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Neurocognitive predictors of financial capacity across the dementia spectrum: Normal aging, mild cognitive impairment, and Alzheimer's disease

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Abstract

Financial capacity is a complex instrumental activity of daily living critical to independent functioning of older adults and sensitive to impairment in patients with amnestic mild cognitive impairment (MCI) and Alzheimer's disease (AD). However, little is known about the neurocognitive basis of financial impairment in dementia. We developed cognitive models of financial capacity in cognitively healthy older adults (n = 85) and patients with MCI (n = 113) and mild AD (n = 43). All participants were administered the Financial Capacity Instrument (FCI) and a neuropsychological test battery. Univariate correlation and multiple regression procedures were used to develop cognitive models of overall FCI performance across groups. The control model (R^2 = .38) comprised (in order of entry) written arithmetic skills, delayed story recall, and simple visuomotor sequencing. The MCI model (R^2 = .69) comprised written arithmetic skills, visuomotor sequencing and set alternation, and race. The AD model (R^2 = .65) comprised written arithmetic skills, simple visuomotor sequencing, and immediate story recall. Written arithmetic skills (WRAT-3 Arithmetic) was the primary predictor across models, accounting for 27% (control model), 46% (AD model), and 55% (MCI model) of variance. Executive function and verbal memory were secondary model predictors. The results offer insight into the cognitive basis of financial capacity across the dementia spectrum of cognitive aging, MCI, and AD.

Keywords

Financial capacity; IADLs; Cognitive predictors; Cognitive aging; MCI; AD

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INTRODUCTION

Financial capacity is a complex instrumental activity of daily living (IADL) that comprises a range of conceptual, procedural, and judgment skills (Marson et al., 2000) and is critical to independent functioning in both younger and older adults (Melton et al., 1987). Financial capacity is also highly vulnerable to Alzheimer's disease (AD) and related dementias (Marson et al., 2000). Prior studies using psychometric and clinical interview assessment approaches have demonstrated mild financial deficits in patients with amnestic mild cognitive impairment (MCI) (Griffith et al., 2003; Marson et al., submitted), emerging global deficits in patients with mild AD (Griffith et al., 2003; Marson et al., 2000, submitted), and advanced global impairment in patients with moderate AD (Marson et al., 2000, submitted). A recent longitudinal study found that mild AD patients show further rapid decline in financial skills over a 1-year period (Martin et al., 2008).

The neurocognitive basis of impairment in IADLs like financial capacity represents an important scientific and clinical issue. Such knowledge can illuminate the complex interrelationships of neurocognitive change and functional change (Farias et al., 2003), clarify the extent to which specific cognitive impairments translate into IADL impairments (Cullum et al., 2001), and provide clinical markers for IADL impairment across dementia stage (Perneczky et al., 2006; Santillan et al., 2003). Initial neurocognitive studies of financial capacity have suggested the importance of working memory processes to financial abilities in patients with AD (Earnst et al., 2001), the contribution of attention and executive dysfunction to impaired financial skills in patients with MCI (Okonkwo et al., 2006), and the significance of dyscalculia as a hallmark cognitive deficit in patients with AD (Carlomagno et al., 1999; Girelli & Delazer, 2001; Martin et al., 2003).

One outstanding question concerns whether the neurocognitive basis of financial capacity may differ across the dementia spectrum of cognitive aging, MCI, and mild AD. By identifying cognitive abilities differentially associated with financial performance in these groups, we may better understand the interface between neurodegenerative disease and higher order functional impairment, and how and why specific financial abilities break down at different points in the dementia process. Such knowledge can lead to earlier identification of financial capacity impairments in patients with MCI and AD, provide guidance to clinicians and families, and support interventions to reduce risks of exploitation and financial mismanagement.

The present cross-sectional study represents an initial effort to identify neurocognitive predictors of financial capacity across a dementia spectrum. Specifically, we developed multivariate cognitive models of overall financial capacity in well-characterized groups of healthy older adults, patients with MCI, and patients with mild AD.

METHOD

Participants

Participants for this study were 85 healthy older adult controls, 113 patients with MCI, and 43 patients with mild AD. All participants were community-dwelling individuals recruited into the Alzheimer's Disease Research Center (ADRC) at the University of Alabama at Birmingham and who participated in the Cognitive Observations in the Elderly Study (NIH AG021927). All participants were evaluated by a neurologist (L.E.H., E.Y.Z., J.C.B., or D.G.C) or geriatric psychiatrist (R.E.P.), and a neuropsychologist (D.C.M. or H.R.G.) and were diagnostically characterized through an ADRC diagnostic consensus conference.

Controls were neurologically intact, cognitively normal older adults with an absence of medical and psychiatric conditions that could compromise cognition. All but two control participants in this study received a Clinical Dementia Rating (CDR) staging of 0.0 (Morris, 1993) (Table 1).

Participants with amnestic MCI were either patients who presented to the UAB Memory Disorders Clinic for clinical evaluation or volunteers recruited from the community into the ADRC. All MCI patients were well characterized based on neurological evaluation, neuroradiological evaluation, and neuropsychological testing. The diagnosis of amnestic MCI was made in the ADRC diagnostic consensus conference using original Mayo criteria (Petersen et al., 2001a, 2001b) (1) subjective memory complaint by the patient and/or an informant; (2) objective memory impairment falling approximately 1.5 standard deviations or more below age and education equivalent control performance on a neuropsychological measure of memory; (3) relatively normal performance in other cognitive domains; (4) relatively normal activities of daily living; and (5) lack of dementia, as reflected by a failure to meet NINCDS-ADRDA criteria for AD (McKhann et al., 1984). Petersen (2004) has recently refined the classification scheme of MCI to include both single-domain (or purely amnestic) and multi-domain subtypes in order to acknowledge that nonamnestic/multiple-domain deficits are often present in MCI. While the current study did not make this subtype distinction within our MCI group, the majority of our MCI participants would likely be classified as multi-domain amnestic MCI, with impairment of expressive language, abstraction, executive function, or arithmetic abilities in addition to memory (Table 3). Patients with nonamnestic forms of MCI were excluded from the study. All but two MCI patients in this study received a CDR staging of 0.5 (Table 1).

Patients with mild AD were also community-dwelling individuals recruited into the ADRC. Their dementia was well characterized based on neurological, neuropsychological, and neuroradiological procedures. Diagnosis of mild AD was made in the ADRC diagnostic consensus conference and was based on the NINCDS-ADRDA criteria (McKhann et al., 1984) and the CDR (Morris, 1993) (Table 1). Mild AD patients had a CDR staging of either 0.5 or 1.0 (Table 1).

Written informed consent was obtained from all control and MCI participants and from all participants with AD and their caregivers, as part of this institutional review board–approved research study.

Conceptual Model of Financial Capacity

We have previously developed a conceptual model that views financial capacity at three levels: specific financial abilities (18 tasks), broader financial activities (9 domains, which are summation of specific task scores), and overall financial capacity (2 global scores, which are the summation of domain scores). The development of the model is discussed in other reports (Earnst et al., 2001; Griffith et al., 2003; Marson, 2001; Marson et al., 2000; Martin et al., 2008). A schematic of the model is presented in Table 2. In the present study, we focus on neurocognitive predictors of global or overall financial capacity.

Financial Capacity Instrument

The Financial Capacity Instrument (FCI) is a standardized psychometric instrument for directly assessing the financial abilities and performance of older adults (Marson, 2001; Marson et al., 2000). The FCI assesses financial abilities based on the aforementioned conceptual model of financial capacity (Earnst et al., 2001; Griffith et al., 2003; Marson, 2001; Marson et al., 2000). The psychometric properties of the FCI have been detailed in previous reports (Marson, 2001; Marson et al., 2000).

All participants were administered the FCI by well-trained staff. Administration and scoring of the FCI have been previously described (Marson et al., 2000). The FCI utilizes a number of financial props and materials to enhance ecological validity within the laboratory setting. The specific FCI-9 variable examined in the current study was the global score for Domains 1–7.

Data Exclusion for Prior/Premorbid Financial Experience

Because individual financial experience can differ across subjects (Marson et al., 2000), we accounted for lack of prior financial skills and experience in our participants using the Prior/Premorbid Financial Capacity Form (PFCF) (Marson et al., 2000). The PFCF is a rating instrument completed by both participants and their informants that identifies a subject's prior or premorbid experience across the 18 tasks, 9 domains, and global capacity levels of the financial capacity model. Ratings for each PFCF task and domain fell into three categories: could do without help, could do but needed help, and could not do even with help. Any participant either who self-identified as having no prior experience or capacity on overall financial abilities or whose informant reported that the participant lacked experience or was previously incapable of carrying out overall financial abilities was excluded from the analysis. In the rare case of discrepant data (i.e., an informant rating a participant as incapable but the participant rating capacity for the same domain or task), an informant's rating was used as the decision rule. However, not all control or MCI participants had an informant available. In such rare cases, participant's report of experience was used.

From the initial group of 88 controls, 117 MCI patients, and 48 AD patients, a total of 12 participants were excluded from subsequent analyses of global financial capacity because of lack of prior experience in one or more financial domains or tasks (three controls, four MCI, and five mild AD).

Neuropsychological Test Battery

A standardized neuropsychological test battery was administered to all participants, similar to those widely used in the clinical diagnosis of dementia (Butters et al., 1994; Lezak, 1995; Pasquier, 1999).

Global cognitive status—Mini-Mental Status Examination (MMSE) (Folstein et al., 1975) and total score of the Dementia Rating Scale-2 (DRS-2; Jurica et al., 2001).

Attention—Attention subscale of the DRS-2, the Digit Span and Letter-Number Sequencing subtests of the Wechsler Memory Scale—Revised (WMS-R) (Wechsler, 1987), Spatial Span subtest of the Wechsler Memory Scale—Third Edition (WMS-III) (Wechsler, 1997b), and Conners' Continuous Performance Test—Second Edition (CPT-II) (Conners, 2000).

Expressive language—A short (30 item) version of the Boston Naming Test (BNT) (Kaplan et al., 1983), measures of phonemic word fluency (CFL) (Benton & Hamsher, 1983) and semantic word fluency (Spreen & Strauss, 1991).

Memory—Memory subscale of the DRS-2, the Logical Memory I and II subtests of the WMS-R (Wechsler, 1987), and Visual Reproduction I and II subtests of the WMS-III (Wechsler, 1997b) and the California Verbal Learning Test—Second Edition (Dellis et al., 2000).

Processing speed—The Digit Symbol subtest of the WAIS-III (Wechsler, 1997a), Trail Making Test A (Reitan & Wolfson, 1993), and CPT Hit Reaction Time (Conners, 2000).

Visuospatial abilities—Construction subscale of the DRS-2 and the copy portion of the Executive Clock Drawing Task (CLOX2) (Royall et al., 1998).

Abstraction—Conceptualization subscale of the DRS-2 and the Verbal Reasoning subtest of the Cognitive Competency Test (Wang & Ennis, 1986).

Executive function—Initiation/Perseveration subscale of the DRS-2, CPT Perseverations, spontaneous generation portion of the Executive Clock Drawing Task (CLOX1), Trail Making Test B (Reitan & Wolfson, 1993), and Trails 3 (Okonkwo et al., 2008).

Arithmetic skills—Arithmetic subtest of the Wide Range Achievement Test— Third Edition (WRAT-3; Wilkinson, 1993).

Procedures

All participants were administered the FCI by trained staff. Participants and their informants also completed the PFCF rating forms. The neuropsychological test battery was administered by the same staff either on the same day as the FCI or, if two sessions were necessary, within a week or so of the FCI administration date. All participants' FCI data were summarized for task-level performance, domain-level performance, and global performance. As discussed, the FCI global score for Domains 1–7 was the variable of interest for the present study.

Statistical Analyses

Group differences—Group differences on demographic variables were compared either with one-way ANOVA (for continuous variables) or chi-square (for categorical variables). *Post hoc* analyses for significant ANOVA findings were analyzed using the Bonferroni multiple comparisons test. Performance on the FCI Total Score and neuropsychological test measures were analyzed using one-way ANOVA with Bonferroni multiple comparison *post hoc* analyses.

Cognitive predictor models across groups—Zero-order Pearson correlations were computed within each participant group to assess the relationship between FCI Total Score and neuropsychological variables. For the control and MCI groups, the five test measures with the highest univariate correlations were selected for entry into stepwise multiple regression analyses to create predictor models of overall financial capacity. For the smaller mild AD group, the three test measures with the highest univariate correlations were selected for multivariate analysis. In addition, we proposed to enter demographic variables of age, education, gender, and/or race into the multivariate analysis for each group, if one or more of these variables demonstrated significant group differences. In the multivariate analyses, the subject-to-univariate predictor variable ratio was anticipated to be at least 10:1 for the control and MCI models and approximately 7:1 for the mild AD model.

A cognitive predictor variable was included in a multivariate model if the change in variance accounted for in the model was at or below a significance level of .05. A variable was dropped from the model if the change in variance accounted for by the predictor was at a significance level of .10 or greater.

Statistical analyses were conducted using SPSS 16.0 (SPSS Inc., 2007). An alpha level of .05 was adopted for all *a priori* and *post hoc* analyses.

RESULTS

Demographic and Mental Status Variables

Table 1 displays group comparisons on demographic and mental status variables. Group differences emerged on three of the four demographic variables. Controls were younger than MCI patients, who in turn were younger than mild AD patients. Mild AD patients had fewer years of education than the control group. There was a difference in the racial composition of the groups, with more African Americans in the MCI group. Gender was not significant, although there was a trend for more females in the control group *versus* the patient groups.

Table 1 also displays mental status and dementia staging data. As expected, Mini-Mental State (MMSE) scores (Folstein et al., 1975), DRS-2 Total Score, and CDR dementia stage ratings differed across the three groups ($p < .001$). As an index of functional status (Petersen et al., 1999), the CDR sum of box scores also differed across the three groups. The sum of boxes mean (1.48) for MCI participants was comparable to that (1.5) previously reported by Petersen et al. (1999) for their MCI sample.

Neuropsychological Test Results

Table 3 details the neuropsychological test results for the study groups. All one-way ANOVAs were significant. As expected, mild AD patients performed below control participants on all measures and below MCI participants on all measures except Digit Span Forward and Backward, BNT, DRS-2 Construction, and DRS-2 Conceptualization. Controls performed significantly better than MCI patients on all measures except DRS-2 Construction and CLOX1.

Financial Capacity Performance Results

The FCI Total Score (Domains 1–7) differed across the three study groups ($p < .001$). *Post hoc* analyses revealed that controls performed significantly better than MCI and mild AD patients and MCI patients performed significantly better than the mild AD patients.

Cognitive Models of FCI Total Score

Table 4 presents the multivariate predictor models of FCI Total Score by group. The stepwise regression models for all three study groups were significant (all $p < .05$). As discussed in the Method section, the five strongest univariate cognitive predictors were entered into each of the control and MCI analyses, and the three strongest univariate cognitive predictors were entered into the mild AD analysis. In addition to the univariate cognitive predictors, three demographic variables (age, education, and race) were entered into each multivariate analysis because these demographic variables showed group differences (Table 1).

Control group model—In order of entrance into the stepwise model, predictors of the FCI Total Score for the control group were WRAT-3 Arithmetic, WMS-R Logical Memory II, and Trail Making Test A (simple visuomotor sequencing). This model accounted for 38% of the variance in the FCI Total Score, with the primary predictor WRAT-3 Arithmetic itself accounting for 27% of variance.

MCI group model—Predictors for the MCI group were WRAT-3 Arithmetic, Trail Making Test B (visuomotor sequencing and set alternation), and race. This model accounted for 69% of the variance in the FCI Total Score, with the primary predictor WRAT-3 Arithmetic accounting for 55% of variance.

Mild AD model—Predictors for the mild AD group consisted of WRAT-3 Arithmetic, Trail Making Test A (simple visuomotor sequencing), and WMS-R Logical Memory I. This model accounted for 65% of the variance in FCI Total Score, with the primary predictor WRAT-3 Arithmetic accounting for 46%.

DISCUSSION

The results of this study indicated that the IADL of financial capacity is mediated by similar neurocognitive predictors across the dementia spectrum of normal cognitive aging, amnestic

MCI, and mild AD. Specifically, a measure of written arithmetic skills (WRAT-3 Arithmetic) was the primary predictor of financial capacity in the control, MCI, and mild AD group models, accounting for a substantial portion (27%, 55%, and 45%, respectively) of the total variance achieved by each model. Thus, it appears that conceptual knowledge of numbers and arithmetic operations and actual calculation abilities are cognitive skills strongly associated with financial capacity in normal older adults and also with declining financial capacity in patients with both preclinical and clinical dementia of the AD type. Secondary model predictors shared by the three groups involved measures of executive function (visuomotor sequencing; Trails A and B) and verbal memory (immediate and delayed story recall). As discussed below, these secondary predictors provide additional insight into the interrelationships between financial capacity and the cognitive deficits characteristic of preclinical and clinical AD.

The cognitive model for financial capacity in older controls provided a normative reference point for interpreting the models in the two patient groups. The control model comprised predictors of written arithmetic ability (WRAT-3 Arithmetic subtest) (Wilkinson, 1993) (Table 4, Step 1, R^2 = .27), delayed verbal memory (Logical Memory II sub-test of the WMS-R) (Wechsler, 1987) (Table 4, Step 2, incremental R^2 = .08), and simple visuomotor sequencing (Trails A) (Reitan & Wolfson, 1993) (Table 4, Step 3, incremental R^2 = .03). WRAT-3 Arithmetic is an academic achievement measure that requires a participant to complete a series of written calculation problems of graduated difficulty in a time-limited context. The measure is believed to tap conceptual knowledge of numbers and arithmetic operations, counting and written calculation abilities, spatial organization, and processing speed (Lezak et al., 2004). Such skills are arguably integral to a range of financial tasks, including understanding coin–currency relationships (how many nickels are in $1?); counting coins/currency and making change; calculating tips, percentages, and investment returns; and completing a check register with deposit and payment transactions.

The control model's secondary predictor was delayed verbal episodic memory (Logical Memory II subtest of the WMS-R). Logical Memory II taps delayed recall of auditory verbal narrative material (story recall), a cognitive ability integral to the communication and retention of various forms of financial information, such as medical deductibles, investment information, or tax form instructions. Lezak et al. (2004) explain that story recall most resembles everyday memory demands for the meaningful discourse found in conversation, radio and television, and written material. Story recall also provides a measure of the amount of information retained when the material exceeds the immediate memory span and of the contribution of meaning to attention and recall (Lezak et al., 2004). The control model's tertiary predictor of simple visuomotor sequencing (Trails A) taps simple visual attention, visual scanning, and visuomotor tracking (Lezak et al., 2004). Such cognitive abilities are arguably integral to basic financial tasks such as visual identification and counting of coins, as well as more complex tasks of visually navigating financial documents such as a check register or bank statement.

Overall, the predictor model for controls accounted for a substantial amount of variance in FCI Total Score (38%). However, a majority of the variance was still left unexplained after cognitive and demographic were entered into the model. While controls did not approach ceiling on the FCI, there were other factors that we were not able to assess, such as socioeconomic status and quality of education, which might account for some of the unaccounted variance. There appear to be a number of noncognitive factors associated with financial capacity in normal older adults that await further identification.

In contrast, the cognitive predictor model of financial capacity for patients with amnestic MCI accounted for a majority of variance (66%) and provides insight into the effects of preclinical cognitive change on financial skills. The group comparison results (Table 1) replicated our group's prior finding that MCI participants perform intermediate to controls and mild AD patients in overall financial capacity (Griffith et al., 2003). With respect to cognitive predictors, the MCI model comprised written arithmetic ability (WRAT-3) (Wilkinson, 1993) as the Step 1 predictor (R^2 = .55) but also complex visuomotor sequencing requiring mental flexibility (Trails B) (Reitan & Wolfson, 1993) as the Step 2 predictor (incremental R^2 = .11). The noncognitive variable of race was the Step 3 predictor (incremental R^2 = .03) (Table 4). While similar to the control model, the overall MCI model was statistically much more robust, accounting for almost 70% of the variance in FCI Total Score—nearly double that in the control model. In particular, knowledge of arithmetic operations and calculation (WRAT-3) accounted for a majority of variance (55%), suggesting that emerging MCI patient performance declines in written arithmetic (Table 3) were translating into related declines in overall FCI performance (Table 1).

This finding is consistent with the dementia literature documenting loss of arithmetic abilities as a characteristic deficit in patients with AD (Carlomagno et al., 1999; Deloche et al., 1995; Girelli & Delazer, 2001; Martin et al., 2003, 2008; Parlato et al., 1992; Rosselli et al., 1998). These studies also suggest that initial erosion of arithmetic skills, or dyscalculia, may begin even earlier in the period prodromal to AD. However, very few studies to date have examined arithmetic abilities in MCI patients.

Existing studies have found differences between the performance of healthy older controls and MCI patients on arithmetic tasks, with healthy controls performing significantly better than MCI patients on measures of written calculation tasks (Griffith et al., 2003; Ribeiro et al., 2006). The current paper adds additional support to these findings by showing written arithmetic impairments (dyscalculia) (WRAT-3) in MCI patients *versus* controls (Table 2).

The secondary predictor in the MCI model was a measure of complex visuomotor sequencing and set alternation (Trail Making Test B) (Reitan & Wolfson, 1993). Trails B is a well-known neuropsychological measure that is associated with complex visual scanning, visuomotor tracking, divided attention, and cognitive flexibility (Lezak et al., 2004). This finding replicates previous findings that suggest that visuomotor skills are integral to successful performance of everyday functional skills (Mahurin et al., 1991). More specifically, the emergence of Trails B as a secondary predictor suggests that declining executive and mental flexibility—in the context of visual attention, scanning, and tracking demands— contributes to diminished financial performance in MCI patients. An example of a financial task presumably mediated by such cognitive functions might be reviewing a monthly bank statement for detailed financial information related to bank account activity and productivity. The FCI contains such a task, which assesses an individual's capacity to identify and orally report different monetary transactions indicated on a typical monthly bank statement (FCI Task 5b). *Post hoc* bivariate correlations indicated a significant association between performance on Trails B and Task 5b. As performance on Trails B declined (increased time in seconds), performance on Task 5b also declined, both for controls ($r = -.26$, $p < .02$) and MCI participants ($r = -.60$, $p < .01$). The relationship was not significant for mild AD patients ($r = -.20$, $p = .20$), probably reflecting this group's smaller sample size and increasing floor effects on Trails B (Table 3).

As a tertiary predictor, race accounted for a final small portion (3%) of the variance in the MCI model. This predictor suggested that African Americans with MCI performed more poorly on the FCI than Caucasians, after other demographic factors were accounted for. As noted above in the Results section, African Americans were more heavily represented in the MCI group relative to the other two study groups. It is likely that quality of education in the African American group, rather than simply years of education, may help explain why race emerged as a minor predictor in the MCI model of financial capacity (Cosentino et al., 2007; Manly et al., 2002).

The predictor model of financial capacity for the mild AD group was similar to the MCI model and almost identical to the control model (Table 4). The AD model comprised three univariate and also multivariate predictors: written arithmetic ability (WRAT-3 Arithmetic subtest) (Wilkinson, 1993) as the Step 1 predictor (R^2 = .46), simple visuomotor sequencing (Trails A) (Reitan & Wolfson, 1993) as the Step 2 predictor (incremental R^2 = .10), and immediate verbal recall (Logical Memory I subtest of the WMS-R) (Wechsler, 1987) as the Step 3 predictor (incremental R^2 = .09). Like the MCI model, the mild AD model was robust, accounting for 65% of the variance in FCI Total Score. However, this model should be viewed more cautiously than the control and MCI models due to the smaller sample of mild AD patients.

The mild AD model was striking insofar as it shared the same predictors as the control model and overlapped strongly with the MCI model. The findings suggest that, despite the mild AD patients' frank dementia (Table 1), and despite their greater level of financial skills impairment on the FCI (Table 1), the same core cognitive functions are mediating financial skill performance across the three groups. These core cognitive functions are knowledge of numbers and arithmetic operations and written calculation, and to a lesser extent, visual attention, scanning and sequencing, and auditory verbal recall.

A limiting factor of the current study is that our laboratory-based psychometric approach to measuring financial abilities may not replicate some ecological aspects of participants' real-world financial context and functioning. For example, a laboratory-based assessment may limit some aspects of short-term memory and executive control normally present in a person's everyday management of financial affairs. Both research and clinical assessments of financial capacity should employ convergent data sources, such as collateral informant methods or examination of records, to support psychometric findings.

In summary, this study identified group-specific neurocognitive predictors of overall financial capacity in healthy older adults, patients with MCI, and patients with mild AD. The predictor models illustrate that across this dementia spectrum, the same cognitive functions are associated with both intact financial capacity in older controls and declining financial capacity in patients with preclinical and clinical AD. The consistency of predictors across the three models has implications for development of a general cognitive model of financial capacity for older adults and potentially for adults in general. Future predictor studies might next focus on specific financial functional domains and tasks, such as checkbook management, bill payment, or simple investment decision making, in order to better understand the cognitive mechanisms of impairment and loss of discrete financial skills in patients with MCI and AD.

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Table 1

Demographic and clinical characteristics of study participants

Variables	Control (n = 85)	MCI (n = 113)	Mild AD (n = 43)	$p^{\dagger}$	*Post hoc*
Gender, *n*(%)					
Males	30 (35)	49 (43)	24 (56)	.084	n.s.
Females	55 (65)	64 (57)	19 (44)		
Race, *n* (%)					
Caucasian	75 (88)	82 (73)	39 (91)	.004	AD > MCI > controls
African American	10 (12)	31 (27)	4 (9)		MCI > controls > AD
Age (years)					
X	67.2	70.3	73.8	<.001	AD > MCI > controls
SD	8.2	7.4	8.5		
Education (years)					
X	15.0	14.6	13.6	<.05	MCI, controls > AD
SD	2.4	3.2	2.9		
Medications, *n* (%)					
CI	1 (1)	27 (24)	31 (72)	<.001	AD > MCI > controls
NCI	84 (99)	86 (76)	12 (28)		Controls > MCI > AD
MMSE score					
X	29.4	28.1	24.6	<.001	Controls > MCI > AD
SD	0.9	1.9	2.9		
FCI Total Score					
X	225.1	205.1	182.0	<.001	Controls > MCI > AD
SD	10.6	24.1	31.8		
DRS-2 Total Score					
X	138.75	130.89	118.67	<.001	Controls > MCI > AD
SD	3.291	6.42	10.2		
CDR staging					
0, *n* (%)	83 (98)	2 (2)	0 (0)	<.001	AD > MCI > controls
0.5, *n* (%)	2 (2)	111 (98)	24 (56)		
1, *n* (%)	0 (0)	0 (0)	18 (42)		
2, *n* (%)	0 (0)	0 (0)	1 (2)		

Variables	Control (n = 85)	MCI (n = 113)	Mild AD (n = 43)	$p^{\dagger}$	*Post hoc*
X	0.01	0.49	0.74		
SD	0.08	0.07	0.32		
CDR sum of boxes					
X	0.01	1.48	3.92	<.001	AD > MCI > controls
SD	0.08	0.81	1.30		

Note. CDR, Clinical Dementia Rating Scale; CI, cholinesterase inhibitors; DRS-2, Dementia Rating Scale-2; FCI, Financial Capacity Instrument; MMSE, Mini-Mental Status Examination; NCI, no cholinesterase inhibitors.

† *p* Value for omnibus test of group differences

Table 2

Conceptual model of financial capacity

	Task description	Difficulty
Domain 1. Basic monetary skills		
Task 1a. Naming coins/currency	Identify specific coins and currency	Simple
Task 1b. Coin–currency relationships	Indicate relative monetary values of coins/currency	Simple
Task 1c. Counting coins/currency	Accurately count groups of coins and currency	Simple
Domain 2. Financial conceptual knowledge		
Task 2a. Define financial concepts	Define a variety of simple financial concepts	Complex
Task 2b. Apply financial concepts	Practical application/computation using concepts	Complex
Domain 3. Cash transactions		
Task 3a. 1-item grocery purchase	Enter into simulated 1-item transaction; verify change	Simple
Task 3b. 3-item grocery purchase	Enter into simulated 3-item transaction; verify change	Complex
Task 3c. Change/vending machine	Obtain change for vending machine use; verify change	Complex
Task 3d. Tipping	Understand tipping convention; calculate/identify tips	Complex
Domain 4. Checkbook management		
Task 4a. Understand checkbook	Identify and explain parts of check and check register	Simple
Task 4b. Use checkbook/register	Enter into simulated transaction; pay by check	Complex
Domain 5. Bank statement management		
Task 5a. Understand bank statement	Identify and explain parts of a bank statement	Complex
Task 5b. Use bank statement	Identify specific transactions on bank statement	Complex
Domain 6. Financial judgment		
Task 6a. Detect mail fraud risk	Detect and explain risks in mail fraud solicitation	Simple
Task 6c. Detect telephone fraud risk	Detect and explain risks in telephone fraud solicitation	Simple
Domain 7. Bill payment		
Task 7a. Understand bills	Explain meaning and purpose of bills	Simple
Task 7b. Prioritize bills	Identify overdue utility bill	Simple
Task 7c. Prepare bills for mailing	Prepare simulated bills, checks, envelopes for mailing	Complex
Domain 8. Knowledge of personal assets/estate arrangements[a]	Indicate asset ownership, estate arrangements	Simple
Domain 9. Investment decision making	Understand options; determine returns; make decision	Complex
Overall financial capacity	Overall functioning across tasks and domains	Complex

[a]Requires corroboration by informant.

Table 3

Group comparisons on neuropsychological measures

	Range	Controls (*n* = 85), mean (*SD*)	MCI (*n* = 113), mean (*SD*)	Mild AD (*n* = 43), mean (*SD*)	*p*	*Post hoc* comparisons
Attention						
DRS-2 Attention	0–37	35.6 (1.1)	35.2 (1.6)	34.3 (2.3)	.001	Controls > MCI > AD
Digit Span Forward		8.9 (1.9)	7.6 (1.8)	7.6 (2.1)	.001	Controls > MCI; controls > AD
Digit Span Backward		6.9 (2.1)	5.5 (2.1)	4.7 (1.8)	.001	Controls > MCI; controls > AD
Spatial Span Forward		7.6 (1.7)	6.9 (1.7)	6.1 (1.8)	.001	Controls > MCI > AD
Spatial Span Backward		6.9 (1.7)	5.8 (1.8)	4.7 (1.8)	.001	Controls > MCI > AD
CPT-II Omission Errors		3.2 (5.6)	11.3 (12.6)	20.9 (18.4)	.001	AD > MCI > control
CPT-II Commission Errors		8.4 (4.9)	11.8 (6.2)	14.9 (7.8)	.001	AD > MCI > control
Expressive language						
BNT (30 item)		27.8 (1.7)	24.5 (5.1)	23.8 (4.1)	.001	Controls > MCI; controls > AD
Semantic Fluency		59.5 (9.5)	45.2 (9.1)	35.6 (9.4)	.001	Controls > MCI > AD
Memory						
DRS-2 Memory	0–25	23.9 (1.2)	21.3 (2.9)	16.1 (3.5)	.001	Controls > MCI > AD
Logical Memory I		26.6 (5.2)	18.0 (6.7)	10.3 (6.5)	.001	Controls > MCI > AD
Logical Memory II		22.8 (5.3)	11.5 (7.7)	3.4 (4.9)	.001	Controls > MCI > AD
Visual Reproduction I		76.2 (11.7)	58.6 (15.7)	37.1 (13.1)	.001	Controls > MCI > AD
Visual Reproduction II		51.9 (17.9)	25.9 (18.9)	7.7 (10.4)	.001	Controls > MCI > AD
CVLT-II Trials 1–5 Total		46.2 (8.2)	30.6 (7.7)	23.9 (6.6)	.001	Controls > MCI > AD
CVLT-II Short Delay Free Recall		9.3 (2.7)	4.1 (2.9)	1.7 (1.7)	.001	Controls > MCI > AD
CVLT-II Long Delay Free Recall		10.5 (2.7)	4.0 (3.2)	1.3 (1.7)	.001	Controls > MCI > AD
Visual spatial						
DRS-2 Construction	0–6	5.8 (0.5)	5.6 (0.8)	5.4 (0.8)	.019	Controls > AD
CLOX2	0–15	13.6 (1.1)	13.1 (1.2)	12.2 (1.6)	.001	Controls > MCI > AD
Abstraction						
DRS-2 Conceptualization	0–39	36.7 (2.3)	34.3 (3.5)	33.1 (3.5)	.001	Controls > MCI; Controls > AD
Cognitive Competency	0–20	17.9 (1.4)	16.7 (2.1)	15.4 (2.7)	.001	Controls > MCI > AD

	Range	Controls (n = 85), mean (*SD*)	MCI (n = 113), mean (*SD*)	Mild AD (n = 43), mean (*SD*)	*p*	*Post hoc* comparisons
Executive function						
DRS-2 Init/Perseveration	0–37	36.4 (1.1)	34.5 (3.2)	29.8 (5.6)	.001	Controls > MCI > AD
Trail Making Test A (sec)		31.4 (9.6)	46.8 (19.5)	63.0 (31.7)	.001	AD > MCI > controls
Trail Making Test B (sec)		76.7 (21.2)	144.3 (72.6)	213.9 (86.8)	.001	AD > MCI > controls
Trail Making Test 3 (sec)		78.0 (26.9)	159.7 (87.9)	280.7 (103.4)	.001	AD > MCI > controls
CLOX1	0–15	12.1 (1.9)	11.4 (2.0)	9.6 (2.8)	.001	Controls, MCI > AD
Digit Symbol		62.6 (13.4)	43.8 (13.4)	31.7 (12.3)	.001	Controls > MCI > AD
Achievement						
WRAT-3 Arithmetic		41.6 (4.7)	38.0 (5.2)	33.7 (4.8)	.001	Controls > MCI > AD

Note. CVLT-II, California Verbal Learning Test—Second Edition.

Table 4

Multivariate cognitive predictor models[a] of FCI Total Score (Domains 1–7) across groups

	Control predictor model (n = 85)			MCI predictor model (n = 113)			Mild AD predictor model (n = 43)		
	Measure	r	Cum R^2	Measure	r	Cum R^2	Measure	r	Cum R^2
Step 1	**Arithmetic**	**.54**	**.27**‡	Arithmetic	**.74**	**.55**‡	Arithmetic	**.67**	**.46**‡
Step 2	**Log Mem II**	**.35**	**.35**†	Trails B	**−.73**	**.66**‡	Trails A	**−.60**	**.56**†
Step 3	**Trails A**	**−.29**	**.38***	Race	**−.55**	**.69**‡	Log Mem I	**.63**	**.65**†
	Digits Forward	.34		Dig Symbol	.59				
	Trails B	−.31		Vis Rep I	.54				

Note. Arithmetic = Wide Range Achievement Test—Third Edition (Arithmetic subtest); Log Mem I, Logical Memory I (immediate recall) subtest from the Wechsler Memory Scale—Revised; Log Mem II, Logical Memory II (delayed recall) subtest from the Wechsler Memory Scale—Revised; Digits Forward, Digit Span subtest (digits forward portion) from the Wechsler Memory Scale—Third Edition; Dig Symbol, Digit Symbol from the Wechsler Adult Intelligence Scale—Third Edition; Spat Back Raw, Spatial Span Backwards subtest from the Wechsler Memory Scale—Third Edition; Vis Rep I, Visual Reproduction I (immediate recall) subtest from the Wechsler Memory Scale—Third Edition.

[a] Tasks in bold entered into the multivariate predictor models, while unbolded tasks did not enter into the model.

$^{*}p < .05$.

$^{†}p < .01$.

$^{‡}p < .001$.