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Mild Cognitive Impairment and Objective Instrumental Everyday Functioning: The Everyday Cognition Battery Memory Test

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Abstract

OBJECTIVES—Examine the performance MCI and non-MCI participants on an objective measure of everyday or real-world memory and subjective items assessing competency within the same instrumental domains. In addition, determine whether ECB can uniquely predict MCI status.

DESIGN—Cross-sectional

SETTING—Independently-living sample of urban dwelling elders in Baltimore MD.

PARTICIPANTS—The sample consisted of 555 ranging in age from 50 to 95 years (M = 68.75, SD = 9.61)

MEASUREMENTS—Objective performance in three instrumental domains (i.e., medication use, financial management, nutrition/food preparation) was assessed by the Everyday Cognition Battery ECB Memory Test. Subjective performance with in the same instrumental domains was also assessed.

RESULTS—No difference was found between MCI and Non-MCI elders on the subjective items of IADL competency. A significant multivariate effect for cognitive status group [$F(3, 507) = 21.88, p < .05, 2 = .12$] was observed for the objective measure, with MCI participants performing, on average, significantly worse than Non-MCI participants on all three instrumental domain subscales. The medicine use (OR = .96, 95% CI = .94–.99) and financial management (OR = .93, 95% CI = .91–.96) subscales of the ECB Memory Test were both unique and significant predictors of MCI.

CONCLUSION—This study adds to the growing body of literature suggesting that cognitively complex instrumental activities of daily living might be compromised in elders with MCI. Moreover, the ECB Memory Test might be a clinically useful tool in evaluating real-world competency.

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Author Contributions:

Jason Allaire contributed to the conceptualization and design of the study, statistical analysis, and drafted the manuscript.

Alyssa Gamaldo assisted in the writing of the manuscript as well as data analyses and interpretation.

Brian Ayotte and Regina Sims made substantial contributions to the revisions of the manuscript and assisted in the interpretation of results.

Keith Whitfield led the conceptualization, design, and implementation of the study. He also made important theoretical contributions to the paper as well contributing to the revisions of the manuscript.

Keywords

Mild Cognitive Impairment; Instrumental Activities of Daily Living; Everyday Functioning

INTRODUCTION

The general maintenance of basic everyday task performance is one of the factors differentiating mild cognitive impairment (MCI) from dementia.¹ However, there is a growing body of evidence that suggests while the ability to perform the basic activities of daily living may be retained in elders with MCI, difficulties performing more complex instrumental everyday tasks might be observed.^{1,2} The purpose of the current study is to examine the performance of elder African Americans, with and without MCI, on an objective measure of real-world memory within three instrumental domains: medication use, financial management, and nutrition/food preparation. A number of studies have found that, on average, elders with MCI are significantly less competent in performing instrumental tasks of daily living (IADLs) than elders without MCI and show a greater rate of decline in everyday competency over a 3-year period.³⁻⁶ In fact, one recent study reported deficiencies in cognitively complex, instrumental tasks of daily living 10 years prior to clinical diagnosis of dementia.⁵ Differences between MCI and non-MCI elders are particularly salient when the everyday instrumental task or daily activity is memory laden.^{7,8}

Most of these studies assessed IADL competency using self-report or proxy (e.g., relative, friend, or caregiver) assessments. While subjective evaluations are important, they do not assess actual ability or performance competency nor do they assess elders' ability to perform various tasks within a single domain. That is, asking a single overarching question about a domain (e.g., medication use) ignores the multidimensional nature of the task (e.g., remembering to take medication, taking the correct dosage, understanding the label). Similarly, the scales that subjective evaluations typically use do not capture subtle differences in performance ability, but instead classify individuals' ability more broadly (e.g., independent, needs some help, completely dependent).

Given these concerns, discrete subjective evaluations may not be able to accurately represent elders' competency within the complex, multidimensional domain of everyday functioning. Fortunately, two classes of objective measures have been developed. The first class comes from the clinical literature and focuses on behavioral assessments of actual performance (e.g., preparing breakfast or writing a check). Performance on these measures, particularly those assessing ability in the domain of finances, is significantly lower in MCI relative to non-MCI elders.⁹⁻¹¹

The second class of measures comes from the cognitive aging literature and includes measures of everyday cognition or everyday problem solving.^{12,13} These assessments present cognitively challenging real-world problems embedded within instrumental domains in an attempt to assess cognitive functioning within these real-world domains. One such measure, the Everyday Cognition Battery Memory test (ECB Memory Test) was developed to assess elders' ability to solve memory-related problems within the domains of medication use, financial management, and nutrition/food preparation.¹² Taking a multidimensional approach to performance, the ECB Memory Test goes beyond measuring rote performance by assessing memory ability within these three instrumental domains. For instance, participants are presented and allowed to study real-world printed material such as a medication label or a checking account statement and then after the material is removed they are asked "what dosage should be taken?" or "when is the payment due?" Previous research has found that ECB Memory Test is strongly associated with performance on measures of

memory as well as reasoning and verbal knowledge.¹² In addition, the ECB Memory Test and other similar measures are associated with self-reported instrumental functioning, cognitive impairment, and even mortality.^{14–16}

The analysis presented here utilized data from a large sample of African American elders to explore differences between MCI and non-MCI participants on the ECB Memory Test and on subjective items assessing competency within the same instrumental domains assessed in the ECB Memory test. Specifically, the objectives of the current investigation were: (1) examine the frequency of self-reported difficulties in the instrumental domains of medication use, financial management, nutrition/food preparation, (2) determine if performance on the three domain subscales of the ECB Memory Test differed between MCI and non-MCI participants; and (3) assess the unique salience of the ECB Memory Test domain subscales to predict MCI status.

Methods

Sample

This analysis was conducted using a sample of 555 urban dwelling, independently living African American elders drawn from the first wave of the Baltimore Study of Black Aging: Patterns of Cognitive Aging (BSBA: PCA). The main objective of the BSBA is to systematically examine patterns and individual factors that contribute to individual differences in cognitive functioning among older African-Americans. The BSBA: PCA has a total sample of 602 elders. Four participants were dropped who meet the criteria for dementia as outlined in the DSM-IV,¹⁷ while an additional 43 participants did not have sufficient cognitive data to evaluate MCI status and therefore were not included in the analysis. The participants with missing cognitive data performed significantly lower on the MMSE $t(595) = 7.68$, $p < .05$ and SPMSQ $t(595) = 5.09$, $p < .05$, were older $t(595) = -3.08$, $p < .05$, reported less education $t(595) = 5.78$, $p < .05$, but did not differ in income $t(595) = 1.40$, $p > .05$ than participants with sufficient data..

The resulting 555 elders ranged in age from 50 to 95 years ($M = 68.75$, $SD = 9.61$), their average monthly income was \$1000 ($SD = \600; range = $< \$100 - > \2300), and the average years of education was 11.82 years ($SD = 2.83$ years, range = 3–20). Participants were recruited from 29 senior apartment building which consisted primarily (75% or more) of African Americans living in the West Baltimore area. In order to obtain a heterogeneous and representative sample the BSBA: PCA broadly sampled community dwelling adults aged 50 years and older. The only inclusion criteria was the participant's willingness to participate in the study.

Measures

The 30-item ECB Memory Test included two real-world stimuli (e.g., medication labels, checking account statement) for each of three instrumental domains (medication use, financial management, and food preparation/nutrition).^{12,15} Each of the six stimuli was associated with five items (3 domains $\times$ 2 stimuli $\times$ 5 questions). Participants were instructed to study a stimulus for 60 seconds, and then were given an additional 60 seconds to turn the page and answer the five multiple choice (i.e., recognition) questions about the information in the stimulus. They were not allowed to refer back to the stimuli. Each item either received a score of "1" if correctly answered or "0" if incorrectly answered. The mean within each functional domain was taken, producing subscales for medication use, financial management, and food preparation/nutrition. The ECB Memory Test has been used with African American elders and is a psychometrically sound and reliable measures.^{12,15}

Overall cognitive function was assessed using the Mini-Mental State Examination (MMSE)¹⁸ and the Short Portable Mental Status Questionnaire.¹⁹

Subjective instrumental functioning in the domains of medication use, financial management, and food preparation/nutrition was measured using items from the Activities of Daily Living (ADL) questionnaire.²⁰ Participants were asked to rate their ability to prepare meals, shop for food, take medication and pay bills/handle money using a scale using one of three responses “No, I never need help”; “Yes, I have difficulty and need help”; “Yes, I have difficulty but can do without help”.

Cognitive Battery

The current study included a number of psychometric measures assessing a broad array of cognitive abilities. Inductive reasoning was assessed using the Letter Series Test²¹ and the Shipley Institute of Living Scale Abstraction Test,²² a measure of a participant's ability to identify the most logical item. Declarative memory was assessed using the Hopkins Verbal Learning Task (HVLT) and the Rey Auditory Verbal Learning Task (AVLT).^{23,24} Perceptual speed was assessed using the Number Comparison Test, the Identical Pictures Test, and the Digit Symbol Substitution Test.^{25, 26} Working memory was assessed using the Alpha Span Task, the Operation Span Task (SPAN), and the Backward Digit Span task.^{26–28} Executive functioning was assessed using the Clock Drawing Test (CDT), a measure that asks participants to draw a 3:25 clock and 11:10 clock; clocks were scored based on a 10 point scoring system scoring systems.²⁹ Language was assessed using the Verbal Ability Test and the Shipley Institute of Living Verbal Meaning Test.^{21,22}

MCI Classification

Participants were classified into one of two groups, either a Non-MCI group (n = 423) or a MCI group (n = 123). MCI status was determined using a modified version of the age-associated cognitive decline criteria, which classifies individuals as mildly impaired if they indicate impairment on objective measures of at least one cognitive domain (i.e. language, memory, reasoning, executive function, working memory, and perceptual speed).³⁰ Given this criteria does not require a subjective memory complaint and allows for some impairment in daily functioning, it has shown to have better predictive validity in detecting subsequent dementia in a non-clinical sample than MCI criteria.³⁰ To help identify individuals meeting the criteria, individuals were classified as MCI if they scored 1.5 SD below the sample average on any one of the six cognitive domains assessed. To reduce the influence of age and education, the effect of both were residualized from each cognitive composite using a regression approach. The resulting residualized scores were standardized (M = 50, SD = 10). This process resulted in composite scores for six cognitive domains: Reasoning (i.e. Letter Series and Shipley), Memory (i.e. HVLT, AVLT, and Immediate Recall), Perceptual Speed (i.e. Number Comparison, Identical Pictures, and DSST), Executive Function (i.e. 3:25 CDT and 11:10 CDT), Working Memory (i.e. Alpha Span, OSPAN, and Backward Digit Span), and Language (i.e. Verbal Ability Test and Shipley Institute of Living Verbal Meaning Test). Individuals that scored 1.5 standard deviations below the sample mean on at least one objective measure of cognitive functioning and did not meet the criteria for dementia according to Statistical Manual of Mental Disorders were classified as MCI.³⁰

Forty-four participants did not complete the ECB Memory Test. Thirty-three of these participants were classified as Non-MCI, while 11 were from the MCI group resulting in a final sample of 399 Non-MCI and 112 in the MCI group. There was no relationship between impairment status and completing the ECB Memory test, $\chi^2(1) = .22$, $p > .05$, indicating that a failure to complete the ECB Memory test was not due to impairment status. However,

those who did not complete the ECB Memory Test performed significantly lower on the MMSE $t(553) = -2.09$, $p < .05$, were slightly older $t(553) = 1.96$, $p = .05$, reported less education $t(553) = -3.75$, $p < .05$, and less income $t(553) = -2.89$, $p < .05$ than participants who completed the ECB Memory test.

Design and Statistical Analysis

Participants were individually tested by a trained proctor in a vacant, public room of their apartment building. During the testing session, participants were administered an assessment battery that included the ECB Memory test and the other measures described above. Each participant was compensated \$30 for their participation.

Differences between non-MCI and MCI participants on the socio-demographic and the cognitive status measures were evaluated using t-tests and chi-square tests where appropriate. Group differences on the subjective IADL items were assessed using the Mann-Whitney U test. A Multivariate Analysis of Variance (MANOVA) test was used to test for an overall difference between MCI and Non-MCI participants on the domain subscales (i.e., medication use, financial management, food preparation/nutrition) of the ECB Memory Test. Follow-up ANOVA's were used to test for differences on each domain subscale. Logistic regression was then used to determine which domain subscale a unique predictor of MCI status is controlling for cognitive functioning and sociodemographic characteristics.

RESULTS

Table 1 shows the means and standard deviations for the demographic variables and the two general measures of cognitive status. The MCI group was slightly younger than the non-MCI participants, but this difference fell short of statistical significance. Relative to the non-MCI group, participants classified as MCI reported significantly lower income and performed more poorly on the MMSE and SPMSQ. There was a slight but significant difference in the distribution of gender across the two groups.

First, group differences were examined in terms of the likelihood of self-reporting deficiencies in the three IADL domains. A significant effect of group was found for two of the self-rated IADL items: Preparing Meals [$\chi^2(2) = 7.99$, $p = .02$] and Paying Bills/Handling Money [$\chi^2(2) = 5.92$, $p = .05$]. Specifically, a greater proportion of participants in the MCI group reported dependency on others for preparing meals and paying bills/handling money (see Table 2). No significant group effect was found for Shopping for Food, [$\chi^2(2) = 2.36$, $p = .31$] or Taking Medication [$\chi^2(2) = 1.47$, $p = .48$].

Next, mean differences in performance on the ECB Memory subtests of medication use, financial management, and food preparation/nutrition were examined. Results from the MANOVA indicated a significant multivariate effect between the MCI group and the non-MCI group [$F(3, 507) = 21.88$, $p < .05$, $\eta^2 = .12$]. Follow-up ANOVA's (see Table 3) indicated that MCI participants performed significantly worse than the Non-MCI participants on all three everyday memory domain subscales.

A logistic regression was conducted to determine the unique predictive salience of each of the subscales relative to one another, as well as in relation to a number of covariates. Covariates were entered into the model (age, gender, education, income), and performance on the MMSE and SPMSQ was evaluated. Results indicated that ECB Medicine Use (OR = 0.96, 95% CI = 0.94–0.99) and ECB Financial Management (OR = 0.93, 95% CI = 0.91–0.96) were both unique and significant predictors of MCI group membership.

DISCUSSION

The primary objective of the current analysis was to examine differences in everyday functioning between African American elders with and without MCI. Unlike many of the previous studies, the current investigation examined both subjective and objective performance within three instrumental domains: medication use, financial management, and nutrition/food preparation.

Significant differences between the two groups of elders were found for the subjective evaluations food preparation and finance and not for of medication use or shopping. Interestingly, only 1% to 10% of MCI participants indicated impairment in the three instrumental domains, while 1% to 6% of the Non-MCI indicated dependency. These results are counter to many studies that have found marked differences between MCI and non-MCI elders on subjective evaluations of instrumental functioning.

In contrast, our results indicated significant group differences on the measures of objective competence. Regarding the ECB Memory Test, the results of this study indicated that participants with MCI performed, on average, significantly lower than non-MCI on the domain subtests of medication use, financial management, and nutrition/food preparation. In fact MCI participants were, on average, performing 0.5 SD below the non-MCI participants on all three subscales.

These differences were further highlighted by the results from the logistic regression model. When entered together, the ECB Memory Test subscales for medication use and financial management subscales emerged as uniquely significant predictors of MCI status even after controlling for performance on two measures commonly used to screen for impairment as well as a number of socio-demographic characteristics. Specifically, with each unit increase in performance on the medication use and financial management subscales, participants were 4% and 7% respectively, less likely to be in the MCI group. Coupled with the previous results of mean differences, a 0.5 SD difference between the two groups would result in a 20% and 35% decrease in the likelihood of being classified as MCI.

The results of the current investigation are particularly important for three reasons. First, they highlight the shortcomings of some subjective evaluations of instrumental everyday functioning. One possible explanation for the atypical percentage of participants reporting dependency and the subsequent non-significant differences for two of the four items is that each domain was assessed with only one item. Each item presented participants with only three broad and non-descript response options. Providing more items per domain and more response options per item could potentially capture more subtle differences in performance competency. Informant ratings of everyday functioning, which were not obtained in this study, in addition to more multidimensional self-ratings could potentially increase the reliability of the subjective approach. Second, by using an objective measure, this study adds to the growing body of literature suggesting that cognitively complex instrumental activities of daily living might be compromised in elders with MCI. That is, performance on basic measures of functioning that do not rely on cognition, such as getting dressed or maintaining self-hygiene, remain intact, but tasks that require cognitive capacity, such as memory, show significant deficiencies. Similar to previous research, the largest effect was found for the Financial Management subscale.^{11–13} Finally, the ECB Memory Test might be a clinically useful tool in evaluating real-world competency and perhaps in predicting dementia. However, additional research is needed to evaluate the diagnostic saliency of the ECB Memory Test particularly in sample that includes elders with dementia as well as elders with MCI.

Though the current study's results suggest that performance of cognitively complex instrumental activities might suffer in elders with MCI, there are limitations that need to be considered when interpreting these findings. First, the sample was entirely African American. While we consider this a strength given the dearth of information on MCI in minority populations, we do acknowledge that it limits the generalizability of our results to the broader aging population. Second, the study did not include elders with dementia, which would have allowed us to examine whether differences on the ECB

Memory Test is further exacerbated by the onset of serious cognitive impairment. Third, the cross-sectional nature of the data does not allow us to make statements regarding the utility of the ECB Memory test to predict future MCI status. However, this study represents the first wave of a two-wave longitudinal study, which will allow us to build on the results of this study by examining patterns and correlates of change. Fourth, 7% of the participants who were classified as MCI or Non-MCI did not complete the ECB Memory Test. This was primarily due to the placement of the test at the end of the testing session leading to some refusals due to fatigue. Finally, given the non-clinical focus of the BSBA: PCA, mild cognitive impairment was not evaluated using a clinical "gold standard," which may have lead to some misclassification of participants.

CONCLUSION

The results of the current study suggest that constellation of symptoms brought about by MCI should be broadened to include difficulties with cognitively complex instrumental tasks of daily living. On a practical level, it suggests that elders diagnosed with, or at risk for, MCI might have difficulties in their everyday lives that might impact their health, well-being, and even safety.

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Table 1

Mean Differences between Non-MCI and MCI participants on Socio-demographic Characteristics and MMSE/SPMSQ Performance.

	Non-MCI (<i>n</i> = 399)	MCI (<i>n</i> = 112)	<i>p</i>
	M (SD) range	M (SD) range	
Age	68.97 (9.56) 50–95	67.08 (9.57) 50–93	.06
Education	11.83 (2.65) 3–20	12.30 (3.04) 3–20	.11
Income	10.98 (5.92) 1–23	9.24 (5.26) 1–23	.006
MMSE	26.20 (3.01) 19–30	25.07 (3.16) 16–30	.001
SPMSQ	9.40 (.83) 5–10	9.08 (1.04) 6–10	.001
Gender (% male)	22%	34%	.04

Table 2
Response Frequencies for the Subjective Items for the Non-MCI and MCI Participants.

	Non-MCI			MCI		
	Independent	Some Difficulty	Dependent	Independent	Some Difficulty	Dependent
Preparing Meals*	92%	7%	2%	91%	3%	7%
Shopping for Food	88%	6%	6%	83%	7%	10%
Taking Medication	98%	1%	1%	96%	3%	1%
Paying Bills/Handling Money*	92%	6%	2%	91%	3%	7%

Table 3

Mean Differences between Non-MCI and MCI groups in Performance on the ECB Memory Subscales.

	Non-MCI		MCI		<i>F</i>	<i>p</i>	η^2
	<i>M (SD) range</i>		<i>M (SD) range</i>				
ECB Memory – Medicine Use	51.16 (9.43) 17.96–71.32		45.96 (10.93) 17.96–71.32		24.74	.003	.05
ECB Memory – Nutrition	51.13 (9.67) 22.41–97.63		46.04 (10.18) 17.40–67.54		23.67	.00	.04
ECB Memory – Fin. Management	51.66 (8.99) 11.52–70.43		44.12 (11.20) 18.07–70.43		54.87	.00	.10