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Daily Activity Abilities in MCI, Alzheimer's Disease, and Healthy Controls

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Abstract

Mild cognitive impairment (MCI) is a risk state for dementia. The present study assessed daily functioning in MCI individuals (amnestic [aMCI] and nonamnestic [naMCI]) relative to those with Alzheimer's disease (AD) and healthy controls (NC). Twenty AD participants, 14 aMCI, 12 naMCI, and 30 healthy controls were administered the Direct Assessment of Functional Status (DAFS). The AD group performed poorer than all groups on all DAFS subscales. The aMCI group performed poorer than controls on the shopping subtests, while the naMCI group performed poorer than controls on only the free recall shopping. Finally, DAFS subscales discriminated the AD and aMCI groups well, but only recognition shopping discriminated between naMCI and aMCI individuals. These findings suggest that circumscribed ADL deficits distinguish subtypes of MCI and AD.

Keywords

MCI; activities of daily living; Alzheimer's disease

Mild cognitive impairment (MCI) is a condition defined by cognitive deficits exceeding what is expected in normal aging yet are of insufficient severity to warrant a diagnosis of dementia (Binegar, Hynan, Lacritz, Weiner, & Cullum, 2009; Smith & Bondi, 2013; Wadley et al., 2007; Weakley, Schmitter-Edgecombe, & Anderson, 2013). Reported prevalence rates and rates of progression to dementia vary considerably because of the lack of consensus regarding diagnostic methods and criteria (Farias, Mungas, & Jagust, 2005; Ganguli et al., 2011; Smith & Bondi, 2013).

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Declaration of Conflicts of Interest
There are no sources of conflict of interest.

The heterogeneity of cognitive deficits among those diagnosed with MCI may reflect different underlying etiologies (Petersen & Morris, 2005; Smith & Bondi, 2013). MCI subtypes are characterized by patterns of cognitive deficits classified as amnestic MCI (aMCI; indicating the presence of a memory deficit) or nonamnestic MCI (naMCI; indicating the presence of nonmemory deficits) (Wadley et al., 2007). Conversion rates to AD are much higher in aMCI, while naMCI is more likely to progress to non-AD dementias (i.e., frontotemporal dementia, Lewy Body dementia, vascular dementia) (Loewenstein et al., 2006; Wadley et al., 2007). These findings highlight the potential for MCI subtypes to be valuable nosological entities identifying those at risk of further decline (Clark et al., 2013).

Loss of ability to perform activities of daily living (ADLs) is a defining feature of dementia (Cahn-Weiner et al., 2007; Desai, Grossberg, & Sheth, 2004; Perneczky, Pohl, Sorg, Hartmann, Komossa et al., 2006), with basic skills remaining intact and more complex skills (i.e., instrumental ADLs [IADLs]) impacted to a greater degree in the early stages (Cahn-Weiner et al., 2007; Desai, Grossberg, & Sheth, 2004; Pereira et al., 2010; Perneczky, Pohl, Sorg, Hartmann, Komossa et al., 2006). Because IADLs are (more) complex and demanding, they are susceptible to mild impairments in MCI (Goldberg et al., 2010; Perneczky, Pohl, Sorg, Hartmann, Tosic et al., 2006).

ADL functioning in MCI appears to fall somewhere between the preserved abilities associated with normal aging and the marked impairments associated with dementia (Bangen et al., 2010; Bombin et al., 2012; Jefferson et al., 2008; Luck et al., 2010; Pereira et al., 2010; Wadley et al., 2007) and performance varies between MCI subtype (Bangen et al., 2010; Farias, Mungas, & Jagust, 2005; Zanetti et al., 2006). However, the current literature presents several major limitations that prevent a clear understanding and characterization of the specific functional impairments in MCI. Inconsistent findings may be due to a variability in the methods used to assess IADL impairment (Bangen et al., 2010). Other-reports and self-reports are often used to gather information on the functional status of MCI patients, although this information is often biased by an informant's unawareness, stress associated with caregiver burden, or a lack of insight on the part of the patient (Albert, Michaels, Padilla, Pelton, Bell, Marder, & Stern, 1999; Bangen et al., 2010; Pereira et al., 2010; Razani et al., 2007; Wadley et al., 2007). Furthermore, clinical classifications based on cognitive rating scales are often unable to capture the subtle functional difficulties typically demonstrated by MCI patients (Jefferson et al., 2008; Smith & Bondi, 2013).

Observation-based assessment of IADLs offers an objective alternative to subjective reports (Smith & Bondi, 2013). Studies have found observation-based tasks to be more reliable and predictive of AD patients' actual abilities than caregiver reports (Razani et al., 2011) and able to detect greater impairment between MCI and controls relative to informant/self-based reports (Goldberg et al., 2010). Observation-based tasks are more meaningful if they measure more than a single domain. Given the heterogeneity of the disorder, distinguishing specific areas of functional deficits in each subtype may enhance the prediction of future decline and/or conversion to dementia. Although it is clear that individuals with MCI exhibit impairments in IADL, researchers have yet to characterize the precise areas of IADL dysfunction (Jefferson et al., 2008).

This study differentiates impairment in specific ADL domains and their severity in individuals with two subtypes of MCI from that of probable AD and healthy normal controls. We hypothesized that the AD group would perform worse on most areas of ADL functioning relative to the MCI and control groups, but that the two MCI groups would display circumscribed deficits on the different ADL domains relative to each other and controls.

Method

Participants

Twenty individuals with AD, 14 aMCI participants, 12 naMCI participants, and 30 healthy age- and education- matched older adults (NC) participated. The AD patients were recruited from an Alzheimer's Association Center, a geriatric center, and a Veterans Administration healthcare center. Participants were had been diagnosed with AD by their primary physician and/or neurologist using the National Institute of Neurological and Communicative Diseases and Stroke-Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA; McKhann et al., 1984) criteria for probable AD, prior to being referred to the study (Razani et al., 2007).

All MCI participants (aMCI and naMCI) were recruited from the UCLA Alzheimer's Disease Research Center (ADRC). These participants were referred to the study with a research diagnosis of MCI based on a multidisciplinary evaluation conducted at the UCLA ADRC and the modified Petersen criteria (Petersen, 2004): (1) reports of essentially intact ADLs, (2) individuals not meeting clinical criteria for dementia, and (3) objective cognitive impairment. The latter was defined as performing at least 1.5 *SD* below the age- and education-adjusted norms on at least one of the neuropsychological measures (Attention: WAIS-III Digit Span and Digit Symbol Coding, Wechsler, 1997a; Trail Making Test [TMT]– Part A, Tombaugh, 2004; Visuospatial: WAIS-III Block Design, Wechsler, 1997a; Rey-O copy, Meyers & Meyers, 1995; Language: Boston Naming Task, Kaplan, Goodglass,& Weintraub, 1983; Semantic Fluency [animals], Tombaugh, Kazak, & Rees, 1999; Memory: WMS-III Logical Memory II and Visual Reproduction II, Wechsler, 1997b; Rey-O 3-minute delay, Meyers & Meyers, 19951; CVLT-II long delay free recall, Delis et al., 2000; Executive: TMT-Part B, Tombaugh, 2004; Phonemic Fluency [FAS], Tombaugh et al., 1999; Stroop – Interference, Demick & Harkins, 1997; Wisconsin Card Sorting Test [WCST], Heaton, Chelune, Talley, Key, & Curtiss, 1993)

The MCI group was further subtyped into (1) aMCI if they had significant impairment in memory or (2) naMCI if they had normal performance in memory but impairment in another cognitive domain. Descriptive information regarding neuropsychological performance on some tests are provided in Table 1 in order to give some indication of the overall group profile. Since the point of this study was not to study cognitive performance per se, the complete battery of neuropsychological test results are not provided, nor did we performed group comparison analyses. A review of Table 1 shows the aMCI performing the poorly on the memory tests (CVLT and Rey-O) while the naMCI performs relatively well on these tests.

Exclusion criteria for the MCI participants included: (1) age < 50; (2) significant neurological disease other than MCI; (3) MRI or CT of the brain demonstrating any major focal lesions (only participants with very mild, defined as a few scattered white matter signal changes, were included, and all subjects with evidence of old strokes were excluded); (4) abnormal vitamin B12 or thyroid function tests; (5) premorbid history of DSM-IV Axis I psychiatric disorders (APA, 1994); and (6) significant systemic illnesses or unstable medical conditions that could contribute to impaired cognition. All were required to have MMSE > 24 at MCI, though some may have declined after that while being still able to live independently.

The NC group consisted of the partners of the patients or individuals who were recruited via newspaper advertisements, posted flyers, or word of mouth. Health questionnaires and not neuropsychological testing was used to determine the cognitive health of these participants.

All NC participants were administered a comprehensive health questionnaire for screening purposes. Participants were excluded if the following were present: history of medical condition, psychiatric illness, substance abuse, experienced a loss of consciousness of > 5 minutes, and/or a neurological disorder other than AD or MCI.

Demographic information (age, sex, education level) for the participants as well as MMSE scores can be found in Table 2. No significant differences were found in age, $F(3, 72) = 1.56$, $p = .21$, or in education $F(3, 72) = .46$, $p = .71$. As expected, there was a significant difference between groups on MMSE scores $F(3, 72) = 113.81$, $p < .001$. Specifically, the AD group scored significantly lower than all other groups, followed by both the aMCI and naMCI groups, who scored similarly, yet significantly lower than the NC group.

Materials

Daily Functional Measure

The Direct Assessment of Functional Status (DAFS; Loewenstein et al., 1989) is a performance-based measure designed to assess daily functional activities in patients with dementia. Participants are instructed, then observed and scored while performing 14 tasks within five functional domains. The total number of points one can achieve in each domain varies as each has a different number of items:

1. Time Orientation (total of 16 points): (1) ability to tell time presented on a clock (0–8 points), and (2) Orientation to person, place, and date (0–8 points).
2. Communication Skills (total of 14 points): (1) ability to use a telephone when presented with names and phone numbers and instructed to dial specific individuals (0–8 points), and (2) prepare a letter to mail by writing the correct location of addresses, place a stamp, and seal the envelope (0–6 points).
3. Transportation Skills (13 total points): (1) ability to identify road signs requires that they describe the use of specific signs presented (0–10 points), and (2) knowing driving rules requires defining specific rules (0–3 points).

4. Financial Skills (19 points): (1) ability to identify currency in coins and bills (0–7 points), (2) count currency in specified amounts (0–4 points), (3) write a check by placing the numeric and written amounts, date, and signature on a check (0–4 points), and (4) balance a check-book on a ledger when instructed of specified purchase amounts (0–4 points).

5. Shopping Skills (17 points): (1) ability to freely recall a list of six grocery shopping items that were verbally presented 10 minutes prior (0–6 points), (2) "shop" by recognizing shopping items at a mock grocery store (0–6 points), (3) "shop" for items with a list (0–4 points), and (4) make correct change when purchasing the mock grocery items (0–1 points).

The reported interrater reliabilities for the DAFS have been in the mid .90 range and test-retest reliabilities for individual subscales have been high with Cohen's κ ranging from.57 to .92 (Loewenstein et al., 1989).

Procedures

Participants were administered the DAFS by trained university research assistants using the standardized written instructions and procedures provided by the DAFS test. Only one examiner administered and rated each participant's performance on the DAFS. Participants had the choice of being tested in their home or at the CSUN campus. The majority opted to be tested in their home, in a quiet room, allowing for the participant and examiner to sit across a table from one another (Razani et al., 2011).

Statistical Analyses

Because of the lack of variance on certain DAFS subscales by specific groups (i.e., skewed distribution), nonparametric statistics were performed. To test overall group differences on each DAFS subscale, we first performed a series of Kruskal-Wallis tests. Mann-Whitney U tests were performed as follow-up analyses for scales that demonstrated significant group differences. In order to assess how well each DAFS subscale classified the aMCI group from the naMCI and AD groups, we conducted two separate series of discriminant function analyses (DFAs). The three groups were used as the dependent variables and the 14 DAFS subscales were each entered individually in separate analyses as the independent variable. Finally, in order to better understand how well the DAFS subscales cluster individual performance of members of each group, the two-step cluster analysis method, which combines nonhierarchical and hierarchical procedures, was used. Chi-square analyses were then performed based on the clusters, so that the cluster classifications could be compared with actual group membership.

Because of the multiple statistical analyses, the *p*-value required for statistical significance was lowered to .01 rather than the standard .05 value. Significance values for the follow-up analyses were set at the standard .05 level. While we recognize that this may not entirely protect against Type I error, a more stringent criteria would have increased Type II error due to the small sample size.

Results

Group Comparisons

All Kruskal-Wallis tests revealed significant differences between the groups for the 14 DAFS subscales (see Table 3). Follow-up Mann-Whitney U tests found that the AD group performed significantly worse than both MCI groups and the normal controls on all DAFS subscales. Furthermore, the Mann-Whitney U tests revealed that aMCI, naMCI, and normal controls performed similarly on all DAFS subscales with the exception of two of the shopping tasks. The aMCI and naMCI performed similarly on shopping free recall task, but worse than the normal controls, suggesting equal difficulty in recalling the shopping items. However, the aMCI performed worse on the shopping recognition portion of the task than the naMCI, who performed the same as the normal controls, indicating that the naMCI benefited from being cued to selecting the correct items.

Classification Rate

The results from the DFAs are presented in Table 4 and Table 5. All but two subscales (ID currency and shopping with a list) were statistically significant (all *p*-values <.05) in accurately classifying the aMCI and AD groups. The orientation to date, mailing a letter, ID road signs, driving rules, write check, balance checkbook, shop-free recall, shop-recognition, and making correct change tasks demonstrated the best overall classification rates (71.4%–82.9%). When it came to classifying the aMCI group, all but shop-free recall demonstrated excellent classification rates (71.4%–100%). As for the AD group,the balance checkbook and shop-free recall tasks demonstrated the best classification rates (81%–85.7%), and adequate classification rates (66.7%–76.2%) were revealed for the orientation to date, driving rules, write check, shop-recognition, and making correct change tasks. However, all other tasks demonstrated poorer accuracy in classifying the AD cases (60% or less).

While most of the tasks were able to distinguish between AD and MCI, they were less reliable in discriminating between MCI subtypes. Only the shop-recognition task was statistically significant ($p = .03$) in accurately classifying the aMCI and naMCI groups. Furthermore, while the overall classification rate was 61%, more naMCI cases were accurately classified (75%) than aMCI cases (50%).

A two-step cluster analysis was performed using all 14 DAFs subscales as the independent variable. The results revealed two distinct clusters that were then used in chisquare analysis to better understand how well the clusters classified participants in the different groups. The analysis showed that the clusters significantly classified the groups ($\chi^2(3) = 43.91$, $p < .001$). As shown in Table 5, the 14 DAFS subscales classified 75% of the AD participants together in cluster 1 and the rest of the aMCI, naMCI and NC participants in cluster 2. These findings indicate that all subscales of the DAFS are used, the MCI and NC group show a similar pattern of responding which is different than that of AD. A second two-step cluster analysis using only shop-free recall and shop-recognition tasks as the independent variables was performed and also found two distinct clusters. This chi-square analysis also revealed that the two clusters significantly classified the four groups ($\chi^2(3) = 45.11$, $p < .001$). Table 5, which presents the classification rates, however, indicates that performance on these DAFS shopping tasks classified all AD and the majority of the aMCI under cluster 1, while the majority of NC and naMCI are classified under cluster 2. These findings suggest that, when the shopping tasks alone are used, aMCI and AD show similar patterns of responding that are different from naMCI and NC.

Discussion

This study differentiates the domains of IADL impairment and their level of severity in MCI subtypes relative to healthy normal controls and to probable AD using a performance-based measure of ADLs. Our results are consistent with prior literature demonstrating observable impaired daily functioning of individuals with MCI (Bangen et al., 2010; Bombin et al., 2012; Jefferson et al., 2008; Luck et al., 2010; Pereira et al., 2010; Wadley et al., 2007). Adding to the limited literature regarding MCI subtypes, our examination of multiple IADL skills revealed rather subtle differences between aMCI and naMCI on a shopping task requiring verbal memory mediation. Another important finding of this study supports the use of performance-based assessments in differentiating patients with AD from those with MCI.

As expected, the aMCI group demonstrated poorer performance, relative to the naMCI group and the NC group, on the shopping tasks involving memory skills (shop-free recall and shop-recognition). Impaired recall and recognition in aMCI, often referred to as rapid forgetting (Smith & Bondi, 2013), is indicative of an inability to retain or save information presented to them (i.e., the list of grocery items) (Greenaway et al., 2006; Libon et al., 2010; Libon et al., 2011). This pattern of performance is consistent with the neuropsychological memory testing patterns found in AD patients in that they often have difficulty encoding/saving verbal information and are not aided by recognition cues (Smith & Bondi, 2013). The naMCI group also demonstrated impaired performance on shop-free recall relative to the NC group, yet performance on shop-recognition did not significantly differ between these two groups. This pattern of performance suggests that the naMCI were able to retain the list of items verbally presented to them, but had difficulty with retrieval (i.e., freely recalling the list of items) and were aided by cues (i.e., recognizing grocery items placed in front of them) (Nelson & O’Connor, 2008).

Our findings agree with several other studies comparing memory deficit profiles among MCI subtypes (Greenaway et al., 2006; Libon et al., 2010; Libon et al., 2011; Schmitter-Edgecombe, Woo, & Greeley, 2009). However, literature comparing MCI subtypes on specific IADLs that are highly dependent on memory is lacking. Despite the paucity of such research, prior studies did indicate a relationship between verbal learning performance and functional abilities in MCI (Farias et al., 2006; Jefferson et al., 2008). Moreover, verbal learning measures demonstrated excellent sensitivity in MCI (de Jager, Hogervorst, Combrinck, & Budge, 2003; Rabin et al., 2009; Smith & Bondi, 2013), suggesting that their use may provide key insight to the different etiologies underlying MCI subtypes (Smith & Bondi, 2013). For example, the rapid forgetting deficits, on both free recall and recognition tasks, exhibited by individuals with aMCI on the DAFS Shopping task in the current study reflects the characteristic profile exhibited by those with AD, while the *retrieval*, but not recognition, deficits displayed by those with naMCI in the current study is more consistent with a profile similar to that of VaD or other non-AD dementias (Libon et al., 2011; Smith &

Bondi, 2013). Interestingly, the cluster analysis in the present study using only the shopping tasks supports this idea: Clusters created based on just the shopping tasks classified the pattern of performance of the AD and the majority of the aMCI as similar, while the pattern for the NC and majority of naMCI was classified as the same. While not specifically examined in this study, the pattern of performance of these two groups is similar to that of MCI individuals with and without high vascular burden. For example, Villeneuve, Massoud, Bocti, Gauthier, and Belleville (2011) found that MCI individuals with high vascular burden had difficulty with the free recall of learned information on a verbal memory task but not with recognition of items. This pattern appears similar to that of the naMCI participants in our group. Further, Villeneuve et al. (2011) found that MCI with no vascular burden had difficulty with both recall and recognition of learned items, making their performance similar to AD and a pattern displayed in our aMCI participants.

Taken together, these findings support the notion of a continuum of decline (Bangen et al., 2010; Bombin et al., 2012; Greenaway et al., 2006; Jefferson et al., 2008; Luck et al., 2010; Pereira et al., 2010; Wadley et al., 2007) where such subtle deficits may constitute an early sign of development of a specific type of dementia (Artero, Petersen, Touchon, & Ritchie, 2006). More research is needed to examine the relationship between distinct verbal learning profiles in MCI subtypes and progression to different types of dementia. Our current findings suggest that we would expect different challenges for the two MCI groups on this shopping task, which is heavily mediated by verbal memory skills.

The susceptibility of financial skills to mild cognitive decline was previously demonstrated in the literature (Gold, 2012; Griffith et al., 2003; Marson et al., 2009; Peres et al., 2006). Similar to past studies, our AD group underperformed relative to MCI (Bangen et al., 2010; Pereira et al., 2010; Peres et al., 2008), though in the current study the MCI group did not display impairments in financial skills relative to the controls. This may be because the financial subscales in the DAFS assess more basic abilities and may not capture the subtle changes in MCI, in ways that other more complex tasks do (Bangen et al., 2010). Additionally, individuals with multiple-domain MCI tend to demonstrate more functional impairments compared to individuals with single-domain MCI (Aretouli & Brandt, 2009; Burton, Strauss, Bunce, Hunter, & Hultsch, 2009; Farias et al., 2008). This could explain why the MCI group in Pereira and colleagues' (2010) study were more impaired than normal controls on the DAFS financial domain, as a majority of these MCI cases had multiple-domain impairments. In the present study a majority of the naMCI cases were single-domain, and the single-domain/multiple-domain ratio was even in our aMCI sample.

Overall, our results agree with previous literature indicating that individuals with MCI have subtle deficits on various IADL tasks (Bangen et al., 2010; Giovannetti et al., 2008; Goldberg et al., 2010; Pereira et al., 2010; Wadley et al., 2007). In order to establish guidelines for subtle versus frank deficits, researchers must identify specific IADL domain impairments and the magnitude of such impairments that are characteristic of each MCI subtype. In the current study, the transportation subscales, the subscales requiring basic functional skills (orientation to date, mailing a letter, and telephone skills), the subscales requiring complex financial abilities (balance checkbook and making correct change), and the two shopping subscales assessing free recall and recognition demonstrated the most accuracy in discriminating between aMCI and AD groups. Additionally, while the performance of aMCI and AD clustered together when free recall and recognition recall shopping task was used – suggesting similar response patterns on these tasks by the two groups – the same subscales demonstrated the most accuracy in discriminating between aMCI and AD groups, indicating that the poorer performance of AD is distinguishable from the aMCI.

Interestingly, the shop-recognition task was the only subscale that discriminated between aMCI and naMCI subtypes. These findings further support the notion that the memory impairment of aMCI appears to be one of encoding *and* retrieval, while the naMCI demonstrates a pattern more consistent with retrieval, but not necessarily encoding, difficulties (Libon et al., 2011; Smith & Bondi, 2013).Consistent with the neuropsychological literature, verbal memory-mediated tasks, such as the DAFS shopping subscale, seem to demonstrate good sensitivity in distinguishing subtypes of MCI (de Jager, Hogervorst, Combrinck, & Budge, 2003; Rabin et al., 2009; Smith & Bondi, 2013).

There were some limitations to the current study. First, some subscales of the DAFS may lead to ceiling effects in the MCI and NC groups on more basic ADLs (i.e., tell time, orientation to date, ID road signs, ID currency, count currency), because it may not capture all of the complexities of IADL domains. As a result, these ceiling effects may have attributed to the lack of ability to discriminate between groups. Second, the DAFS does not include IADL domains assessing medication management, household management, or actual transportation use – all of which are important daily activities often included in other IADL measures (Bangen et al., 2010; Binegar et al., 2009; Goldberg et al., 2010; Pereira et al., 2010). These complex IADL domains may be more sensitive to early cognitive decline (Nygard, 2003). Nonetheless, the subscale of DAFS shopping, in particular, does indicate some ability to differentiate MCI subtypes as well as between the MCI groups, AD, and controls, as demonstrated by the classification rate and clustering of groups found in the current study. In particular, the subscale of DAFS shopping indicates some distinct patterns of performance in MCI subtypes as well as between the MCI groups, AD and controls.

The current study presents several implications for researchers and clinicians to consider. First, our findings support prior literature recommending that mild IADL impairment be considered one of the criteria for MCI (Bangen et al., 2010; Goldberg et al., 2010; Morris, 2012; Nygard, 2003; Perneczky, Pohl, Sorg, Hartmann, Komossa et al., 2006). Our findings also demonstrate subtle differences between MCI subtypes that may further aid in detecting MCI and in specific treatment planning needs.

Findings of the present study add to the literature demonstrating that individuals with MCI exhibit impairments across a range of IADL abilities that increase in severity over time (Wadley et al., 2007). IADL impairment is a major risk factor for future development of dementia, and early IADL impairments also present a risk for more rapid decline (Artero et al., 2008; Bangen et al., 2010; Gold, 2012; Peres et al., 2006; Peres et al., 2008). Therefore, it is important to understand the variation among MCI subtypes regarding specific IADL domain impairment, the severity of such impairments, and the overall rate of functional decline over time (Gold, 2012; Wadley et al., 2007). Furthermore, understanding whether distinct patterns of performance in MCI subtypes are attributable to different under-lying etiologies should improve the accuracy of prediction to dementia (Bangen et al., 2010; Farias et al., 2005; Peres et al., 2006; Peres et al., 2008; Smith & Bondi, 2013). Longitudinal objective assessment of multiple IADL domains is imperative to developing a clear definition of MCI that contributes to a more stable diagnosis over time and to a better understanding of conversion to dementia.

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Table 1

Mean (SD) for neuropsychological test performance of the groups

Test	aMCI	naMCI	AD	NC
Digit Span	16.64 (3.25)	17.40 (4.38)	12.35 (4.44)	16.17 (3.61)
FAS	37.92 (13.05)	39.40 (10.05)	18.15 (10.31)	38.31 (13.78)
Animals	15.14 (3.59)	18.30 (3.83)	6.35 (3.38)	18.28 (4.66)
CVLT Free Delay	2.73 (1.89)	6.50 (2.12)	0.37 (.76)	6.52 (1.94)
Rey-O Copy	29.27 (5.32)	28.75 (5.56)	17.11 (12.10)	31.90 (3.47)
Rey-O 3 min delay	10.17 (4.10)	14.15 (7.15)	1.35 (3.15)	15.30 (7.81)
WCST Categories	2.38 (1.85)	2.30 (1.70)	0.93 (1.70)	3.60 (1.47)
WCST Tot Errors	23.08 (12.89)	20.27 (10.55)	30.93 (10.63)	15.60 (9.70)

Note. CVLT = California Verbal Learning Test; WCST = Wisconsin Card Sorting Test.

Table 2

Means (SD) for demographic information by group

Demographic variable	AD	aMCI	naMCI	NC
n	20	14	12	30
Sex (M/F)	13/7	7/7	3/9	4/26
Age	73.15 (10.22)	71.71 (8.24)	74.67 (10.17)	69.03 (10.59)
Years of education	14.53 (3.47)	15.00 (3.11)	15.67 (2.19)	15.00 (2.75)
MMSE [**a]	17.65 (3.92)	28.07 (1.77)	28.42(1.24)	30 (0)
MMSE range	9–22	24–29	26–29	30

Note. MMSE = Mini Mental State Examination.

[a] NC scored higher than all groups, and AD performed worse than all groups.

[**] $p < .001$.

Table 3

Mean (SD) for ANOVAs and results from Kruskal-Wallis tests

DAFS Variable	Kruskal-Wallis χ^2	aMCI	naMCI	AD	NC
Tell Time[a]	15.57*	8.00 (.00)	8.50 (2.43)	6.00 (3.37)	7.80 (0.81)
Orientation to Date[a]	44.70**	7.29 (1.27)	7.83 (.58)	3.00 (3.08)	8.00 (.00)
Telephone Skills[a]	18.49**	7.57 (.51)	7.42 (.79)	5.95 (2.16)	7.80 (.41)
Mailing a Letter[a]	23.42**	5.43 (.85)	5.83 (.39)	3.75 (1.92)	5.73 (.45)
ID Road Signs[a]	29.97**	10.00 (.00)	9.83 (.39)	8.35 (2.06)	9.97 (.18)
Driving Rules[a]	37.14**	2.86 (.36)	2.83 (.39)	1.60 (1.05)	2.97 (.18)
ID Currency[a]	11.66**	7.00 (.00)	7.00 (.00)	6.55 (1.09)	7.00 (.00)
Count Currency[a]	21.56**	4.00 (.00)	3.83 (.58)	2.55 (1.79)	3.97 (.18)
Write Check[a]	21.99**	3.79 (.43)	3.92 (.29)	2.85 (1.31)	3.90 (.40)
Balance Checkbook[a]	30.02**	3.14 (1.29)	2.92 (1.62)	0.60 (1.14)	3.13 (1.07)
Shop – Free Recall[b]	40.12**	1.71 (2.02)	2.92(1.73)	0.55 (.76)	4.20 (1.22)
Shop – Recognition[c]	36.88**	3.21 (1.89)	4.75 (1.42)	1.35 (1.76)	5.03 (0.81)
Shop – with List[a]	10.39*	3.71 (.83)	4.00 (.00)	3.65 (.67)	4.00 (.00)
Making Change[a]	25.14**	0.86 (.36)	0.83 (.39)	0.40 (.50)	0.97 (.18)

Note.

[a] AD performed worse than all groups; aMCI, naMCI, and NC performed similarly.

[b] aMCI and naMCI performed similarly, but worse than NC; AD performed worse that all groups.

[c] aMCI performed worse than naMCI; naMCI performed the same as NC; AD performed worse that all groups.

* $p < .01$,

** $p < .001$.

Table 4

Results of discriminant function analysis between AD and aMCI

DAFS variable	AD	aMCI	Overall classification	*p*-value
Tell time	28.6%	100%	57.1%	.040
Orientation to date	76.2%	92.9%	82.9%	<.001
Telephone skills	47.6%	100%	68.6%	.008
Mailing a letter	57.1%	92.9%	71.4%	.005
ID road signs	57.1%	100%	74.3%	.007
Driving rules	71.4%	85.7%	77.1%	<.001
ID currency	19%	100%	51.4%	*ns*
Count currency	47.6%	100%	68.6%	.005
Write check	66.7%	78.6%	71.4%	.006
Balance checkbook	81%	85.7%	82.9%	<.001
Shopping – free recall	85.7%	50%	71.4%	.015
Shopping – recognition	76.2%	71.4%	74.3%	.002
Shopping – with list	28.6%	85.7%	51.4%	*ns*
Making change	66.7%	85.7%	74.3%	.002

Note. *ns* = not significant.

Table 5

Results of discriminant function analysis between aMCI and naMCI

DAFS variable	aMCI	naMCI	Overall classification	*p*-value
Tell time	100%	8.3%	57.7%	*ns*
Orientation to date	28.6%	91.7%	57.7%	*ns*
Telephone skills	57.1%	41.7%	50%	*ns*
Mailing a letter	42.9%	83.3%	61.5%	*ns*
ID road signs	100%	16.7%	61.5%	*ns*
Driving rules	85.7%	16.7%	53.8%	*ns*
ID currency	*a*	*a*	*a*	*ns*
Count currency	100%	8.3%	57.7%	*ns*
Write check	21.4%	91.7%	53.8%	*ns*
Balance checkbook	78.6%	25%	53.8%	*ns*
Shopping – free recall	78.6%	66.7%	73.1%	*ns*
Shopping – recognition	50%	75%	61.5%	.030
Shopping – with list	14.3%	100%	53.8%	*ns*
Making change	14.3%	91.7%	52.2%	*ns*

Note.

[a]could not be computed because variable was constant. *ns* = not significant.