

**Financial capacity and neuropsychological performance
in acquired brain injury (ABI)**

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Dedications

For my parents who continue to inspire me, my sister for instilling the enthusiasm for life, my husband for believing in me, and my parents- and sister-in-law for being patient and nurturing.

For Emily Reid O’Conner, an unforgettable friend.

For all people with brain injuries—there is so much more to learn from you.

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Abstract

Financial capacity and neuropsychological performance in acquired brain injury (ABI)

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Difficulty with financial capacity (i.e., difficulty with efficiently managing one's finances), a common consequence in individuals with moderate to severe brain injury, has been found to affect self-autonomy and limit the individual from fully integrating into the community. Previous studies have found that individuals with brain injury have impaired financial capacity six months post-injury. However, the nature of financial capacity with post-injury periods extending to more than a year has not been studied. Moreover, there is mixed evidence regarding the nature and extent to which different cognitive abilities contribute to financial capacity. Therefore, the current study had three specific aims: (1) To compare the nature of financial capacity in individuals with chronic, moderate to severe acquired brain injury (ABI) with demographically matched controls. (2) To examine the contributions of various cognitive abilities (attention, working memory, executive functions, impulsivity) to financial capacity in the ABI group. (3) To investigate the association between the self-report and informant-report report of financial capacity, in the ABI group. A total of 25 participants with chronic, moderate to severe ABI were recruited from a day-treatment program, and 9 age and education matched-healthy control participants were recruited from the community. All participants were administered a comprehensive battery of neuropsychological tests to measure cognitive abilities and the Financial Competence Assessment Inventory (FCAI) to assess financial capacity. In

addition, 22 informants were interviewed using the Third Party Perspective FCAI. Results indicated that the control group outperformed the ABI group on the overall and the different dimensions of financial capacity. In the ABI group, specific cognitive abilities, including attention, working memory, delayed verbal memory, abstract reasoning and impulsivity contributed to different dimensions of financial capacity. However, no associations were found between ABI- and informant-reports of financial capacity suggesting the confounding presence of a combination of cognitive impairments and biases. These findings shed light on the compromised nature of financial management in ABI individuals years after a brain injury, and underscore the importance of focusing on continued monitoring and rehabilitation of this crucial functional ability.

1. INTRODUCTION

An acquired brain injury (ABI) is commonly defined as an injury to the brain that has occurred after birth and is not hereditary, congenital or degenerative. The injury commonly affects the physical integrity, the metabolic activity, and/or the functional ability of the cell. This term includes traumatic brain injuries (TBIs) and injuries caused by an internal insult to the brain such as stroke, blood clot, or infectious diseases.

Among individuals with acquired brain injury (ABI) approximately 30% are documented to have difficulty with financial capacity (i.e., difficulty with efficiently managing their finances) Australian Bureau of Statistics, 1996; ¹. A recent survey of neuropsychologists found that questions related to an individual's financial capacity was the second most frequently encountered area in which assessment was requested ². As such, the issue of financial capacity has been identified as one of the key problems for individuals in the chronic stages of ABI ^{3,4}. Specific difficulties can include problems with bill payments, completing their taxes, repaying mortgages, balancing the checkbook, banking, making timely and appropriate purchases, managing their disability benefits, budgeting, and operating the ATM machines ^{5,6}. Inadvertently, such difficulties may impact the individual's self-autonomy ⁷, affect the self-esteem and confidence, and limit the ability to completely integrate with the community because of impaired functioning at home and at work ⁸.

Difficulty with financial capacity may also lead to increased claims of bankruptcy; in fact five years post-injury the incidence of bankruptcy in the individuals with ABI, amongst others, is estimated to be 3.5% ⁹. Loss of financial

capacity may also adversely affect their chances of transitioning from supervised living to independent living^{4,7,8}. Considering the wide-spread implications of financial mismanagement following ABI, it is not surprising that questions about an individual's financial capacity frequently arise in both legal and medical contexts.

Due to the sudden nature of the injury and depending on the type of injury, individuals with ABI rarely have the time to completely comprehend the extent, nature or severity of their financial difficulties⁴. More often than not, as a consequence of the injury, individuals with ABI may not know how to fulfill their pending financial commitments or may experience financial stressors because of the sudden loss of income. This issue becomes compounded if the individual with the injury is the primary bread-winner of the family or if s/he has other financial commitments towards the other members of a large family. On the other hand, individuals with ABI may also receive large personal injury settlements but may lack the financial capacity to manage such sums because of cognitive deficits. If deemed legally incompetent to manage finances, then such individuals are usually assigned financial guardians or conservators to manage their finances. A family member or an agency (such as a rehabilitation center or a trust) may be adjudicated as a financial guardian. Owing to the unexpectedness of the situation and the resulting lack of independence in managing one's finances, individuals with ABI who have otherwise always handled their finances in the past, may experience frustration.^{4,5,7} and develop other emotional and psychiatric consequences such as depression¹⁰. This may thus ultimately hinder rehabilitation efforts.

1.1 Distinguishing between financial competency versus financial capacity

Despite having distinct meanings, the terms competency and capacity are often used interchangeably in legal and medical practice ^{7,11}. Competency is a legal concept and refers to the final judgment rendered by a legal decision maker (such as a judge) regarding an individual's legal status in terms of whether the individual is competent or not. From the legal perspective, financial competency represents the presumed ability to manage one's own personal financial affairs efficiently. Conceptually it helps determine issues of conservatorship and may include other more specific abilities such as testamentary ability and donative ability. However, the definition of competency is determined by the state statutes and varies from state to state. For example, the adjudication of incompetency in North Carolina encompasses a different definition as compared to that in Ohio or Nevada. This has implications for financial decision making because an individual who is adjudicated as financially competent in one state may be adjudicated as financially incompetent in another state merely because of the variability in state statute's definition.

In contrast, the term capacity is a non-legal construct. Capacity evaluations involve clinical decision making by various health care professionals such as psychologists and physicians ^{7,12}. The clinical judgment is rendered after a thorough evaluation of the individual using various cognitive tests, history taking, and medical record review. Depending on the referral question, financial capacity evaluations (sometimes also called guardianship evaluations) are generally

carried out for individuals living in rehabilitation residential facilities or for those living in the community.

Currently, there exists a working definition of financial capacity; it is as follows: “the capacity to manage money and financial assets in ways that meet a person’s needs and which are consistent with his or her values and self-interest.”^{7,10,13}. However, this definition still remains to be widely accepted and there remains considerable variability in the interpretation of this construct. On the whole, from a clinical perspective, the determination of financial capacity is problematic because of the absence of a standard definition of this construct⁷, the lack of guidelines regarding which assessment instruments can be used to measure financial capacity, and because of insufficient information about what clinical and contextual factors influence clinicians judgments about an individual’s financial capacity¹⁴. Similarly, in rehabilitation settings not much is known about the clinical decision-making process for adjudicating a financial guardian to an individual with ABI. Different working groups are developing and evaluating objective performance-based instruments to directly assess financial capacity. Researchers from Australia, for example, are developing financial capacity models with a focus on identifying strengths and weakness in the various financial capacity dimensions to develop rehabilitation strategies.

1.2 Framework for conceptualizing financial capacity

Establishing standard guidelines for defining and assessing financial capacity may be challenging because of two reasons. First, the multidimensional nature of financial capacity that includes the efficient management of different types of

financial needs such as those related to estate management, debt management, and everyday financial abilities (such as bill paying). Second, there is significant variability that can exist within any given dimension ¹⁴. For example, an individual managing one estate versus another individual managing several estates reflects the variability that can exist within the dimension of estate management ¹⁵. The challenge of establishing guidelines gets more confusing when the complex and diverse range of factors that may influence financial capacity is considered ^{7,10,16}. First, it has been shown that different cognitive abilities such as attention, working memory, executive function may influence various dimensions of financial capacity in dynamic ways. In ABI individuals this pattern gets complicated by other clinical considerations such as the length of post-injury period at the time of assessment. For instance, a recent study found that the contribution of verbal memory to financial capacity is different in the acute phase of brain injury as compared to six months post-injury ¹⁷. Second, depending upon the complexity of the task, within any one given dimension financial capacity, there may exist considerable variability in the nature and extent to which different cognitive abilities influences that dimension. It then follows that competency in one dimension does not automatically mean competency in other dimensions ^{18,19}. For instance, an individual who pays his or her utility bills on time, may show deficits in terms of managing the estate.

Based on ongoing studies of financial capacity with different clinical populations, Kershaw and Webber (2004, 2008) conceptualize financial capacity to be a multidimensional construct that can be examined from both a clinical perspective based on six different dimensions and from a legal perspective based

on four dimensions. Based on their conceptualization, these researchers recently developed the Financial Competence Assessment Inventory (FCAI) to assess financial capacity with a focus on rehabilitation. The six clinically based dimensions were extracted after surveying various health care professionals and other service providers and then conducting a factor analysis on that data. The six dimensions are as follows: everyday financial abilities (e.g., paying bills), financial judgment (e.g., financial goals), cognitive functioning related to financial tasks (e.g., functional memory), estate management (e.g., understanding Power of Attorney), debt management, and support resources (e.g., knowing where to look for help in managing finances^{15,20}). Currently, the FCAI is the only measure that has been developed with a focus on rehabilitation and that has been validated on individuals with different neurological diagnoses including those with ABI.

1.3 Research on Financial Capacity and ABI

Few empirical studies have been undertaken on financial capacity in individuals with ABI and cognition^{5,21} with the majority of research focusing on examining the financial capacity of older adults and dementia populations. In ABI, initially, much of the research focused on understanding the nature of the financial capacity impairments. It is only recently that the studies have focused on understanding the longitudinal factors associated with recovery pattern of financial capacity and exploring the neurocognitive predictors of financial capacity.

1.4 Nature of Financial Capacity Deficits

An early study found that as compared to controls, participants with focal lesions in the prefrontal cortex (8 out of 10 had penetrating head injuries) were impaired on a real-world financial problem-solving task ²². According to the researchers, the impairments occurred primarily because of poor planning associated with organizing and structuring goals which were ill-defined, there being no clear right or wrong answers and when no corrective feedback was easily available. A more recent study found that compared to age, education and sex-matched controls, the capacity to manage finances was diminished in individuals within one-year after the injury and was not associated with lowered familiarity with task ⁵. This study found that those with ABI displayed core executive function (EF) deficits when tested on a budgeting task. These deficits were primarily noted in the domain of planning which included organization and structuring problems, and focusing and remembering the goals.

1.5 Neuropsychological Impairments and Financial Capacity

A series of ongoing studies by researchers at La Trobe University in Australia have begun to shed light on the nature of and the neuropsychological correlates of financial capacity in ABI individuals. In an initial two-phase study, the prior knowledge of using automated machines and self-reported problems was first assessed using a questionnaire and then the actual use of automated machines was observed in real-time ⁶. Thirty age-, education- and sex- matched controls were compared to 90 participants with ABI (30 each classified as mild, moderate and severe). The first-phase of the study found that the ABI group self-reported

significantly more difficulty with the use of various automated service delivery machines (such as, automated transport ticketing machines, automatic teller machines, and automated telephone devices). Findings from the second-phase of the study revealed that ABI individuals with severe functional impairments had reduced proficiency in using the automated machines.

In another related study, these researchers investigated whether the performance on a neuropsychological battery could predict actual performance on various automated devices ²³. Fifteen demographically matched controls were compared with 45 participants with ABI. Different sets of neuropsychological abilities were found to predict performance on the various automated devices. For instance, working memory, processing speed, verbal learning and verbal fluency significantly predicted performance on the automated teller machine, whereas working memory, visuo-spatial perception, processing speed, verbal learning, and visual immediate memory, among others, was found to significantly predict performance on the automated telephone device. Overall, the researchers concluded that neuropsychological test performance was a strong predictor of performance on automated machine use.

In another exploratory study, Hoskin, Jackson and Crowe (2005b) designed and developed a survey called as the Money Management Survey (MMS) to examine financial capacity of ABI individuals as compared to demographically matched controls. The responses of 15 matched control participants were compared with 35 ABI participants. Both the groups had similar problems with handling money such as late bill payment and spending all their money within the first few days. However, the ABI group had additional

problems associated with impulse buying, poor prioritizing and having no money left for essentials, going without essentials because they had run out of money, and problems using an ATM. Next, these researchers examined the relation between the responses on the MMS to their performance on a comprehensive neuropsychological battery comprising of specific cognitive domains related to intelligence, memory, attention, executive functions and mood ¹⁸. They found that overall 19% of the variance in the neuropsychological performance predicted the overall financial capacity. However, the percentage value increased substantially if specific one-to-one correspondence was made between the financial task and the neuropsychological tests. For instance, they found that memory tests accounted for 63% of the financial tasks related to late bill or rent payment.

To better understand the relation between financial capacity and attention/executive function, Hoskin, Jackson and Crowe ¹⁹ compared the performance of individuals with ABI who were managing their finances independently with those who had being assigned a legal guardian. The former group had more severe impairments as compared to the latter group. In addition, they also found that measures of executive function and attention (impulse control, planning, cognitive flexibility, and working memory) explained about 63% of the variance in financial capacity and that these tests were able to correctly classify individuals into group membership (as financially independent) with 83.7% accuracy. These researchers also found that tests of attention and executive function were different between the two groups.

In sum, studies to date examining the relationship between neuropsychological measures and financial capacity have found strong but mixed evidence for the contribution of various cognitive abilities to financial capacity in individuals with ABI.

1.6 ABI, Impulsivity, and Financial Management

In addition to cognitive deficits in attention, language, memory, working memory and executive functioning post-injury, a frequent consequence of ABI is impulsivity in which individuals lacking inhibitory control display problems related to efficient financial management ²⁴. Using a temporal discounting paradigm in which participants have to choose between smaller immediate rewards and larger delayed ones, McHugh and Wood (2008) found that the ABI group temporally discounted more (i.e., select smaller immediate rewards more often) than the controls. It has been suggested that such a preference leads to risky and disadvantageous decision-making in real world functioning ²⁵. In the ABI group such a preference can be taken as preliminary evidence for impulsive decision making because of the need for immediate gratification ²⁶. Expanding on this study, these researchers wanted to further investigate which neurocognitive abilities were associated with impulsivity as measured by an objective clinical test of impulsivity (using temporal discounting paradigm described above)²¹. Their findings revealed that discounting performance was not associated with any of the neurocognitive abilities including those of executive function. Therefore, it seems likely that a clinical test of impulsivity such as the temporal discounting

paradigm may provide independent neuropsychological information and as such will be useful to include while assessing financial management abilities.

1.7 Recovery Pattern of Financial Management and Neuropsychological Abilities

It is important to note that most of the aforementioned studies were cross-sectional in nature and some of them suffered from methodological limitations associated with small sample size and low power. Two recent studies, have conducted longitudinal investigations comparing financial management abilities in healthy controls and individuals with ABI with the goal of better conceptualizing the potential recovery pattern of financial capacity. Using a performance-based instrument called as the Financial Capacity Instrument FCI-9; ^{10,16,27}, 34 individuals with moderate to severe head injury were compared to 26 healthy controls on a range of financial skills at two time-points - during the acute hospitalization period (baseline) and at 6-month follow-up ⁸. During baseline, between-group analysis revealed that the ABI group performed significantly worse than the controls on all the 9 domains assessing financial skills. At follow-up, within group analysis showed that the ABI group showed improvements on 7 out of the 9 domains, whereas the control group's performance remained stable indicating absence of practice effect. Between-group analysis revealed that both the groups performed equivalently on simpler financial tasks such as those requiring basic monetary skills, cash transactions and financial judgment. However, the ABI group's performance remained worse on the more complex tasks such as knowledge of financial concepts, checkbook

management, bank statement management, bill payment, and investment decisions. These findings suggest that individuals with ABI show a pattern of recovery for simple financial skills, but have diminished functioning for the more complex financial skills.

Expanding on this study these researchers examined the key neurocognitive predictors of financial capacity at 2 time points - in the subacute period (30 days post-injury) and at 6 months post-injury ¹⁷. In the subacute period, mental arithmetic, working memory, and immediate verbal recall were the main cognitive abilities that predicted financial capacity performance. In the 6-month follow-up, a different set of cognitive abilities - mental arithmetic, working memory, and executive function abilities were the key cognitive abilities mediating financial capacity performance. This study thus underscores the changing and dynamic influence of cognitive predictors with the recovery of financial capacity in individuals with moderate to severe injury. In line with this finding other studies have also found multiple neurocognitive abilities such as mental and written arithmetic, short term memory, knowledge of financial concepts, and executive skills (organization and intact judgment) are required for efficient financial management ^{23,28}.

Taken together, these findings suggest that examining the nature of financial capacity after a longer recovery period of over 18 months may provide information about the typical pattern of improvement of financial capacity for individuals with chronic ABI. By investigating the relationship between financial capacity and cognitive abilities for chronic ABI individuals the

neuropsychological basis of financial capacity can be better understood for rehabilitation purposes.

Summary of modifications:

- All the ABI participants were recruited from one recruitment site (Bancroft Brain Injury Services) which had unique site characteristics – it had a day treatment program and supported living arrangement wherein participants were supervised by in-house staff. Recruiting participants from other sources/sites (e.g., outpatients) could have made the sample too heterogeneous thus affecting the internal validity of the study.
- For the ABI group, even after perusing medical records for each participant, the Glasgow Coma Scale score, the length of posttraumatic amnesia, the duration of loss of consciousness, and the neuroimaging findings could not be obtained for most participants. However, all the participants have been documented by the site as being moderately to severely injured, and to date require some level of supervision.
- Despite unyielding attempts, demographically matched control participants could not be recruited as per the original enrollment plan. Due to the limited sample size of the control group, the previously proposed statistical analysis was modified.
- To reduce the effects of self-reporting bias, the original financial capacity measure was modified for the current study. This has been detailed in the following sections.

- For hypothesis 2, Pearson's correlations yielded fewer than expected significant associations. Hence, the regression model was not used.

1.8 The current study

In summary, the extant literature, although limited, has found that individuals with ABI have worse and more varied financial capacity impairments as compared to demographically matched controls. The pattern of improvement for financial capacity is congruent with the typical cognitive recovery patterns found in ABI. Moreover, this improvement is dynamic in the sense that role of neurocognitive predictors change with the post-injury ABI period.

However, most of the studies that have examined the nature of financial capacity in individuals with ABI have specifically and exclusively investigated the financial capacity affected within one year post-injury. It is well-known that post-injury cognitive and psychosocial recovery patterns changes with time ²⁹ and therefore it becomes crucial to examine this issue in relation to financial capacity to better aid rehabilitation efforts. Moreover, the studies focusing on assessing the contribution of cognitive abilities to financial capacity have found mixed evidence regarding the influence of various cognitive abilities. Among the cognitive abilities, the role of impulsivity in relation to financial capacity has not been exclusively examined.

The current study was designed to directly address many of the gaps in the literature and proposed to – (1) compare the nature of financial capacity in individuals with moderate to severe chronic ABI with demographically matched controls to examine the nature of financial capacity. (2) investigate the

association between cognitive abilities (attention, working memory, language comprehension, executive functions, impulsivity) and financial capacity performance in the ABI group, and (3) to understand the nature of association of ABI group's self-report on the financial capacity and their informant's (clinical case managers, therapists, or care-givers) report on a parallel version.

Understanding these three questions was vital to the current study because specific rehabilitation plans can be developed in a targeted manner. For example, if the study finding revealed that impulsivity contributed to low scores on financial judgment dimension, then therapists can design interventions that focuses on reinforcement strategies that seek to reward behaviors that manifest delayed gratification or modify the environment to allocate smaller amounts of money instead of a larger sum. On the other hand, if the study finding revealed that individuals with ABI had difficulty managing their finances because of poor arithmetic skills, then specific efforts to strengthen the individuals Math skills can be undertaken. Another advantage of conducting this study was that the findings would aid in making critical decisions regarding whether an individual should be appointed a legal guardian and/or if the individual could transition to an unsupervised or a lowered level of supervision in managing the finances.

The specific aims and hypotheses of this proposal were:

Aim 1: To compare the financial capacity of the ABI group with demographically-matched healthy controls.

Hypothesis 1: Control group would perform better than ABI group on overall financial capacity.

Hypothesis 2: Control group would perform better than ABI group on all the clinical dimensions of financial capacity.

Aim 2: In the ABI group, to examine the cognitive predictors (attention, working memory, verbal memory, executive function, impulsivity) of financial capacity in the ABI group.

Hypothesis 3: Working memory (Arithmetic) and executive functioning (WCST) will contribute to the overall FCAI score to a higher extent as compared to the other cognitive abilities.

Hypothesis 4: Due to the multidimensional nature of financial capacity, specific and unique one-to-one correspondence will be found between specific cognitive abilities and the clinical dimensions of the FCAI.

Aim 3: In the ABI group, to explore the relationship between self report and informant report of financial capacity on the overall FCAI, and its clinical dimensions.

Hypothesis 5: There will be a positive relationship between self and informant report of financial capacity.

2. DESIGN AND METHODS

2.1 Participants

The study enrolled 29 individuals with moderate to severe ABI from Bancroft Brain Injury Services, a post-acute, community-based rehabilitation center based in central and southern New Jersey. Twelve age- and education-matched control participants were recruited from the community via flyers posted at various venues, such as various community centers, hospitals, college campuses, and the Applied Neurotechnologies (ANT) Lab database of individuals

who had volunteered to participate in research studies. The inclusion criteria for those with moderate to severe ABI were: 1) per review of medical records, the presence of an ABI. 2) age at the time of injury was 18 years or more, 3) were able to read English at the 5th grade level, 4) aged between 18 to 60 years. Older adults aged above 60 years were not recruited because studies have found differences in financial decision making and cognition between younger and older individuals^{30,31}. Only the last two inclusion criteria were applied for control group participants. The exclusion criteria for all participants were: 1) individuals diagnosed with schizophrenia, severe depression (with the exception of depression), bipolar disorder or those undergoing pharmacological treatment for substance abuse or dependence, or using substances such as alcohol, amphetamines, barbiturates, benzodiazepines, cocaine, and opioids, 2) estimated pre-morbid intellectual ability below the cutoff of 70 as determined by previous clinical records, 3) compromised ability to understand instructions, and was not able to give informed consent as deemed during the semi-structured interview, 4) was currently or actively involved in legal proceeding or a lawsuit, 5) had severe motor and/or sensory deficits because of which testing becomes infeasible, and 6) For healthy controls, no neurological diagnosis of acquired brain injury, or neurological diagnosis related to degenerative disorders such as dementia or movement disorders such as multiple sclerosis should be present.

To ensure that participants met the inclusion/exclusion criteria, a two-tiered screening process was adopted – for the first-tier, a brief telephone screening was conducted with control participants. For those with ABI, given the chronicity of the injury, several participants' medical records did not have all the

information pertaining to their initial Glasgow Coma Scale rating, the presence and length of posttraumatic amnesia, and their neuroimaging records. Therefore, to determine eligibility, in addition to the medical records, a formal meeting with the day-treatment program's neuropsychologist was conducted. All the ABI participants that were recruited were characterized as having moderate to severe brain injury, and were confirmed by the neuropsychologist as living in a residential community requiring at least some level of supervision. Once deemed eligible, for the second-tier, potential participants were invited to participate in the study. If they indicated interest, a testing session was scheduled wherein after obtaining informed consent, participants underwent a formal screening process to ensure they met criteria for participating in the study. Two out of eleven control participants and four out of 29 ABI participants were excluded as they did not meet the screening criteria.

The total sample consisted for 9 control and 25 ABI participants. Table 1 details the demographic characteristics for both these groups, including a comparison between the control and a matched subgroup of ABI participants. Eleven ABI participants (44%) received cognitive therapy related to financial management.

2.2 Procedure

For participants who cleared the screeners, a predetermined, counterbalanced order of tests was used (see Appendix A) to control for the effects occurring due to fatigue. Participants were encouraged to take breaks whenever required. All the recruited participants, except for those from Bancroft, will be given \$40 at the

end of session. Those from Bancroft were paid \$5; paying a larger sum was deemed by Bancroft Brain Injury Services' Institutional Review Board (IRB) as being potentially coercive).

All control group participants completed the testing and the interview in one session, whereas five out of 25 ABI participants took two sessions to complete the testing. During both the sessions, participants were encouraged to take short breaks to decrease the impact of fatigue on test performance. All procedures were approved by Drexel University's and Bancroft Brain Injury Services' IRBs.

2.3 Informants

In addition, for the ABI group, interviews with 22 informants were conducted.

Informants were selected based on their familiarity with the individual's past and present financial functioning. They consisted of cognitive therapist (n=16, 73%), clinical case manager (n=2, 9%), speech therapist (n=1, 4.5%), and family members [sister, n =2, 9%; father, n = 1, 4.5%]. All informants were interviewed either face-to-face or over the telephone.

2.4 Measures

2.4.1. Financial Capacity:

The Financial Competence Assessment Inventory (FCAI) is a 38 item individually administered structured interview and uses a combination of self-report and performance-based tasks to assess an individual's financial capacity¹⁵. Self-report items consist of asking individuals to respond to questions such as, "do you receive bills?", or "do you keep money aside for expected bills?". Performance-based items comprise of observing individuals perform specific tasks such as

filling a form, or the ability to calculate a hypothetical account balance. The financial capacity is measured on six clinical dimensions: Everyday Financial abilities, Financial Judgment, Estate Management, Cognitive Functioning related to Financial Tasks, Debt Management, and Support Resources. The FCAI produces two outcome indices based on – (1) each of the six clinical dimensions, and (2) the Overall score.

Using an empirical approach, the conceptual model underlying this instrument was first developed after consultation with various professionals such as clinicians, lawyers, and accountants. The FCAI has demonstrated adequate psychometric properties when used with individuals with and without cognitive impairments. It has a high internal consistency ($r = .96$) and split half reliability (Guttman split-half $r = .96$). Similarly, its inter-rater reliability (89%) is strong, whereas its test-retest reliability when administered a week apart ranges from moderate to high for the different dimensions of the test (r ranges from .57 to .99). Validity analyses showed that this instrument can adequately distinguish between individuals who were financially competent versus those who were not (as determined by the presence of a legal guardian or conservator). Using factor analysis, the FCAI was found to have six underlying factors (represented as the six clinical dimensions) that accounted for 54% of the variance. For the four legal abilities, using a Q-sort technique, professionals such as lawyers and psychologists showed a 75% rate of agreement.

The developers of this instrument did not create cut-off scores because they intended for this instrument to be primarily used as rehabilitation tool rather than for diagnostic purposes per se. For example, based on an individual's

patterns of strengths and weaknesses on the FCAI, specific strategies can be taught to enhance the individual's financial ability in the weak areas. Given the purpose and the format of the test, the authors purposefully made this test an untimed one. On an average, researchers have found that participants taken approximately 30 minutes to complete this test. These two indices – scores on the six clinical dimensions and the overall score - will be considered as the outcome variables for the current study.

2.4.2. Financial Capacity Assessment - Third-Party Perspective (Informant Report):

The FCAI has also been developed to provide information from a third-party perspective ³². Research has found that informants' scores on four of the six FCAI subscales (Everyday Financial Abilities, Financial Judgment, Estate Management, and Cognitive Functioning) were positively associated with participants with a cognitive impairment (Kershaw & Webber, 2010; 2012). The FCAI Third-party Perspective response form is designed to be administered to someone who knows the person well (such as a family member, caregiver, therapist, etc). The FCAI Third-Party Perspective Form comprises of 38 items, analogous to the self-report FCAI form, with the aim of measuring the same six FC dimensions. However, per the manual, the wording of the items are different from the FCAI form. For example, Item 4 on the original Form reads, "This is a typical household bill. Would you please read this bill and tell me who it is from and how much is due? When is this bill due for paying?" On the Third-party Response form item 4 reads "How well would (the person) be able to read a

typical household bill, that is, determine who the bills is from, how much is due, and when the bill is due for paying”?

2.4.3. Cognitive variables:

The neuropsychological tests pertaining to different cognitive abilities were administered following published procedures. These domains and their corresponding tests were as follows:

Pre-morbid Intelligence

The Wechsler Test of Adult Reading WTAR; ³³ was employed to measure an estimate of premorbid intelligence . This brief test consists of 50 words that become increasingly complex and has several irregular pronunciations. The WTAR was normed on a large national sample and has shown to possess excellent psychometric properties ³⁴ and has been found to be a reliable estimate of premorbid intelligence in a brain injured sample ³⁵.

Current Intelligence

The Full Scale IQ was calculated using the Wechsler Abbreviated Scale of Intelligence WASI-II; ³⁶. The WASI-II is a popular and psychometrically sound test that has been used for measuring the FSIQ in clinical, educational and research contexts. The two-subtest form comprising of Vocabulary and Matrix Reasoning was favored over the four-test form because of brevity and time considerations.

Attention

Trail Making Test TMT- A; ³⁷ – To perform efficiently on TMT-A, participants require intact attention to sequence numbers. Participants were scored based on time taken (in seconds) to accurately complete the task.

Digit Span-Forward subtest from the Wechsler's Adult Intelligence Scale, Fourth Edition WAIS-IV; ³⁸: The Digit Span-Forward subtest requires participants to repeat numbers in the same sequence as the examiner and is a commonly used test to measure attention. Following the WAIS-IV scoring guideline, participants were scored based on the total number correct.

Memory

Immediate and delayed verbal recall of contextual information was examined via the Logical Memory subtest of the Wechsler Memory Scale - Third Edition WMS-III; ³⁹. This test has been often used to assess verbal memory in both clinical and research settings.

Executive Functioning

Trail Making Test TMT-B; ³⁷ – TMT-B requires cognitive flexibility and set-shifting ability, and as such this test was used to measure executive functioning. Participants were scored based on time taken (in seconds) to accurately complete the task.

Similarities - The Similarities subtest from the Wechsler Adult Intelligence Scale - Fourth Edition WAIS-IV; ³⁸ was used to measure abstract thinking.

Controlled Word Association Test COWA; ³⁴ - For this test of verbal fluency, participants were asked to generate as many words as they can in one minute for the letters F, A and S.

Category Fluency - Similarly, participants were asked to generate as many animal names under one minute to examine their semantic fluency.

Processing Speed:

Oral Symbol Digit Modalities Test SDMT; ⁴⁰ - Because of the presence of motor deficits in individuals with ABI, the processing speed was assessed using the oral SDMT. The oral version of the SDMT has been normed according to age and education level, and has been shown to have good psychometric across many clinical participants ⁴⁰. For this task, participants were given a sheet of paper with a set of nine geometric symbols paired with numbers from one to nine. Participants were required to say aloud the numbers that corresponded to each geometric symbol for a total of 90 symbols.

Working Memory

Digit Span and Arithmetic subtests from the WAIS-IV (WAIS-IV; Wechsler, 2008) were administered to measure working memory. The Digit Span-Backwards subtest required participants to repeat the numbers in the reverse order, whereas Letter-Number Sequencing subtest required that numbers and letters be arranged sequentially in an ascending order. The Arithmetic subtest consists of word problems that are read aloud to which answers have to be provided within a specified time. All three of these tests require mental control and as such will be taken to measure working memory.

Impulsivity

Temporal Discounting task – Based on the work of McHugh et al. (2008), this study utilized an automated discounting task where participants compared and chose the relative monetary values in the face of short-term rewards (SSR) versus long-term rewards (LLR). For this task, all trial presentations were presented on a computer. The computer was pre-programmed to use an automatic choice algorithm as was initially described by Richards et al. (1998). For each trial

presentation, the LLR value was kept constant (\$100) while the SSR value varied (from \$1 to \$ 99) across nine time delays (1 day, 2 days, 1 week, 2 weeks, 1 month, 3 months, 6 months, 9 months and 1 year). The combinations of the LLR/SSR were randomized across trails. Over several trails, using a random adjusting-amount procedure the algorithm gradually converged on the indifference point for the LLR. The convergence was based on the prior responses made by the participant wherein the algorithm was pre-programmed to select a SSR value for the next trail presentation based on an adjusted narrower band of values.

By using each participant's indifference scores, the Area Under the Curve (AUC) was derived. After perusing the work of Myerson and Green (1995), the authors of the discounting task used a similar theoretically neutral and a mathematically driven method for calculating the AUC. In the current study, the AUC was derived by following a similar methodology and this value was used for all statistical analyses.

2.4.4 Questionnaires and Scales:

Depression – The Beck Depression Inventory, Second Edition BDI-II; ⁴² is a 21 item self-report questionnaire frequently used to assess the intensity of depression. Upon comparing the BDI-II against the original BDI in a large clinical sample, the BDI-II has been found to have high clinical sensitivity (Coefficient Alpha = .92) as compared to its predecessor.

Anxiety – Similar to the BDI-II, the Beck Anxiety Inventory BAI; ⁴³ is a 21 item self-report questionnaire frequently used to assess the severity of anxiety

symptoms. This popular test has been found to adequately discriminate between people with and without anxiety.

Impulsivity – Barratt Impulsivity Scale II BIS-II; ⁴⁴ has been validated on a TBI sample ⁴⁵ and has been widely used in clinical and research practice ⁴⁶. This self-report questionnaire comprises of 30 items and yields an overall score and three second order factor scores; viz, Attentional, Motor (acting without thinking), and Nonplanning. Participants were asked to rate their behaviors and preferences on a 4-point likert scale. This questionnaire has been commonly used to describe personality/behavioral impulsivity and as such as good psychometric properties ⁴⁵.

2.5 Statistical Analysis

All analyses were performed using PASW 22.0. Analyses in the current study used descriptive analyses, Pearson's correlations and considering the small sample size, non-parametric statistics (Mann Whitney U Test or Wilcoxon Signed Rank Test) to compare the performance between control and ABI groups, and to compare the ABI and their informant reports. Descriptive analyses were performed for demographic, cognitive, and financial variables. Means and standard deviations (or percentage/frequencies for categorical variables) for variables of interest were reported for each group. For all the analyses raw scores were used.

To examine the inter-rater reliability of financial capacity's Overall score and its dimensions when administered by different raters, all the FCAI protocols were double scored, and analyzed for consistency using intra-class correlations.

Preliminary analysis was conducted to examine the data for the presence of outliers, and the appropriateness of assumptions of linearity and normality. In case of outliers above or below 3SD, the extreme values were replaced with the next smallest or largest value ⁴⁷. Due to the presence of skewed distributions and given the small sample size, non-parametric tests were employed.

Of the six clinical dimensions, Debt Management was omitted from the analysis for Hypotheses 1 and 2 owing to its limited number of items and its restricted variance ⁴⁵. This is in congruence with the study by Pachana et al ⁴⁸ wherein this dimension was found to be problematic, and was similarly dropped from all their analyses .

To maintain the objectivity of the FCAI and eliminate the potential biasing influence of items which rely on intact memory and awareness, a subset of 20 out of 34 items were selected. Specifically, in the current study, objective items referred to those items which were purely based on objectively scored performance on a task (e.g., writing a check) or responding to a question which clearly relied on an external definition (e.g., meaning of assets). Recall-based responses (e.g., do you owe debts) or responses for which verifiable information would have to be obtained through other sources (e.g., do you budget) were considered as non-objective or biased. After eliminating the biased items, the modified objective FCAI consisted of 2/9 items on Everyday Financial abilities, 7/8 items on Financial Judgment, 4/7 on Estate Management, and 1/4 on seeking Support Resources. All the 6 items on the Cognitive Functioning related to Financial Tasks were objectively assessed, and thus this dimension was not modified.

Therefore, after excluding Debt Management dimension, analyses for the **Hypotheses 1 and 2** were conducted for the full version of the FCAI (FCAI-full) which consisted of the five clinical dimensions and the composite score derived from those five dimensions (34 items), and on the objective version of the FCAI (FCAI-objective) which consisted of objectively derived scores for the five dimensions and composite score derived from these objective dimensions (20 items).

Of note, for hypothesis 3, all the 38 items and six dimensions (FCAI-original) were considered during the analysis to maintain the integrity of the self and informant interviews, and to better elucidate the contrasting nature of their responses.

Analyses and results have been described in relation to each of the study hypothesis. To examine the first hypothesis, considering the small sample size and the skewed distribution, non-parametric statistics were conducted. Specifically, the Mann-Whitney U test was used to compare the performance between the control and the ABI groups. Supplementary analysis, using Pearson's correlations for the control participants was conducted to investigate the association between FCAI-full and FCAI-objective Overall score and its dimensions, and the different cognitive abilities. To examine the second hypothesis, Pearson's correlation analysis was conducted in the same manner described above. To address the final hypothesis of the study, self-report was compared to informant-report for the overall FCAI and its five dimensions using Pearsons' correlation and Wilcoxon signed-rank tests for related samples.

3. Results

Regarding demographics, there were no group differences between control and ABI subgroup with respect to sex, age, education, current and premorbid intelligence (Table 1).

3.1. Inter-rater reliability: To assess inter-rater reliability of FCAI-full, intraclass correlations (ICC; absolute agreement) were calculated for the Overall score and each dimension in all control (N = 9) and ABI participants (N = 25). For all the variables examined, the ICC showed a high degree of agreement. It ranged from 0.96 to 0.99 for the ABI group, and from 0.83 to 0.99 for the control group. Values above 0.75 are considered as acceptable ⁴⁹, and as such the FCAI reflects adequate inter-rater reliability.

3.2. Comparing financial capacity in control versus the ABI group:

Using the FCAI-full, control participants were significantly better in performing financial activities related to Everyday functioning, Financial Judgment, seeking Support Resources and the Overall FCAI score, compared to ABI participants (see Table 2). After eliminating items representing self-reporting bias, the results for the FCAI-objective remained mostly comparable, with the exception of seeking Support Resources which was no longer significantly different between the two groups. Of note, although not significant, the median values for the control group was higher than those found for the ABI group for this dimension.

Supplementary correlation analysis between the Overall score and the five clinical dimensions of financial capacity, and the cognitive abilities in the control group was conducted. In case of FCAI-full, the Overall FCAI score was significantly and positively associated with working memory ($r = 0.68, p < 0.05$) and abstract thinking ability ($r = 0.67, p < 0.05$). But, when the analysis was reconducted for FCAI-objective, although not significant, the significance level for working memory ($r = 0.65, p < 0.06$) and abstract thinking ability ($r = 0.65, p < 0.06$) and the Overall score was trending. For the dimension of Everyday Functioning, using FCAI-full, significant and positive associations were found for mental Arithmetic ($r = 0.70, p < 0.05$), and self-rated impulsivity ($r = 0.79, p < 0.06$), whereas for FCAI-objective, the significant correlations changed and was present for working memory ($r = 0.67, p < 0.05$) and abstract thinking ability ($r = 0.83, p < 0.01$). For Financial Judgment, significant associations were found for abstract thinking ability ($r = 0.71, p < 0.05$), and immediate ($r = 0.73, p < 0.05$) and delayed ($r = 0.74, p < 0.05$) verbal memory. Interestingly, these associations remained the same even when items were eliminated, showing that participants response styles were consistent irrespective of the type of questions asked. Lastly, for Estate Management, significant positive correlations with attention was present ($r = 0.66, p < 0.05$) in the FCAI-full, but this disappeared when the FCAI-objective was considered. No other correlations were significant.

3.3. Association of financial capacity and cognitive abilities: For the ABI group, correlation analysis findings for the association between Overall score and the five dimensions of financial capacity and the different cognitive abilities are

presented in Table 3. In case of FCAI-full, no significant associations were found for the Overall score. But, in case of FCAI-objective, significant and positive correlations were found between the Overall score and working memory, whereas the significance level was trending for delayed verbal memory. Similarly, in case of FCAI-full, a significant, negative association between Estate Management and temporal impulsivity as measured by the discounting performance, and a significant, positive association between seeking Support Resources and attention was found. A higher number of significant associations were found when data was reanalyzed with FCAI-objective, such that Everyday Functioning was positively associated with working memory and abstract thinking, Estate Management with steeper temporal discounting indicating impulsivity, and seeking Support Resources with verbal fluency. The Cognitive Functioning related to Financial Tasks dimension was positively associated with delayed memory, and negatively associated with complex working memory. For the ABI group, additional correlation analyses between the two measures of impulsivity (self-rated and objectively measured on the discounting task) and the cognitive abilities was conducted to shed light on the nature of impulsivity in the context of financial capacity. For the ABI group, the area under the curve was significantly related to the motor subscale ($r = -0.46, p < 0.05$). There was no relationship between AUC and the total BIS II ($r = -0.30, p = 0.19$), or the attention ($r = -0.22, p = 0.33$) and non-planning ($r = -0.35, p = 0.88$) subscales.

3.4. Association between and Comparison of Self and Informant

Report: Using Pearson's' correlation, none of the association between self-and

informant-report was significant for the Overall score and dimensions of the FCAI-full. Using Wilcoxon signed-rank tests, for the Overall score, the ABI participants self-report did not differ from their informant report. At the dimensions level, ABI participants self-report differed from their informant report on two out of six dimensions (see Table 4). Specifically, for seeking Support Resources, ABI participants displayed significantly higher levels of knowledge than the informant's perception of their knowledge level. This discrepancy was relatively large as noted from the effect size (r). In the case of Debt Management, relatively medium effect sizes were found, wherein ABI participants endorsed significantly better awareness of and ability to manage their debts than their informants. Although not significantly different, medium effect size for the Estate Management was present, with informants rating ABI participants' estate management ability as higher than ABI participants themselves.

4. Discussion: The empirical investigation of financial capacity in relation to cognitive abilities in individuals with chronic, moderate to severe brain injury has not been studied. Our findings demonstrated that individuals with ABI had lowered performance on the overall and the different dimensions of financial capacity as compared to demographically-matched individuals without neurological deficits. Unique and varied sets of cognitive abilities were associated with the overall and specific dimensions of financial capacity, thus stressing the complex, multidimensional nature of the construct and elucidating the importance of memory processes in the ABI group. The role of impulsivity, which

was heretofore unexplored in this context, was found to be associated with financial capacity. Finally, based on quantitative and qualitative analysis the discrepancy between self and informant report highlights the finding that both ABI group and their informants are prone to misestimating their financial management abilities for various reasons such as reduced self-awareness in the ABI group and using inadequate behavioral referents in the case of the informants. In summary, these findings confirm the need for providing constant assistance in helping people with brain injuries to manage their finances.

4.1. Comparing financial capacity in control versus the ABI groups:

Differences between the ABI and control group were examined on the overall and various financial capacity dimensions. As anticipated, the control group performed better than the ABI group on the overall and dimension levels. Specifically, group comparisons revealed that control group performed significantly better than ABI on the overall financial capacity and on two of five clinical dimensions, viz Everyday Functioning and Financial Judgment, even when items reflecting biased self-report were excluded. Both these dimensions subsume functional activities requiring problem-solving and decision-making abilities associated with tasks such as understanding a bank statement and knowing the importance of paying a bill. Comparatively, other dimensions such as Estate Management and Cognitive Functioning subsume activities requiring relatively simpler abilities pertaining to conceptual knowledge and basic numerical ability such as knowing what assets are or identifying and counting currency. This finding is consistent with those reported by Dreer et al ⁸ in which

control participants performed better than TBI group on the overall financial task, and on six out of nine domains. Specifically, TBI participants evidenced lowered performance on complex financial dimensions such as financial concepts, checkbook management, bank statement management, bill payment, and investment decisions, but performed comparably on simpler dimensions such as performing transactions. Such findings reflect the sustained nature of financial impairments that exist in people with moderate to severe level of brain injury, and highlight the need for continued monitoring and assistance from their support system.

In the present study, for the control group, working memory and abstract thinking abilities were associated with both the original and objective versions of the overall financial capacity. Similarly, abstract thinking and verbal memory was associated with the original and objective clinical dimension of Financial Judgment. However, the nature of the association changed for the clinical dimension of Everyday Functioning such that Arithmetic and self-rated impulsivity were associated with the original version, whereas only abstract reasoning was associated with the objective version after eliminating items with the potential for self-report bias. The finding that abstract thinking was associated with Overall financial capacity, Everyday Functioning and Financial Judgment reflects the sturdy contribution of executive functioning to financial capacity. Similarly, the finding that Overall financial capacity and Everyday Functioning was associated with working memory reflects the contribution of complex and higher level cognitive abilities which required the ability to juggle and manipulate incoming information with already processed information. The

association of verbal memory with Financial Judgment is not surprising given the composition of tasks, such as having long term financial goals or ability to recall information pertaining to elements present in a bank statement, for example. Interestingly, when items for which verifiable information could not be obtained were included, other cognitive abilities such as Arithmetic and self-rated impulsivity were found to be associated Everyday Functioning dimension. This may reflect the varied item pool included in the dimension of Everyday Functioning, and may shed light on item-specific correlations. It makes logical sense that attention was associated Estate Management given the basic nature of questions, such as describing their assets, encompassed in this dimension. Of note, after discarding items representing bias, attention was no longer significantly associated with this dimension. Finally, the absence of strong associations between the cognitive abilities and two dimensions of financial capacity (Cognitive Functioning associated with financial abilities and seeking Support Resources) may indicate the contributory role of other abilities such as planning and reasoning, which were not subsumed in the present study, and as such requires further investigation.

In summary, the exclusive nature of associations between specific sets of cognitive abilities and each dimension of financial capacity confirms the multifaceted nature of this construct. Remarkably, the permutation of these associations varies when the objective compared to the original version of the financial capacity dimensions were considered, thus underscoring the importance of accounting for the measurement approach employed (subjective versus

objective) when evaluating financial capacity in the context of cognitive predictors.

4.2. Association of financial capacity and cognitive abilities: To examine the cognitive associations of financial capacity, various cognitive tests assessing attention, memory, executive functioning and impulsivity were correlated with the overall FCAI and its dimensions. The expectation that working memory and executive functioning ability would contribute to the overall FCAI was partially supported. The overall objectively measured financial capacity was associated with working memory and the significance level was trending for delayed memory. This finding is not surprising and can be easily explained given the nature of the tool. Specifically, a detailed inspection of the FCAI reveals that several items (e.g., paying bills, knowing how to read a bank statement, knowing whom to seek for help, etc) rely on information in which the respondents have to register and process the information by thinking about it in other contexts, and then draw that information from their memory based on their experiences. Thus it makes sense that the given the nature of FCAI items, the integrity of working memory and delayed verbal memory play a critical role. The original study by Kershaw and Webber¹⁵ did not utilize the cognitive tests that were used in the study, and therefore a direct comparison cannot be made. However, in congruence with the present study, previous studies have also underscored the importance of complex memory processes to manage finances efficiently^{8,17-19,28}.

The expectation that unique and varied one-to-one correspondence will be found between specific cognitive abilities and the clinical dimensions of the FCAI

were partially supported (Table 3). Five of the six clinical dimensions were found to be associated with specific sets of cognitive abilities, and parallel to the earlier observations made for the control group, the permutation of associations varied for the objective versus the original version of the financial capacity dimensions. Furthermore, the number of associations was higher when the objective version was used.

Specifically, for the dimension of Everyday Financial Abilities, the objective version was associated with working memory and abstract reasoning (Table 3). This finding is not surprising considering that this dimension includes activities done on a routine basis such as knowing how to pay bills and the consequences of non-payment, and also includes routine financial problem-solving tasks including knowing how to budget. Both, the original and objective versions of the Estate Management dimension were associated with impulsivity as assessed on the discounting task. Of note, this association was held in a stronger form when items reflecting self-reporting bias were eliminated. Items under the dimension of Estate Management include basic items requiring conceptual understanding of assets and banking protocols. The temporal discounting task, which assesses the tendency of individuals to prefer smaller, more immediate monetary rewards instead of delaying gratification and getting larger monetary rewards, has been found to reflect impulsive decision making in individuals with TBI ^{21,26}. It seems reasonable to expect that individuals who discounted more heavily (ie., were unable to delay gratification) would be worse at managing their finances as reflected by poor management of their financial assets. For the dimension of seeking Support Resources which assesses assistance

seeking skills, whereas the original version was associated attention, the objective version was associated with semantic fluency. Even though semantic fluency is commonly categorized as a measure of executive function, some studies have implicated the role of temporal lobe in animal fluency^{50,51}. Given that this neural substrate is also heavily involved in memory functioning along with verbal fluency–abilities which are critical for remembering what resources are available and who to ask for help, makes this finding reasonable. Lastly the dimension of cognitive functioning was associated with delayed memory and executive functioning. It is noteworthy that, in the comparison group, there was a lack of strong association between cognitive abilities and the latter two clinical dimensions (seeking Support Resources and Cognitive Functioning). The discrepant finding for the two groups suggests that in people with chronic, moderate to severe brain injuries, the role of simple attention and memory is critical while performing functional tasks such as writing a check or remembering a PIN number.

In keeping with the findings from the present study, inconsistent findings between specific cognitive abilities and various financial abilities have also been reported by previous studies. Such divergent findings, both within and across studies, can be partially accounted for by various factors such as the specific financial dimension being measured (ATM use versus knowledge of checking account versus ability to remember a PIN), the choice of the cognitive tests used in the studies (e.g., varied executive functioning tests), and the type of sample selected [clinical (AD, MCI, brain injury) versus non-clinical (control)]. Some researchers have argued that cognitive abilities measured via cognitive tests do

not share one-to-one correspondence with financial abilities for example,¹⁴ and as such can be influenced by myriad, non-cognitive factors including but not limited to prior experience, affect, and personality such as being socially vulnerable^{5,8,17,18,20}. It will be interesting for future studies to expand their studies by include such factors.

In the ABI group, it is intriguing that abstract reasoning was not associated with overall FCAI to a higher extent, and that mental Arithmetic was not associated with any FCAI dimension. In the original study¹⁵, abstract reasoning (using Similarities subtest) was associated with the overall FCAI score and two FCAI dimensions—Estate Management and Cognitive Functioning. In the current study, abstract reasoning was associated with only the FCAI dimension of Everyday Functioning and that too after items with potential for self-reporting bias were eliminated. Regarding Arithmetic abilities, in the original study¹⁵, this was associated with overall FCAI score, and with three dimensions—Financial Judgment, Estate Management and Cognitive Functioning, whereas in the current this was not associated with any FCAI dimension. Superficially, the findings from the current study do not match those found in the original study. Although intriguing, a close examination of the discrepant findings between the two studies may be accounted for by the composition of the sample, the nature of impairments in the ABI group, and the choice of the measures used in the two studies. The original study recruited 36 adults with ABI with mean age 55 years (64% males) with the etiology related to stroke and alcohol-related brain injury. However, the current study consisted of 68% males with mean age of 46 years with etiologies ranging from motor vehicle accidents to falls and tumors.

Whereas, in the current study, the mean time since injury for the ABI group was 18 years and all the participants had supported living, the original study did not explicitly provide both of these critical pieces of information. The time since injury is an important consideration because of the dynamically changing contributions of cognitive functions to financial capacity. In a study by Martin and his colleagues¹⁷, it was discovered that 1 month after the injury, mental arithmetic and immediate verbal memory predicted financial capacity, whereas six months after the injury a different set of cognitive abilities including mental arithmetic and executive function predicted financial capacity. Other studies, have underscored the importance of investigating the contribution of reduced self-awareness to financial capacity^{5,8,17,52,53}. In the current study, although self-awareness was not directly investigated, the self and informant report of financial capacity showed significant discrepancies on items assessing “real-world” abilities such as requiring help paying bills, owing debts. Studies have shown that reduced self-awareness is related to impaired cognitive functioning, and lowered functional independence⁵⁴.

Relative to the performance-based impulsivity task measuring temporal discounting, it is interesting that self-rated impulsivity as measured by the BIS II was not associated with any of the financial capacity dimensions. Additional analysis examining BIS II total score and its subscales with the discounting task revealed that only the motor subscale was significantly and negatively correlated with discounting task, indicating that the self-rated tendency to act impulsively was associated with a higher tendency to discount. Moreover, in the current study, intelligence was not found to be associated with discounting task. These

findings contradict those found by Wood et al.²¹ in which a significant association between the total BIS II score and the attention subscale was found, but no significant association was detected for intelligence. Such contrasting findings may be accounted for by two possible explanations. First, the type of measurement approach used varies across studies; the use of direct behavioral observation versus self-report versus informant rating scales versus performance measures^{24,26,45,46}. For example, in the study by Votruba et al.²⁴, no association between self-reported impulsivity as measured by the BIS II and clinically based, in-vivo observations of impulsivity was found. It has been proposed that whereas self-report measures of impulsivity may be measuring the “trait” dimension of impulsivity, performance-based measures of impulsivity may be measuring the “state” dimension of impulsivity⁴⁶ and as such can be influenced by factors such as financial need, attitude, etc.²¹. Another proposal has been that whereas self-reported impulsivity is associated with ‘verbal impulsivity’, performance based impulsivity is associated with “behavioral or non-verbal impulsivity” for which the individual may be lacking self-awareness⁴⁶. Along these lines, researchers have also suggested that performance based measure of impulsivity may be more ecologically valid and may be sensitive to orbitofrontal compromises which the neuropsychological tests are usually insensitive to^{21,24,46}. This may explain the current studies findings regarding why the self-reported impulsivity was associated with cognitive abilities, but not the performance-based task. Second, the differences in sample characteristics may account for discrepant results found in the current versus previous studies. The sample in the current study comprised of chronic, moderate to severely brain injured individuals who lived in a

supported living community, whereas those in Wood et al's²¹ study were predominantly composed of individuals with executive-type impairments, with injuries ranging from mild to severe and the mean length of injury being 3 years. Therefore, it seems possible that the number and nature of associations found for the BIS II and temporal discounting differ from those found by Wood et al²¹ because of differences in sample characteristics, which have been known to differentially associated with cognitive abilities^{55,56}.

The association of the overall BIS II with objective cognitive abilities of verbal memory ($r = 0.42, p < 0.06$; trending), abstract reasoning ($r = 0.47, p < 0.05$) and verbal fluency ($r = 0.46, p < 0.05$) suggests that BIS II may be tapping into aspects of impulsivity not captured by the performance-based discounting task, thus evincing the factor-structure of these tasks. Interestingly, behavioral observations and participant responses after the discounting task revealed that several participants tended to inconsistently respond and were confused about the purpose of the discounting task. For example, respondents indicated that they “did not understand” the task, and thought that the task was “boring” and “repetitive”. This reflects the questionable construct validity of this task and raises the possibility of the appropriateness of the task for this sample. It is plausible that the abstract and the lengthy nature of the task, may have made a subgroup of participants' responses invalid. Previous studies have also found inconsistent or aberrant responding patterns on this task^{57,58}, thus highlighting the importance of employing behavioral observations and post-task questioning to understand the validity of responses. However, few studies have examined the BIS and temporal discounting task in people with chronic, moderate to severe

ABI, and as such these findings, although unique, need to be replicated with larger samples.

In summary, analogous to the findings for the control group, the second group of analyses once again reinforced the complex and multidimensional nature of financial capacity. Compared to the control group, discrepant relations between specific sets of cognitive abilities and the different clinical dimensions demonstrates the mediating role of structural and neuropathology such as compromised white matter changes⁵⁹ associated with the moderate to severe nature of the brain injury. Furthermore, in the context of financial capacity, as opposed to the control group, the neural mechanisms associated with “accelerated rate of brain atrophy” in individuals with severe brain injury could have also led to the heavier reliance on memory abilities⁶⁰. Lastly, the contribution of impulsivity to financial capacity is a novel finding, and offers an exciting avenue of research.

4.3. Association between and Comparison of Self and Informant

Report: Compared to ABI participant responses, informant responses were likely to represent real-world functioning on the various clinical dimensions of financial capacity^{32,53}. A lack of significant positive correlation was found between the self and informant reports on the overall financial capacity and its dimensions. This suggests that there is a discrepancy between informants’ perception of ABI participants’ financial capacity across all the dimensions. This finding partially contrasts those found by Kershaw et al.¹⁵ where a positive correlation between informants and participants were found on the Overall

financial capacity score and four of its subscales, excepting seeking Support Resources and Debt Management. The lack of congruent results between the current study and Kershaw et al's study ¹⁵ is not surprising because in that study a mixed clinical sample of individuals consisting of those with ABI, schizophrenia, and intellectual disability were included, whereas the current study employed only those with ABI. Given the heterogeneity of their sample and disparity in cognitive impairments that exists among the clinical subgroups, one would not expect to find similar results. For example, differences in neuropsychological performance has been documented between people with brain injury and schizophrenia egs., ^{61,62}. Unfortunately, due to the absence of data on the ABI subsample in Kershaw et al's ¹⁵ study, a direct comparison of findings is precluded.

Previous studies have also found discrepancies in ratings of financial competency between people with ABI and their informants ^{19,23,53,63,64}. It has been argued that impaired self-awareness including impaired memory awareness ^{65,66}, other cognitive and personality changes associated with brain injury sequelae (⁶⁷, the presence of informants' biases ⁶⁸, discrepancies in the informants and their carers use of behavioral referents while answering questions ⁶⁶, and the informants limited knowledge about their carers ³² can lead to informants typically overestimating or underestimating others' abilities.

Impaired self-awareness, especially to perform complex tasks such as money management, has been stipulated to result in discrepancies between self and informant reports ^{64,66}. Congruent with the previous findings in literature, in the current study impaired self-awareness on FCAI responses was also found. For

example, when ABI participants were asked if they required assistance paying bills, 41% endorsed not requiring help, whereas 96% informants reported otherwise. To the question whether ABI participants owed any debts, 36% ABI participants said that they did not owe any debt, whereas all the informants reported that ABI participants were in debt. It is interesting that both these items capture objective “real-world” aspects of financial capacity, and do not leave room for any subjective biases either from the ABI participants or from their informants. Response discrepancies in items such as these may, to some extent, explain why ABI participants may experience difficulty managing their finances and other functional outcomes. Specifically, individuals are highly likely to have difficulty functioning independently if they do not recognize their limitations when performing specific tasks, and appreciate the need for help or acknowledge the help that is being provided to maintain a certain level of functioning in the community. The limited self-awareness may explain the dissociation between “knowing” and “doing” which is often found in people with brain injuries as cited in ¹⁹. Infact, the importance of intact self-awareness has also been found to be related to return to work in people after brain injury ⁶⁹. As such, future studies should aim to study the mediating role of self awareness in financial capacity.

In addition to impaired self-awareness, other aspects of cognition and behavior also need to be considered. In support of the previous findings, the current study found that memory difficulties, impairments in planning and execution of tasks, impulsivity, and discrepancies in behavioral referents between informants and self reports also contributed to the discrepancies between informants and ABI participants’ responses. For example, for the question, “Why

should you pay bills on time?” participants were able to state the consequences of non-payment (electricity will be cut-off, reminders will be sent) and, as per the scoring criteria, such responses were considered to represent ‘complete understanding’. Whereas for the corresponding informant question, “Does he/she appreciate the importance of paying essential bills such as utility bills on time, and understand the consequences of non-payment?”, informants reported that participants were often unable to actually pay their bills on time due to difficulties associated with impulsive spending, forgetfulness, poor awareness of realities associated with receiving different bills and their associated payment schedule, or the lack of ability to perform all the steps required to pay the bill independently. For the question related to the ability to make sound investment decisions, 55% of the ABI participants obtained scores indicating partial to adequate conceptual knowledge of investing money, with only 5% giving responses indicating extremely poor investment ability. By sharp contrast, about 41% of informants reported that ABI participants would spend money impulsively indicating extremely poor investment ability. From these responses, it seems apparent that whereas ABI participants based their responses on purely conceptual knowledge on some of these items, informants based their responses on their actual, real-world behaviors thus resulting in different behavioral referents.

In the current study, informants both underestimated and overestimated ABI participants’ financial abilities. Inspection of the items revealed that informants consistently tended to underestimate ABI participants’ ability to seek support resources such as knowing where to look for help with budgeting, or

where to go for financial advice. On the other hand, informants tended to overestimate ABI participants' ability to state long term goals, understand banking protocols, make determinations regarding an appropriate health care plan, and understand changes in their personal liabilities. In this context, because of the objective nature of these questions, the ABI participants' responses were scored in a relatively straight-forward manner, and as such the informants' responses are suggestive of biases operating in both an upward and a downward direction. An examination of the informant characteristics might shed light on the nature of these biases. In contrast with other studies wherein informants mostly included parents, siblings or other caregivers, about 77% of the informants in the present study were therapists who were, either directly or indirectly, working with the ABI participants on improving their money management skills. Given their role, it may be that these informants perceived their work as having a direct impact aligning with their cognitive therapy goals, and thus may have overestimated ABI participants' skills to understand and formulate long-term goals, understand banking procedures, health care protocols, and their financial situation. Due to ABI participants' unique living arrangements in the community and given the therapists' role, most therapists assumed that ABI would approach them as the primary source of providing support and information when issues related financial abilities emerged (support resources). It may also be that therapists have not yet had a chance to observe ABI participants in situations such as these, and the lack of exposure to situations like this may have led them to underestimate the ABI participants' ability to seek support resources. Further complicating this picture is the finding that people

with head injuries have been found to have limited self-awareness of functional implications of their deficits in terms of their ability to live independently, work and perform other instrumental activities of daily living, and in their ability to set realistic goals and plan for the future ^{64,66}. Therefore, the presence of such discrepancies needs to be carefully evaluated in future studies given that informant report is generally weighed heavily in making competency evaluations. Concerns with using informant report as the gold standard has also been raised by other researchers ⁷⁰. This is not to suggest that informants' information should not be used. Rather, informant and ABI participants' responses should be used in conjunction whenever possible ²³, or information from more than one informant should be collected in addition to objective neuropsychological data to offset the potential for bias from any one single source ⁶³.

In summary, the last group of analyses supports the extant literature and further highlights the idea that a combination of several factors such as impaired awareness, memory difficulty, executive functioning impairments such as planning and goal setting, and impulsivity may be contributing to the discrepancy between the self- and informant-report. In the current study, the presence of diminished self-awareness and memory difficulties, in the ABI sample, posed a challenge while assessing financial capacity. Therefore, instead of solely relying on self-report, the task was made objective, wherein the number of associations between cognitive abilities and the financial capacity dimensions was found to be higher (3 out of 4; excluding Cognitive Functioning) than the original version (2 out of 4). This was also in contrast to the findings found for the control group,

where the original and objective versions had a similar number of associations (3 out of 4). The overall quality of associations was also different; memory abilities impacted the overall financial capacity in the ABI group but not in the control group. Fundamentally, using the objective measure of financial capacity in conjunction with the informant-based report may have yielded more reliable results, and should be strong consideration in future studies.

4.4. Conclusions: The current study aimed to understand the nature of financial capacity in people with chronic, moderate to severe brain injuries compared to matched controls. The overall findings demonstrated that people with brain injury have decreased financial capacity, and that their functioning may be hindered by the presence of cognitive difficulties in the domains of attention, working memory, abstract reasoning, and verbal memory. The role of impulsivity as measured by temporal discounting, which was heretofore unexplored, was found to be associated with financial capacity, and warrants further exploration. Finally, given the lack of solid associations between the self- and the informant- report, the judicious use of informant report while assessing financial capacity is warranted. In summary, the findings emphasize the important role of monitoring financial capacity and providing ongoing support for people with brain injuries.

Autonomous, functional living abilities such as driving, financial management, and medical management are considered quintessential abilities as they directly impact the quality of life through community re-integration and the ability to live responsibly and safely. Ability to manage finances is akin to driving

performance. On evaluation, if a person exhibits difficulties in driving performance, such as a person with ABI who tends to speed, then the person can be provided with retraining using fundamental driving skills and compensatory techniques⁷¹. In other words, rather than requesting the person to cease driving, provision of additional resources and ongoing support may be beneficial from a rehabilitation perspective. By that token, a person exhibiting difficulties managing finances is likely to benefit from periodic monitoring and, financial education and training to manage finances.

4.5. Limitations and Future Directions: The present study has a few limitations. First, the generalizability to other brain injury samples, such as mild TBI, is limited because of the sample characteristics. The size of the control group makes it especially challenging to draw clear conclusions, and should be strictly considered preliminary. The nature of the associations will have to be replicated using larger samples. Second, the financial capacity measure used in the current study was designed and validated in an Australian sample. Although, in the current study, the measure had adequate inter-rater reliability, it is apparent that more work is required to adapt this measure to the US population. A related issue with the measure, for example, was the format of some items which required self-report. However, given the unreliability of self-report, these items were eliminated. The modified version of the task may have changed the construct validity of the dimensions, and may be measuring something different from what the dimensions were supposed to measure. However, in the present study,

eliminating items was deemed necessary to maintain the objectivity of the dimension and as such helps to solidify the findings by eliminating the confounding effects of self-reporting bias. Given the limited sample size, the psychometric properties of this modified version of the measure could not be examined, and future studies using such a modified version of the measure may benefit from examining the factor structure and related instrument measurement properties. A final limitation of the study relates to lack of an explicit measure of self-awareness. Several responses on the financial capacity and other measures such as the BIS II required intact awareness in concert with other cognitive abilities such as memory. Whereas several measures assessing cognitive abilities and other affective variables were included, the absence of a self-awareness data made the interpretation of the data problematic. It will be interesting for to examine the contribution of self-awareness to financial capacity using the framework used in the current study.

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Appendix A: Order of Counterbalanced Tests.

Session 1	Semi-structured Interview 15 mins WTAR 5 mins WASI-II 15 mins <u>If eligible, then testing continues with:</u> FCAI 30 mins BDI 5 mins BAI 5 mins Barrett's Impulsivity Scale 10 mins Digit Span 5 mins SDMT 5 mins Logical Memory 5 mins Arithmetic 5 mins Letter Number Sequencing 5 mins Trail Making Test 10 mins Similarities 10 mins Tests of language fluency 5 mins Temporal Discounting Task 15 mins
Session 1 Counterbalanced	Digit Span 5 mins SDMT 5 mins Logical Memory 5 mins Arithmetic 5 mins Letter Number Sequencing 5 mins Trail Making Test 10 mins Similarities 10 mins Tests of language fluency 5 mins Temporal Discounting Task 15 mins FCAI 30 mins BDI 5 mins BAI 5 mins Barrett's Impulsivity Scale 10 mins
	Total Time 2 hr 55 mins

Table 1: Summary of demographic characteristics for the ABI and control group, including a demographic comparison for the ABI subgroup with the control group.

	ABI		Control	Mann Whitney U, Z value; or X^2
	N = 25	n=9*	N=9	
	Mean (SD), range; or Frequency (%)			
Age (in years)	46.06 (8.26), 30-59	46.55 (7.85), 35-59	45.88 (8.78), 34-59	Z = 0.931
Education (in years)	13.28 (2.09), 9-19	13.67 (1.32), 12-16	14.11 (2.03), 12-18	Z = -0.364
Sex (%Females)	8 (32%)	1 (11%)	3 (33%)	$X^2 = 0.58$
Relationship Status (%)				
Single	15 (60%)	4 (45%)	3 (33%)	
In a relationship	3 (12%)	1 (11%)	-	
Married	2 (8%)	1 (11%)	4 (45%)	
Separated/Divorced	5 (20%)	3 (33%)	2 (22%)	
Ethnicity (%)				
Caucasians	23 (92%)	7 (78%)	2 (22%)	
Asians	1 (4%)	1 (11%)	-	
Blacks	1 (4%)	1 (11%)	7 (78%)	
Employment Status (%)				
Currently working				
Full Time	4 (16%)	5 (56%)	7 (78%)	
Part Time	8 (32%)	-	2 (22%)	
Not working	13 (52%)	4 (44%)	-	
No. of Years since injury	17.61 (9.15), 3-34	19.16 (9.92), 5-34	NA	

Injury Type			NA	
MVA	16 (64%)	7 (78%)		
Snowboarding Accident	2 (8%)	-		
Gunshot Wound	1 (4%)	1 (11%)		
Tumor	2 (8%)	-		
Fall	2 (8%)	-		
Misc	2 (8%)	1 (11%)		
No. of Yrs Living in Supported Setting	6.93 (6.32), 1-22	8.17 (7.59), 1-22	NA	
BDI-II		17.56 (12.74), 1-42	5.63 (4.23), 0-12	-
BAI		6.67 (6.36), 0-16	4 (4.11), 0-11	-
WTAR T		48.33 (7.35), 39-63	45.22 (10.22), 27-59	Z = 0.716
WASI-II Abv IQ		91.56 (6.84), 79-102	88.67 (12.92), 71-108	Z = 0.575

* Subgroup of demographically-matched ABI participants' characteristics has been reported. Note: MVA = Motor Vehicle Accident, BDI II = Beck's Depression Inventory – 2nd version, BAI = Beck's Anxiety Inventory, WTAR = Wechsler's Test of Adult Reading, WASI-II Abv IQ = Wechsler Abbreviated Scale of Intelligence.

^The Cognitive Functioning dimension was not modified..

Table 3 : Correlation Between FCAI and Cognitive Abilities for the ABI Group

	FCAI Dimensions										
	Everyday Functioning		Financial Judgment		Estate Management		Cognitive Functioning	Support Resources		Overall Score	
	Full	Subset	Full	Subset	Full	Subset	Full/ Subset	Full	Subset	Full	Subset
Attention and Working Memory											
#Digit Span Forward	-0.37	0.12	0.09	0.16	0.35	0.38	0.12	0.44*	0.10	0.22	0.33
#Digit Span Backward	0.01	0.60***	0.03	0.13	0.19	0.17	0.10	0.38	-0.01	0.16	0.28
#Digit Span Sequencing	-0.01	0.38	0.11	0.28	0.16	0.17	0.37	0.26	0.02	0.20	0.41*
#Letter Number Sequencing	-0.20	0.35	-0.09	0.03	-0.21	-0.18	0.28	-0.06	-0.12	-0.14	0.07
#Arithmetic Trails A	0.13	0.34	-0.02	-0.01	0.25	0.23	0.04	0.29	-0.07	0.19	0.16
	0.03	-0.06	0.29	0.05	0.22	0.29	-0.26	0.00	0.04	0.11	0.06
Memory											
¥Immediate	0.29	0.26	0.15	0.33	-0.01	-0.09	0.27	0.37	0.18	0.30	0.29
¥Delayed	0.35	0.37	0.01	0.20	-0.02	-0.06	0.57**	0.27	0.34	0.32	0.38(T)
Executive Functions											
#Similarities	0.23	0.43*	0.28	0.32	0.22	0.18	0.08	0.14	0.19	0.30	0.37
Trails B	-0.08	-0.36	0.14	-0.09	0.03	0.03	-0.39*	-0.18	-0.29	-0.10	-0.27
FAS Average	0.20	0.34	0.11	0.18	0.22	0.14	0.10	0.24	-0.05	0.26	0.23
COWAT	0.23	0.27	-0.11	0.11	0.17	0.08	0.29	0.33	0.49**	0.25	0.31
Processing Speed											
Oral SDMT	-0.04	0.18	-0.32	-0.16	-0.26	-0.28	0.30	0.08	0.19	-0.12	-0.04

Impulsivity											
£AUC	0.08	0.06	0.00	-0.01	-0.40*	-0.48*	0.23	0.33	0.17	0.02	-0.10
^BISII	0.40	0.33	-0.13	-0.09	0.21	0.24	0.18	0.07	0.30	0.28	0.23

*p<0.05, **p<0.01, ***p<0.001; +Items were not eliminated from the Cognitive Functioning Dimension; #WAIS-IV Subtests; ¥WMS-II Logical Memory; £Area Under the Curve; n = 24; ^Barrett Impulsivity Scale, n=21; (T) = Trending

Table 4: Comparison of self and informant report of financial capacity

N=22		<i>Mdn</i>	<i>T</i>	<i>p</i>	<i>r</i> *
Everyday functioning	ABI	21.5	157.5	.313	0.22
	Informant	22.5			
Financial Judgment	ABI	15	113	.931	0.02
	Informant	14			
Estate Management	ABI	10	148.5	.104	0.35
	Informant	14			
Cognitive functioning	ABI	21	133	.293	0.22
	Informant	21			
Support Resources	ABI	9	12	.001	0.69
	Informant	6.5			
Debt Management	ABI	4	9	.046	0.43
	Informant	4			
Overall FCAI	ABI	80.5	121	.848	0.04
	Informant	80.5			

* *r*, the effect size estimate, was calculated using the formula $r = z/\sqrt{N}$ (as cited in from ⁷², p. 227, and as such does not rely on the median per se.

VITA

EDUCATION

- Sep 2014-2015 **Pre-Doctoral Intern at Mount Sinai Medical Center (APA Accredited)**
Specialization: Neuropsychology and Rehabilitation Psychology
 Department of Rehabilitation Medicine
- Sep 2010-2015 **Drexel University, Philadelphia, PA.**
 Doctor of Philosophy in Clinical Psychology (APA Accredited)
 Concentration: Clinical Neuropsychology
- Degree Obtained: M.S. (June 2013)
Thesis Title: An Exploratory Study to Examine Decision Making Competency as a Measure of Functional Performance.
- June 2001-03 **Department of Applied Psychology, University of Mumbai, India.**
 Degree: M.A. (Master of Arts) in Clinical Psychology.
Thesis Title: Study of Indecisiveness, Cognitive Estimation, and Anhedonia as related to Eating Attitudes and Gender.
- June 2000-01 **D.G. Ruparel College, University of Mumbai, India.**
 Degree: B.A (Bachelor of Arts), Psychology.

AWARDS AND HONORS

In the US

- 2014 Foundation for Rehabilitation Psychology Dissertation Award
- Committee Member of Division 22's Diversity Committee
- Committee Member of the International Neuropsychological Society's Student Liaison Committee (INS-SLC), International Liaison Representative, 2014-Present
- Publications Committee, National Academy of Neuropsychology (NAN) Student Representative, 2014-Present
- Div 40's Public Advisory Interest Committee's (PAIC) Ethnic & Minority Affairs Subcommittee, Student Representative, 2013-Present
- Drexel University, 2013 & 2014
- Drexel University, 2010-2012; Dean's Fellowship: \$5,000 per annum

GRANT HISTORY

- Dec 2014 2014 Foundation for Rehabilitation Psychology Dissertation Award
 Funded: \$2380 Role: PI
- May 2013 Council on Brain Injury
 Funded: \$745 Role: PI

