient outcome by exploring the four attachment styles outlined by Bartholomew and Horowitz (1991). Additionally, it may be particularly valuable to examine patient personality and attachment styles in mild to moderate brain injuries, rather than or in addition to caregivers, and to investigate the relationships of patterns of attachment and similarities and differences in personality factors within the patient-caregiver dyad. Future research

should also endeavor to gather demographic, attachment style, and personality factors from therapy assistants who spend days and nights with patients in facilities and thereby exhibit high intensity caregiving in the residential setting.

### **Clinical Implications**

More research in this area can improve our ability to predict treatment outcomes and target services for caregivers based on intensity, personality traits, and attachment styles. For individuals with moderate to severe brain injury, who may require lifetime assistance, this study could inform critical educational materials, interventions, and skill development for caregivers. Previous research has established that the general wellbeing of caregivers plays a significant role in the long-term health and quality of life of their loved ones. Further, research examining attachment styles, personality factors, and demographics across time may reveal which caregivers are more likely to need support at various time points post-ABI. Hanson, et al. (2019) found that communicating the value of family caregiving and caregiver training improved caregiver satisfaction and wellbeing, suggesting that relevant caregiver attention can have a positive impact on the caregiver and the patient. Thus, targeted interventions and/or psychoeducation may help promote caregiver involvement and satisfaction.

### **Conclusions**

Overall, the main analysis of this study did not support the hypotheses. However, incidental correlational findings from this study established caregiver intensity as a unique contributor to brain injury rehabilitation gains. Caregivers with secure attachment, high agreeableness and conscientious personality factors were identified as having a positive relationship with rehabilitation gains, which can be used to guide future

investigations. These findings also highlight the need for further study on the influence of caregiver traits and demographics on brain injury rehabilitation outcomes in general, as little is known about these relationships. With more information, new interventions can be developed to target specific caregiving styles to promote positive caregiving experiences and better patient outcomes.

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## Appendix A

Table 2

Table 2  
*Correlations of Study Variables*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. DV: MPAl-4 Pre-Post																
2. Patient Gender	-.03															
3. Caregiver Gender	.11	-.25														
4. Caregiver Education	.13	.03	.01													
5. Caregiver Intensity	.36**	.20	.00	.00												
6. Visiting (days)	.25	.21	.13	-.09	-.59**											
7. Living	-.22	.00	.09	-.15	-.04	.01										
8. Number of Caregivers	.04	.27	.08	-.19	-.11	.03	.24									
9. Extraversion	.22	.10	.14	.11	.22	.37**	-.23	-.18								
10. Agreeableness	.27*	-.09	.15	-.02	.33*	.48**	-.02	-.01	.63**							
11. Conscientiousness	.31*	.00	.31*	.06	.35**	.48**	-.08	.03	.71**	.89**						
12. Negative Emotionality	-.22	.15	-.15	-.25	.03	.14	.12	.10	.04	-.04	-.11					
13. Open-Mindedness	-.08	.04	.32*	.09	.24	.28*	-.09	-.09	.52**	.51**	.57**	-.01				
14. Secure Attachment	.32*	-.12	.05	.16	.18	.18	-.13	-.04	.51**	.41**	.39**	-.36**	.08			
15. Anxious Attachment	-.13	.04	.16	-.25	.07	.08	-.04	.09	.11	.09	.14	.50**	.13	-.48**		
16. Brain Injury Severity	.04	.06	-.01	.00	.02	-.04	-.02	.06	-.03	-.14	-.15	.03	-.18	.10	-.19	
17. Treatment Duration	.33*	.06	.17	.03	.18	.19	-.27	-.15	.27	.17	.19	-.25	.08	.21	-.13	.25

Note. \* p < .05, \*\* p < .01; 1. MPAl-4 Pre-Post: Total change in T-score from pre-MPAl-4 to post-MPAl-4; 5. Caregiver Intensity: number of hours the caregiver spends in contact with the patient on average during the week; 6. Visiting (days): number of days per week the caregiver spends with the patient on average; 7. Living: whether the patient and caregiver were living together at the time of the accident; 8. Number of Caregivers: total caregivers providing ongoing support to patient; 9-13: The Big Five Inventory-2 subscales: Extraversion, Agreeableness, Conscientiousness, Negative Emotionality, & Open-Mindedness; 14-15: The Revised Adult Attachment Scale calculated Attachment Styles: Secure Attachment and Anxious Attachment; 16. Brain Injury Severity: moderate or severe noted in medical chart; & 17: Treatment Duration: total number of days in rehabilitation treatment program.

## Appendix B

Table 3

Table 3  
Hierarchical Regression Analysis for Variables Predicting MPAT Improvement Scores (N = 53 patient-caregiver pairs)

Variable	Step 1					Step 2				
	B	SE B	$\beta$	t	p	B	SE B	$\beta$	t	p
Caregiver Intensity (hours)	.07	.03	.31	2.44	.018	.06	.03	.25	1.86	.070
Duration of Treatment (days)	.02	.01	.27	2.12	.039	.02	.01	.22	1.72	.092
Agreeableness						-.04	.10	-.10	-.36	.722
Conscientiousness						.08	.11	.20	.69	.494
Attachment Style (Secure vs. Insecure)						1.65	1.21	.19	1.36	.179
Overall Model R <sup>2</sup>	.20**					.26*				
F for change in R <sup>2</sup>	6.33**					3.26				

Note. \* p < .05, \*\* p < .01; Secure coded as 1 and Insecure coded as 0