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Predicting Functional Ability in Mild Cognitive Impairment with the Dementia Rating Scale-2

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Abstract

BACKGROUND—We examined the utility of cognitive evaluation to predict instrumental activities of daily living (IADLs) and decisional ability in Mild Cognitive Impairment (MCI).

METHODS—Sixty-seven individuals with single domain amnesic MCI were administered the Dementia Rating Scale-2 as well as the Everyday Cognition (ECog) form to assess functional ability.

RESULTS—DRS-2 Total Scores and Initiation/Perseveration and Memory subscales were found to be predictive of IADLs, with Total Scores accounting for 19% of the variance in IADL performance on average. Additionally, DRS-2 Initiation/Perseveration and Total Score were predictive of ability to understand information, and DRS-2 Conceptualization helped predict ability to communicate with others, both key variables in decision making ability.

CONCLUSIONS—These findings suggest that performance on the DRS-2, and specific subscales related to executive function and memory, is significantly related to IADLs in individuals with MCI. These cognitive measures are also associated in decision making related abilities in MCI.

Keywords

Mild Cognitive Impairment; Cognitive Ability; Activities of Daily Living; Decision Making Ability

INTRODUCTION

Clinicians are frequently asked to judge the ability of older individuals to take care of themselves and make good decisions. There are two major concepts relevant to this capacity 1) specific capacities (i.e., activities of daily living) and 2) global capacity (i.e., general decision making ability) (Association, 2005). Assessment of these capacities in older adults is a complex issue, particularly in the area of Mild Cognitive Impairment (MCI) where

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Conflict of Interest:

none

Author's Roles: Drs. Greenaway and Smith both contributed to study concept and design. Dr. Greenaway performed the statistical analyses and wrote the paper. Dr. Smith aided in the statistical analyses and aided in preparation of the manuscript. Ms. Hanna and Mr. Duncan recruited subjects, performed the assessments with the subjects, compiled the data, and aided in preparation of manuscript.

cognitive abilities may be diminished, but activities of daily living are supposed be “relatively intact.”

Activities of daily living (ADLs) or higher order, instrumental ADLs (IADLs) include skills such as financial management, keeping appointments, accuracy of medication use, and driving. In the dementia literature, executive function and global cognitive measures [e.g., the Dementia Rating Scale-2 (DRS-2) (Jurica, 2001)] appear to be most predictive of IADL and ADL ability (Royall et al., 2007). However, little is known about cognitive correlates of IADLs in MCI. It is now widely accepted that changes, and even impairments, in higher order IADLs can be seen in predementia conditions like MCI (Nygard, 2003). Assessing these changes and rendering decisions about capabilities during MCI is complicated, and much is left to be discovered about the nature and extend of higher order functional difficulties with these individuals.

As many as 40% of individuals with MCI have been judged by clinicians to have impairments in ability to provide consent for research participation (Jefferson et al., 2008b). At a minimum, global decision making ability includes the ability to understand relevant information and communicate a choice (Appelbaum et al., 1998). Additional criteria outlined by the American Psychiatric Association can include an appreciation of how information applies to one’s self specifically and logical reasoning ability (APA, 1998).

One tool frequently used to help clinicians and researchers render an opinion about IADLs and decision making ability is cognitive assessment. In Alzheimer’s Disease (AD), decision making capacity has been shown to be associated with language, memory, and executive function (Marson *et al.*, 1996; Marson *et al.*, 1997). In amnesic MCI, medical decision making capacity appears most related to verbal memory performance (Okonkwo et al., 2008), and financial capability is highly dependent upon attention and executive function (Okonkwo et al., 2006). Yet other research suggests MCI individuals who have difficulties in understanding the nature and procedures of a research study have more difficulty on measures of executive function and not memory (Jefferson et al., 2008b).

While full neuropsychological evaluations are not available to all individuals, screening batteries such as the (DRS-2) may provide some insights into daily functional ability and abilities related to decision making. One study (Fields et al., 2010) recently examined how the DRS-2 could predict ADLs in a large sample of 2469 individuals, ranging in diagnosis from cognitively normal to dementia. They found that lower DRS-2 scores, particularly on the subscales of Initiation/Perseveration (I/P) and Memory were significantly related to worse ADLs. However, this group based their assessment of ADLs on the Record of Independent Living (ROIL)(Weintraub, 1986), a questionnaire geared towards individuals with dementia. The ROIL may have limited utility in MCI. The DRS has similarly been reported to significantly predict ADLs in mild to moderate Alzheimer’s disease (Fitz and Teri, 1994) and a mixed psychiatric/dementia sample(Nadler et al., 1993). There is little information about how DRS-2 performance may relate to IADLs and decision making related skills, particularly in the MCI population.

METHODS

Study Participants

Sixty-seven individuals with MCI by Mayo criteria (Petersen, 2004) and thought to have a high likelihood of progression to clinically probable AD (Petersen and Morris, 2005) were recruited from the Emory and Mayo Alzheimer’s Disease Research Centers and through clinical referrals from Neurology/Neuropsychology practices at these centers. Subjects were enrolled in a larger trial on cognitive rehabilitation(Greenaway et al., 2008). This study

examines pre-intervention data only. All individuals completed full cognitive and neurologic evaluations and were diagnosed with amnesic single domain MCI. As such, all individuals in this study were judged to have basically intact performance in other areas of cognition, including executive function. Subjects had an informant who had regular contact with the individual. All subjects and informants consented prior to participation in this research, and conduct of the study was approved by the respective Institution Review Boards.

Measures

All participants completed the DRS-2 and their informants completed the Everyday Cognition assessment (ECog) (Farias et al., 2008). The E-Cog is an informant-based measure designed for individuals with MCI that assesses a participant's ability to perform everyday tasks in the following areas or subscales: Memory, Language, Visuospatial abilities, Executive function/planning, Executive function/organization, and Executive function/divided attention. The Executive Function subscales will subsequently be referred to solely as "Planning," "Organization," and "Divided Attention." The E-Cog was modified with its author's support to assess the participant's *current* functional ability rather than the original comparison to performance 10 years prior. Higher scores reflect poorer performance on the ECog, while higher scores reflect better performance on the DRS-2.

Individual items from the ECog were selected for further analysis as they related to key IADLs, including, Memory item 8 (M8) "Remembering appointments, meetings, or engagements," Organization item 2 (EO2) "Balancing the checkbook without error," Organization item 3 (EO3) "Keeping financial records organized," and Organization item 6 (EO6) "Using an organized strategy to manage a medication schedule."

Individual items from the ECog were also selected for relevance to decision making skills, including Language item 6 (L6) "Understanding the point of what other people are trying to say," Language item 9 (L9) "Understanding spoken directions or instructions," Planning item 4 (EP4) "Thinking things through before acting," Planning item 5 (EP5) "Thinking ahead," and Language item 4 (L4) "Communicating thoughts in a conversation." These ECog items were reviewed retrospectively, and not phrased specifically to assess decision making competency. As such, they will be referred to as "decision making related" items in the remainder of this manuscript.

The ECog does not specifically ask about driving. Thus, we used the Record of Independent Living (Weintraub, 1986) question about driving in our analysis. This question asks how much assistance the individual requires to drive, ranging from 0 ("does not need help") to 4 ("cannot perform task").

Data Analysis

Statistical Package for the Social Sciences (SPSS) software was used in data analyses. An individual's ECog subscale score was omitted if more than one item was left blank/don't know. This happened most frequently on the visuospatial subscale ($n = 14$ omitted) followed by the organization scale ($n = 8$ omitted). Pearson correlations were utilized to examine the relationship between subscale and total scores on the DRS-2 and ECog, and Spearman's rho was used in analyzing correlations between the ECog and the ROIL driving item. Only significant correlations ($p < .05$) for the Total Score and DRS-2 subscales were examined in ROC analyses to determine the accuracy of DRS-2 variables in predicting whether individual functional abilities were normal or impaired (mild, moderate, or severe). Given multiple analyses, reporting of significance was adjusted to $p < .01$.

RESULTS

Participants had a mean age of 73.8 ($SD = 7.2$), 15.8 years of education ($SD = 2.7$, range 12–20 years), and 54% were male. The majority of subjects were Caucasian (92%), but also included African American (6%) and Hispanic (2%) individuals. Cholinesterase inhibitors were used by 58% of the subjects. Informants completing functional status information on the individual with MCI were most often the spouse (70%), but also included adult children (19%), brothers/sisters (5%), or a friend (6%). Average DRS-2 and ECog performance can be found in Table 1.

On IADL questions, 51% of MCI individuals were reported to have moderate to severe difficulty with remembering appointments. Most individuals reported the individual with MCI had mild to no difficulty on the remaining IADL questions. However, a sizeable minority expressed significant concerns about the individual with MCI balancing the checkbook, maintaining financial records, and managing medication (see Table 2). The vast majority of individuals were reported to have mild or no difficulty on questions related to decision making ability. Age and education were not significantly correlated with performance on any individual IADL or decision making related item.

DRS-2 Total Score was significantly correlated with all subscales of the ECog [Memory ($r = -.42$, $p < .001$), Language ($r = -.44$, $p < .001$), Visuospatial ($r = -.47$, $p < .001$), Planning ($r = -.34$, $p < .01$), Organization ($r = -.54$, $p < .001$), and Divided Attention ($r = -.39$, $p < .01$)]. The DRS-2 I/P subtest was significantly correlated with the ECog subscales of Visuospatial ($r = -.37$, $p < .01$), Organization ($r = -.45$, $p < .001$), and Divided Attention ($r = -.36$, $p < .01$). The Memory subtest of the DRS-2 correlated significantly with the ECog Memory ($r = -.39$, $p < .001$), and Organization ($r = -.34$, $p < .01$) subscales. No other significant correlations were found between the DRS-2 and the ECog subscales. Age and education were not significantly correlated with ECog performance.

ROC analysis revealed that the DRS-2 Total score, Memory subscale, I/P subscale, and Conceptualization subscale all were significantly better than chance in predicting specific IADLs or decision related abilities. AUCs and likelihood ratios are provided in Table 3.

DISCUSSION

In keeping with the MCI diagnostic criterion (Petersen, 2004), most informants in our sample reported that these single domain amnesic MCI individuals had little difficulty with specific IADLs or decision making related abilities. However, when asked about specific IADLs, 51% of informants in this study reported the individual with MCI had moderate to severe difficulty remembering appointments. It is not surprising that a memory related IADL was most often endorsed as impaired in this sample with amnesic MCI.

In addition, despite intact functioning in other cognitive domains per both neuropsychological assessment and clinician opinion, these individuals were also reported to have at least moderate difficulty in executive-functioning-related IADLs, including balancing the checkbook (32%), financial records (29%), and use of an organized strategy of medication management (20%). This is in keeping with reported impairments in executive function (Royall et al., 2004) and executive function related IADLs (Bangen et al.) in individuals with amnesic MCI. Evidence for the presence of IADL impairment in MCI is accumulating (Farias et al., 2006; Tuokko et al., 2005). Our findings on specific IADL function support the report of the authors of the ECog, who found significantly more difficulties in IADLs on the ECog were reported among individuals with MCI compared to healthy controls (Farias et al., 2006). A notable number of these individuals with MCI were reported to have at least moderate difficulty in decision making related items such as

understanding the point someone is trying to make (15%), understanding directions (17%), thinking things through before acting (14%), and communicating thoughts in a conversation (12%). Aspects of understanding relevant information, showing rational thought, and being able to communicate a choice are key aspects of decision making ability. While we cannot directly state that these individuals would have impaired decision making capacity, these findings suggest that perhaps it cannot be automatically assumed that decision making capability is always intact in MCI.

Relationship to the DRS-2

The DRS-2 was significantly associated with many aspects of IADLs in the current study. Specifically, the DRS-2 Total Score was highly related to all six subscales of the ECog, including 18% of the variance (i.e. r^2) for ECog Memory, 19% for Language, 22% for Visuospatial, 12% for Executive Function/Planning, 29% for Executive Function/Organization, and 15% for Executive Function/Divided Attention. Royall et al. (Royall et al., 2007) likewise reported that the DRS accounted for more than 20% on average of functional outcomes. In fact, the DRS explained more variance in functional ability than formal tests of attention, executive function, memory, verbal, or visuospatial function in those authors' large meta-analysis. In our study, the DRS-2 was also significantly predictive of performance on all specific IADL items examined, and comprehension questions related to decision making abilities.

Specific subscales on the DRS-2 also showed significant relationships to function abilities in the current study. The I/P scale of the DRS-2 was correlated with ECog subscales, including Visuospatial, Organization, and Divided Attention. This is consistent with other findings (Boyle et al., 2003) that I/P from the DRS-2 is significantly correlated to IADL function on the Lawton Brody ADL Questionnaire (also informant based) in Alzheimer's disease subjects. DRS-2 I/P is conceptualized to examine executive function aspects of cognitive ability. Many authors have reported that executive functioning is predictive of functional ability in elderly patients, particularly in dementia (Boyle *et al.*, 2003; Cahn-Weiner *et al.*, 2007), (Cahn-Weiner *et al.*, 2007; Royall *et al.*, 2005). We found the DRS-2 I/P to also be significantly predictive of organizing medications.

In addition to the I/P subscale, the Memory subscale of the DRS-2 was also significantly related IADL abilities. This is consistent with the findings in a mixed normal aging, MCI, and AD sample using the DRS-2 and the ROIL (Fields et al., 2010). In our study, Memory from the DRS-2 was correlated with ECog Memory and Organization, supporting similar finding in some studies (Jefferson *et al.*, 2008a; Tomaszewski Farias *et al.*, 2009) and contrasting with finding in other studies (Boyle, et al, 2003). DRS-2 Memory was further predictive of performance on specific IADLs of organizing financial records and remembering appointments, meetings, or engagements. Other have found financial capability to relate more to executive function (Okonkwo et al., 2008).

Only 8% of the sample reported that the individual with MCI needed assistance or could no longer drive independently, suggesting that driving ability may be better preserved than other IADLs examined in amnesic MCI. The fact that we found no significant relationships to driving, while others found that I/P and Memory subscales from the DRS-2 explained a significant amount of the variance in reported driving ability (Fields et al., 2010), is likely explained by the fact that Fields et al.'s sample that ranged from normal aging to AD, providing more range of scores for use in cognitive predictions.

In terms of decision making related skills, the DRS-2 I/P subscale was predictive of ability to understand and think through information, and Conceptualization helped predict ability to communicate with others. Similarly, Jefferson and colleagues found that executive

functioning and information processing were the strongest correlates of understanding information related to research studies in their capacity to consent to research study in MCI (Jefferson et al., 2008b). In contrast, Okonkwo et al. (Okonkwo et al., 2008) found that short term verbal memory was the most relevant cognitive domain to medical decision making capacity, followed by a lesser degree by executive functioning. Bambara et al. (Bambara et al., 2007) found that DRS-2 Total Score was significantly correlated with ability to understand and appreciate the consequences of treatment choice on a measure of consent capacity in individuals with chronic partial epilepsy. There are no comparison articles that we are aware of with the DRS-2 and decision making ability in MCI or dementia.

Limitations

We studied only those with single domain amnesic MCI, and there is growing evidence that ADLs are differentially affected in various subtypes of MCI (Bangen et al.). The sample further included persons volunteering to participate in intervention research, and such individuals may have more or less functional impairment than the general MCI population. This study also used an informant based IADL measure, and informants' ability to predict functional status is not always accurate (Harvey et al., 2007). In addition, our relatively small sample limits our findings. We found several additional items at the $p < .05$ level that were not "significant" after correcting for multiple analyses. With further research and a larger sample, these 'trends' may prove to be significant.

We acknowledge that this study is a preliminary look into decision making ability in MCI, as this was a retrospective examination of items related to aspects of decision making skills. A true assessment of decision making capacity would be tailored towards an individual situation, examining the individual's understanding of the situation/choice (e.g., medical procedure or research participation) and ability to communicate their decision. Nonetheless, we thought it important to introduce the argument that researchers and clinicians may not be able to always assume that an individual with MCI has intact decision making capacity. Follow up research set up apriori to examine decision making capacity in MCI utilizing specific measures of capacity will need to be done to confirm and expand upon these findings.

CONCLUSIONS

Informants largely report intact IADL and decision making related abilities in individuals with single domain MCI. However, a notable percentage report significant concerns about aspects of IADLs and skills necessary for decision making ability. The DRS-2 can help explain a notable amount of the variance in functional ability in MCI. In particular, the DRS-2 Total Score, I/P, and Memory subscales were significantly correlated with items related to both decision making related ability and IADLs of financial management, remembering appointments, and medication management.

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Table 1

Summary of Cognitive and Functional Status

	Mean	SD	Sample Range	Normal Range
DRS-2 Total	131.2	5.9	116–144	130–144 [*]
Attention	35.6	1.3	31–37	32–37
Initiation/Perseveration	34.6	3.5	22–37	32–37
Construction	5.9	0.4	4–6	5–6
Conceptualization	36.7	1.9	31–39	32–39
Memory	18.5	3.5	9–25	22–25
MMSE	26.8	2.3	19–30	24–30
ECog				
Memory	20.1	6.0	8–32	8 [†]
Language	14.2	4.9	9–30	9
Visuospatial	10.8	3.6	7–22	7
Exec Fx/Planning	8.0	3.4	3–18	4
Exec Fx/Organization	11.7	4.8	5–24	6
Exec Fx/Divided Attn	7.9	3.1	3–16	4
ROIL Activities Scale	5.0	6.0	0–35	

Note. DRS-2 – Dementia Rating Scale 2nd Edition, MMSE = Mini Mental State Examination, ECog = Everyday Cognition scale, ROIL = Record of Independent Living, Exec Fx = Executive Functioning

^{*} Normal range scores are based on Mayo Older Adult Normative Studies data [30] for a 74 year old participant (the average age of those participating in this study)

[†] Based on score that would be obtained by selecting “no difficulty” on all items of that subscale. Scores lower than this in the current sample reflect a failure of the participant to answer every item.

Table 2

Percent of Mild Cognitive Impairment Informants Reporting Each Level of Functioning

	No Difficulty	Mild	Moderate	Severe
Point	45	40	13	2
Directions	43	40	9	8
Thinking Through	48	39	9	5
Thinking Ahead	37	48	11	5
Communicating	61	27	8	4
Appointments	24	25	39	12
Checkbook	36	32	20	12
Finances	32	39	14	15
Medications	56	24	12	8
‡	Independent	Has Trouble, But Can Do	Has Trouble, Verbal/Physical Assistance	Can No Longer Do
Driving	55	37	3	5

Note.

‡Heading Titles are Different Between the Everyday Cognition Items and the Record of Independent Living Driving Item; Point = “Understanding the point of what other people are trying to say,” Directions = “Understanding spoken directions or instructions,” Thinking Through = “Thinking things through before acting,” Communicating = “Communicating thoughts in a conversation,” Appointments = “Remembering appointments, meetings, or engagements,” Checkbook = “Balancing the checkbook without error,” Finances = “Keeping financial records organized,” Driving = Driving ability from Record of Independent Living.

Table 3

AUCs, Cut-Offs, and Likelihood Ratios for Predicting IADL Impairment

	AUC	Cut-Off	Likelihood Ratio~
Point			
DRS-2 Total	.78 [†]	128	5.4
Directions			
DRS-2 Total	.84 [†]	128	17.0
DRS-2 I/P	.80 [†]	34	16.3
Communicating			
DRS-2 Conceptualization	.67 [*]	34	3.7
Appointments			
DRS-2 Total	.72 [*]	127	5.3
DRS-2 Memory	.704 [*]	16	5.6
Finances			
DRS-2 Total	.80 [†]	131	6.4
DRS-2 Memory	.81 [†]	17	4.8
Medications			
DRS-2 Total	.78 [†]	127	4.5
DRS-2 I/P	.71 [*]	34	3.4

Note. DRS-2 – Dementia Rating Scale 2nd Edition, MMSE = Mini Mental State Examination, ECOG = Everyday Cognition scale.

^{*}
 $p < .01$,

[†]
 $p < .001$.

~Value indicates increase in risk of impaired IADL if DRS score falls below cutoff, e.g. a person with DRS total less than 128 is 5.4 times more likely to have difficulty understanding the point of conversation than persons with DRS about 128.