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The Independent Living Scale in Amnestic Mild Cognitive Impairment: Relationships to demographic variables and cognitive performance

Kevin Duff, **Sariah Porter**, **Ava Dixon**, **Kayla Suhrie**, **Dustin Hammers**
Center for Alzheimer's Care, Imaging and Research, Department of Neurology, University of Utah

Abstract

Introduction: The Independent Living Scales (ILS) is an objective measure of day-to-day functioning, which can be used to aid in diagnosing dementia in older adults with cognitive impairments. However, no studies have examined this measure in individuals with Mild Cognitive Impairment (MCI), a prodromal phase of dementia.

Method: Therefore, we sought to examine three subscales of the ILS (Managing Money, Managing Home and Transportation, Health and Safety) in a sample of 132 individuals with amnestic MCI, focusing on the relationship of the ILS with demographic variables (age, education, sex) and cognitive abilities (assessed with the Repeatable Battery for the Assessment of Neuropsychological Status [RBANS]).

Results: This MCI sample showed intact daily functioning on the three ILS subscales. In a series of three, separate hierarchical linear regression models, the Managing Money, Managing Home and Transportation, and Health and Safety subscales were all significantly related to demographic variables, and the RBANS Total Scale score significantly added to all models. These models would also allow one to predict an ILS score based on demographic and cognitive data, which could be compared to an observed ILS score to see if it meets expectations.

Conclusions: Overall, these results indicate that daily functioning, as measured with the ILS, is related to cognitive abilities in amnestic MCI, and that demographic variables also influenced ILS scores in this cohort. Although the ILS may be appropriate for identifying functional abilities in MCI, the consideration of these moderating variables seems necessary.

Keywords

Mild Cognitive Impairment; memory; daily functioning; demographics

INTRODUCTION

In the diagnosis of dementia or major neurocognitive disorder, impairments in both cognition and day-to-day functioning are necessary (American Psychiatric Association, 2013; McKhann et al., 2011). In contrast, most diagnostic criteria for Mild Cognitive

Corresponding author: Kevin Duff, PhD, Center for Alzheimer's Care, Imaging and Research, University of Utah, Department of Neurology, 650 Komas Drive #106-A, Salt Lake City, UT 84108. Tel: 801-585-9983. Fax: 801-581-2483. kevin.duff@hsc.utah.edu.

Impairment (MCI) and mild neurocognitive disorder include some indication of cognitive impairment, but daily functioning remains largely intact (Albert et al., 2011; American Psychiatric Association, 2013). Therefore, determining daily functioning is an important variable in making a distinction between MCI/mild neurocognitive disorder and dementia/ major neurocognitive disorder. Whereas there are many tools that objectively assess cognition (Tsoi, Chan, Hirai, Wong, & Kwok, 2015), the evaluation of functional abilities (e.g., driving, managing medications, handling finances, completing household chores) has traditionally relied on the subjective report of the patient and/or collateral sources (Farias, Harrell, Neumann, & Houtz, 2003; Farias et al., 2006; Wadley et al., 2007). However, the Independent Living Scales (ILS) (Loeb, 1996) is one of a relatively few validated measurements that objectively assesses an individual's ability to perform higher-level/ instrumental activities of daily living (A. D. Baird, Solcz, Gale-Ross, & Blake, 2009; Quickel & Demakis, 2013; Rabin, Borgos, & Saykin, 2008).

Although the ILS seems well-suited for assisting in the diagnosis of MCI/mild neurocognitive disorder versus dementia/major neurocognitive disorder, the literature on this measure in these groups is scant. For example, Bangen et al. (2010) found average scores on the Managing Money and Health and Safety subscales of the ILS in their sample of 22 patients with amnestic MCI (T-scores of 53 and 55, respectively). Jak et al. (2009) also found average scores on these two ILS subscales their 90 non-demented older adults, some were diagnosed with MCI (Managing Money T-score = 56, Health and Safety T-score = 55). Across multiple studies, patients with dementia or mixed neurological disease tend to score approximately 1.3 – 2 standard deviations below the mean on the ILS (A. Baird, 2006; A. Baird, Podell, Lovell, & McGinty, 2001; Brunette, Calamia, Black, & Tranel, 2019; Emmert, Schwarz, Vander Wal, & Gfeller, 2019; Loeb, 1996; Mills et al., 2014; Quickel & Demakis, 2013).

Relevant to the use of the ILS in diagnosing MCI/mild neurocognitive disorder vs. dementia/ major neurocognitive disorder, existing literature has shown that some demographic variables are related to ILS scores. For example, age was negatively correlated with scores on the ILS (Ahmed & Miller, 2015; A. Baird, 2006; Emmert et al., 2019). Conversely, education was positively correlated with the ILS in older cohorts (A. Baird, 2006; Emmert et al., 2019). Sex, however, has not been shown to be related to ILS scores (A. Baird, 2006).

Despite the relatively minimal research on the influence of demographic variables on the ILS, several studies have examined the relationship between subscales of the ILS and cognition. Most relevant to the current study, Bangen and colleagues (2010) observed that the ILS subscales of Managing Money and Health and Safety were most strongly associated with global cognition (as measured by the Total score on the Dementia Rating Scale) in amnestic MCI, and that neither memory nor executive functioning were related to ILS scores. In patients with mild dementia, Baird et al. (2001) found that the ILS positively correlated with multiple measures of cognition, including global cognition, attention, premorbid intellect, visuospatial skills, language, memory, and executive functioning. Emmert et al. (2019) reported positive correlations between the ILS Health and Safety subscale and nearly all subtests of the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) in a sample of patients with dementia. More broadly, in a meta-analysis on the relationship between cognition and functional abilities in over 18,000 individuals with MCI, Mcalister, Schmitter-Edgecombe, and Lamb (2016) found that executive functioning, attention, and working memory accounted for more variance in functional outcomes than measures of visuospatial abilities, memory, language, processing speed, and global cognition. Taken together, it appears that in MCI and dementia, the ILS is linked with multiple cognitive domains.

Since there is minimal information on the ILS in individuals diagnosed with MCI/mild neurocognitive disorder, the current study sought to expand upon the existing literature in three ways. First, in a large cohort of patients with amnestic MCI, we provide descriptive information on ILS performance. Since these individuals are, by definition, functionally intact, we expected that their ILS scores would remain within the average range. To our knowledge, only two other studies (Bangen et al., 2010; Jak et al., 2009) have presented such information in older individuals with MCI. Second, we examined the relationship between demographic variables (age, education, sex) and performance on the ILS in this cohort. It was hypothesized that age would be negatively related and that education would be positively related to ILS scores. It was unclear if there would be sex differences on the ILS in this sample. Finally, we examined the relationship between ILS scores and cognition in MCI. It was expected that a global measure of cognition (Total Scale score on the RBANS) would be positively related to ILS scores, as seen in Bangen et al. However, given that the ILS has been positively correlated with most measures of cognition, it was less clear if the ILS would be more strongly related to some cognitive domains (e.g., attention, memory) compared to others (e.g., visuospatial and construction, language). As such, these latter analyses were considered secondary.

METHODS

Participants

One hundred and thirty-two community-dwelling older adults were recruited from either a cognitive disorders clinic (61%) or senior centers and independent living facilities (39%) to participate in a cognitive intervention study. The participants' mean age was 75.3 (SD = 6.1, range = 65 – 91) years and they averaged 16.2 (SD = 2.9, range = 12 – 20+) years of education. The sample of participants was evenly divided by sex (46.9% female) and the majority were Caucasian (97.9%). For inclusion in the study, all participants from this sample were classified as having either single-domain or multi-domain amnestic MCI based on a memory complaint, objective memory deficit, and largely intact daily functioning (Albert et al., 2011). Classification of participants from this sample has been described previously (Duff et al., 2017). General inclusion criteria for the study involved being aged 65 years or older and functionally independent (according to participant and/or knowledgeable informant), along with adequate vision, hearing, and motor abilities to complete the cognitive evaluation. The ILS was not used in the classification of participants as having MCI, so as to not conflate the "diagnosis" of MCI and the dependent variables of interest (i.e., the ILS scores). General exclusion criteria included neurological conditions likely to negatively affect cognition (e.g., stroke, seizures, traumatic brain injury with loss of consciousness of more than 30 minutes), dementia, major psychiatric conditions (including current severe depression), substance abuse, or residence in a skilled nursing or dependent living facility.

Measures

All procedures were approved by the local Institutional Review Board before the study commenced. All participants provided informed consent before completing any procedures. The following measures were administered at an initial study visit:

- ILS (Loeb, 1996) is an individually administered objective assessment of daily functioning for adults. It is a reliable and valid standardized measure for identifying areas of competence in five subscales: Memory/Orientation, Managing Money, Managing Home and Transportation, Health and Safety, and Social Adjustment. The ILS was standardized using a nationally-stratified sample of 400 older adults (age ≥ 65 years) with no known cognitive or functional deficits. An additional 190 older adults with some functional difficulties were used to set cutoffs for the subscales, and an additional clinical sample of 248 adults with various clinical diagnoses were used to validate the ILS. For this project, only the Managing Money, Managing Home and Transportation, and Health and Safety subscales were utilized, as the other two subscales of the ILS seemed either redundant with measures already in our cognitive battery (Memory/Orientation) or less relevant to the study (Social Adjustment). For the Managing Money subscale, individuals were asked practical questions about money (e.g., how much common items cost at a grocery store, counting out exact change, performing simple arithmetic by hand, writing checks, knowing the purpose of a will). For the Managing Home and Transportation subscale, questions and tasks addressed issues around the home and traveling into the community (e.g., how to take public transportation, identifying routine tasks performed at home, looking someone up in a telephone book and calling that number, demonstrating how to call the operator). For the Health and Safety subscale, participants are asked about health and health emergencies (e.g., how to notify officials in health and safety emergencies, explain how to safely cross a busy street, know precautions to take when going out at night, explain how to practice correct personal hygiene). Using normative data from the standardization sample in the test manual, raw scores were converted to T-scores (M = 50, SD = 10), with higher scores indicating better functional abilities. No demographic corrections (e.g., age, education, sex) were provided in the normative data.
- RBANS (Randolph, 1998) is a widely-used, reliable, and valid neuropsychological test battery comprising 12 subtests that are used to calculate Index scores for domains of immediate memory, visuospatial/constructional, attention, language, delayed memory, and global neuropsychological functioning. For this project, the Total Scale score was the primary cognitive outcome. However, the other five Indexes were used as secondary outcomes. These scores utilize age-corrected normative data from the test manual to

generate standard scores (M = 100, SD = 15), with higher scores indicating better cognition.

Procedure

The ILS and RBANS measures were administered during the same baseline visit as part of a larger battery, and each took approximately 30 minutes to administer. All testing was administered in the same location by trained research staff.

Data Analyses

Descriptive statistics examined the means and standard deviations of the three subscales of the ILS in this MCI sample. To evaluate the relationship between the three ILS subscales and 1) demographic variables (age, education, sex) and 2) the Total Scale score on the RBANS, correlations were calculated (Spearman for sex, Pearson for all others). Hierarchical linear regression models were calculated (ILS subscale as dependent variable, and age, sex, education, and RBANS Total Scale as predictor variables). Demographic predictor variables were entered in a first block, followed by the cognitive predictor variable in a second block, to measure the amount of variance accounted for by demographics alone and to gauge how much variance is added by cognition. To further examine if any specific cognitive domain was particularly influential, additional regression models were calculated for each of the other five Indexes of the RBANS. However, these latter models were considered secondary and exploratory analyses. Due to multiple statistical comparisons and an increased risk of Type I error, an alpha value of 0.01 was used throughout.

RESULTS

For the entire sample, the scores on all three subscales of the ILS were within the average range (see Table 1). Consistent with their diagnoses of amnestic MCI, non-memory RBANS Index scores were in the average range, but memory Indexes were more impaired (see Table 1). Correlations between the predictor variables (age, sex, education, RBANS Total Scale) and the three ILS subscales are presented in Table 2. Minimal multicollinearity was observed between the predictor variables, with only sex being significantly related to education (r_s=0.36, p<0.001).

For the primary cognitive outcome, the Managing Money subscale was marginally predicted by the combination of age, sex, and education (F(3,131)=2.75, p=0.04, R^2=0.06), and the Total Scale score significantly added to that prediction, F(4,131)=10.36, p<0.001, final R^2=0.25. Although all three demographic variables were entered as a block in this regression model and the block was related to the Managing Money subscale, only age significantly related to the ILS subscale (p=0.007). The Managing Home and Transportation subscale was significantly predicted by the combination of age, sex, and education (F(3,131)=5.11, p=0.002, R^2=0.11), and the Total Scale score significantly added to that prediction, F(4,131)=6.92, p<0.001, final R^2=0.18. In the demographics block of this model, only education was significantly related to the ILS subscale (p=0.003). Finally, the Health and Safety subscale was significantly predicted by the combination of age, sex, and education (F(3,131)=4.07, p=0.004, R^2=0.10), and the Total Scale score significantly added to that prediction, $F(4,131)=12.71$, $p<0.001$, final $R^2=0.29$. In the demographics block of this model, only age was significantly related to the ILS subscale ($p=0.001$). Additional details about these models, as well as the normative prediction equations, are presented in Table 3.

The remaining Indexes of the RBANS were used as secondary cognitive outcomes to predict the Managing Money subscale (see Table 4), the Managing Home and Transportation subscale (see Table 5), and the Health and Safety subscale (see Table 6).

DISCUSSION

Even though objective measures of daily functioning, like the ILS, would appear to be useful in the diagnosis of MCI/mild neurocognitive disorder vs. dementia/major neurocognitive disorder, there is a paucity of information on how individuals with MCI perform on the ILS. Furthermore, there is relatively restricted literature on the influence of demographic variables (e.g., age, education, sex) and cognition on this scale in these mildly impaired patients. Therefore, we sought to add to that limited literature by highlighting how demographic variables and cognition relate to daily functioning in an MCI population.

To our knowledge, only two studies reported on the ILS in patients with MCI. Both Bangen et al. (2010) and Jak et al. (2009) reported average scores on two ILS subscales in older individuals with amnestic MCI. Additionally, given the predominant definition of MCI as being cognitively impaired but functionally intact (Albert et al., 2011; Petersen et al., 2001; Winblad et al., 2004), it was largely expected that our sample would largely perform comparably to healthy controls. Indeed, across the three subscales of the of the ILS, these 132 older individuals with single or multidomain amnestic MCI scored in the average range: Managing Money (M=51.3 T-score, 53rd percentile), Managing Home and Transportation (M=50.7 T-score, 53rd percentile), and Health and Safety (M=51.6 T-score, 55th percentile). Such scores are consistent with those reported in MCI (Bangen et al., 2010; Jak et al., 2009) and healthy control samples on the ILS (Ahmed & Miller, 2015; A. D. Baird et al., 2009; Loeb, 1996). Conversely, the scores from the current cohort are well-above those reported in patients with dementia, who typically had T-scores in the 30 – 37 range on the ILS (A. Baird, 2006; A. Baird et al., 2001; Brunette et al., 2019; Emmert et al., 2019; Loeb, 1996; Mills et al., 2014; Quickel & Demakis, 2013).

As with most neuropsychological tests, demographic variables appear to exert some influence on the subscales of the ILS. For example, in the current sample, when age was forced into the regression models, it was negatively weighted in all models, indicating that older adults performed more poorly than younger ones. Such a finding is consistent with previous literature that has shown the same negative relationship between age and ILS scores (Ahmed & Miller, 2015; A. Baird, 2006; Emmert et al., 2019). In the primary analysis with the RBANS Total Scale score, age was significantly (but negatively) related to the Managing Money and Health and Safety subscales. These subscales contain many questions about financial and medical issues, which may be more complex and therefore more challenging to answer in older individuals. Education was positively related with the three ILS subscale scores when it was forced into the models, which has also been reported by others (A. Baird, 2006; Emmert et al., 2019). However, of the three ILS subscales, education only significantly contributed to Managing Home and Transportation. This subscale contains items that require problem solving skills in daily life (e.g., home repairs, figuring out a bus schedule, taxi failing to arrive on time), which may be better performed by more educated seniors, with more cognitive reserve (Stern, 2012). Sex has not been shown to be related to ILS scores in the literature, and we did not find significant contributions of sex in any of our regression models. Even though prior studies have not found sex effects on the ILS in dementia (Baird, 2006), we wanted to confirm this finding in individuals with amnestic MCI. Despite these demographic effects on the ILS, the test manual does not correct for age, education, or sex. Admittedly, the ILS was originally developed for use with older adults, and its normative data is predominantly from this group. Nonetheless, corrections for these demographic variables may improve the sensitivity of this test to identify functional declines in patients.

Even though the ILS manual does not provide corrections for demographic information, the current study begins to address this limitation of this functional measure. Using the normative equations in Table 3, one can predict an individual's ILS score using demographic and cognitive data (as applicable). For example, if one wanted to predict the Managing Money T-score for a 75-year old female with 16 years of education whose Total Scale score on the RBANS was 82, then her predicted T-score would be approximately 49 (i.e., 46.35 + [75*−0.32] + [0*1.98] + [16*0.18] + [82*0.29] = 49.01; note that female = 0, male = 1). Predicting this same subscale T-score for a 90-year old male with 11 years of education who scored 70 on the Immediate Memory Index would yield a predicted T-score of 42 (i.e., 46.35 + [90*−0.32] + [1*1.98] + [11*0.18] + [70*0.29] = 41.81)[1]. To see how far an individual's observed ILS score differed from his/her predicted ILS score in z-scores units, one would subtract the predicted score from the observed score and divide by the standard error of the estimate in Table 3 (i.e., $z = [ILS – ILS']/SE_{est}$). For example, if the 75-year old patient's observed Managing Money score was 45, then z = (45 – 49.01)/7.79 = −0.51. This z-score of −0.51 indicates that the patient's observed ILS score is approximately one-half standard deviation below her predicted ILS score (based on demographics and the Total Scale score). If the 90-year old patient's observed score was 45, then z = (45 – 41.81)/7.79 = 0.41, which indicates that the patient's observed ILS score is nearly one-half a standard deviation above his predicted ILS score. Although such equations would need to be validated in an independent sample, they begin to correct for important variables that may make the ILS more sensitive in older adults with MCI.

In the relatively few studies examining the ILS in cognitively impaired individuals, it has been shown that functional decline is related to cognitive decline (A. Baird, 2006; A. Baird et al., 2001; Brunette et al., 2019; Emmert et al., 2019). Most studies have broadly linked the ILS to nearly all cognitive domains assessed (e.g., premorbid intellect, attention, visuospatial, language, memory, executive functioning). For example, Emmert et al. (2019) reported that nearly every subtest of the RBANS was positively correlated to the ILS Health and Safety subscale (i.e., better cognition = better daily functioning) in a sample of patients with dementia. Therefore, it may not be surprising that these three ILS subscales were

[1]Readers may contact the first author to obtain a copy of a spreadsheet that does these calculations.

positively related to the Total Scale score in our cohort of patients with amnestic MCI. When the Total Scale score of the RBANS (primary cognitive outcome) was added as a second step in our hierarchical regression models, it led to an additional 7 – 19% of the variance being accounted for in these predictions. Since the Total Scale score is a composite of all of the other Indexes on the RBANS, its link to the daily functioning tasks in the ILS is consistent with existing literature (Baird, 2006; Baird et al., 2001; Brunette et al., 2019; Emmert et al., 2019).

When looking at the secondary cognitive outcomes (see Tables 3 – 5), the Immediate Memory and Language Indexes also seemed to contribute to predicting ILS scores (18 – 27% and 13 – 28% of the variances, respectively). With items requiring individuals to hold information in their heads (e.g., figuring out change after a purchase, making out a check following instructions, dialing a telephone number after finding it in a telephone book), it seems that immediate or working memory would be utilized. Additionally, since nearly all items are presented verbally, adequate language functioning would appear to benefit the test taker. Although the Attention and Delayed Memory Indexes were also modestly related to these three ILS subscales, the Visuospatial/Constructional Index was the least related (e.g., 9 – 11% of variance). Across the three ILS subscales measured in this study, only one item involves visuospatial/constructional abilities (e.g., finding a route on a map on the Managing Home and Transportation subscale).

Despite the potentially useful findings in the current study, there are some limitations worth mentioning. First, the RBANS does not measure executive functioning, which may be important in daily functioning (McAlister & Schmitter-Edgecombe, 2016; Ziemnik & Suchy, 2019). Additionally, prior studies have found that the ILS subscales relate to executive functioning (Ahmed & Miller, 2015; A. Baird et al., 2001; Brunette et al., 2019; Emmert et al., 2019). Unfortunately, our cognitive battery only contained a single measure of executive functioning (Trail Making Test Part B), so we were unable to create a composite measure of executive functioning like with our other cognitive domains. Nonetheless, future work in this area should include multiple measures of executive functioning. Second, the 132 older adults in the current sample were predominantly Caucasian and highly educated, which may limit the generalizability of our findings. One implication of the restricted variability in the demographics of our sample is that these results may be inaccurate/ inappropriate to use in individuals who do not meet the characteristics of the current sample. A more diverse sample is needed to add to the utility of this measure. Future studies should strive to represent individuals of all races and ethnicities, socioeconomic classes, and educational levels to ensure that results are applicable to our rapidly diversifying society. Third, we did not administer the entire ILS, choosing only three subscales. The other two subscales of the ILS (Memory/Orientation and Social Adjustment) were not included because they seemed less relevant to our goals. Fourth, the percent variance accounted for by the normative prediction models was relatively low (9 – 29%). As such, it is expected that there are additional variables that contribute to the prediction of ILS scores, and determining these variables should be pursued in future studies. Fifth, our sample consisted exclusively of older adults with amnestic MCI. Ideally, normative data (and related prediction models) should include robustly, cognitively intact individuals. Nonetheless, individuals with MCI are, by definition, largely functionally intact. On the ILS, this has been observed in at least three samples (current; Bangen et al., 2010; Jak et al., 2009). So, from a functional standpoint, our sample is normal. Since the progression from MCI to dementia (or mild neurocognitive disorder to major neurocognitive disorder) requires functional impairment due to cognitive deficits, it would seem valuable to know how individuals with MCI are performing on the ILS, so that tracking of any progression of functional abilities can be more sensitively determined. A final limitation of the current study might be its emphasis on functional scores as relative/continuous variables rather than absolute/dichotomous variables. One can view functional measures, like the ILS, as having absolute/dichotomous scores, whereby scores below a certain cutoff are "impaired" and scores above that cutoff are "intact." In such a view, it does not matter if an individual is one point below the cutoff or ten points below because he/she falls below the cutoff. In the absolute/dichotomous view, it might not matter if the patient/participant is a 65-year-old with global cognitive functioning at the 16th percentile or if he/she is a 91-year-old with global cognitive functioning at the 75th percentile because the cutoff is absolute (i.e., same for all) and dichotomous (i.e., impaired/intact). In this view, it does not matter one's demographics or cognitive scores, everyone needs to know what number to dial in an emergency. Conversely, when functional measures are viewed as having relative/continuous scores, the cutoff for an "impaired/intact" score is relative depending on key characteristics of that individual (e.g., age, education, global cognition). Furthermore, within this view, scores are continuous, and the differences between scores have meaning. In this view, one would have different cutoffs for a 65-year-old with cognitive functioning at the 16th percentile and a 91-year-old with cognitive functioning at the 75th percentile. Although both views seem to have merit and may be complimentary, the current study's prediction models clearly take a relative/continuous approach to scores on the ILS. In our opinion, these prediction models may identify subtler differences between observed and predicted scores for individuals with difference demographic or cognitive profiles. For example, a 77-year-old female with 16 years of education and an RBANS Total Scale score of 100 gets a T-score of 50 on the ILS Managing Money subscale. Compared to the current sample (and using the prediction equation in Table 3), her predicted T-score on this subscale is 54, which yields a z-score of −0.51 (i.e., 50 – 54/7.79 = −0.51), indicating that she is about one half of a standard deviation below expectations. A similar individual who got an RBANS Total Scale score of 120 would have a predicted T-score of 60, and a z-score of −1.28 (if her obtained T-score was also 50 [i.e., 50 – 60/7.79 = −1.28]). From the absolute/dichotomous view, it could be concluded that these two individuals had identical levels of money management skills (i.e., average, as both had observed T-scores of 50). From the relative/continuous view, these two individuals appear discrepant (e.g., z-scores of −0.51 vs. −1.28) when one considers demographic and cognitive factors. Again, these two views of interpreting functional scores may both provide valuable information.

Although not necessarily a limitation of the current study, the ILS was published in 1996, and updates will be needed for future objective measures of daily functioning. First, there have been many technological advances in the past 20+ years that are not reflected in the tasks in the ILS. For example, in the Managing Money subscale, participants are asked to pay a bill by writing out a check or money order. In today's society, it is much more likely that payments on the computer will occur. Similarly, participants are asked to count out change, when cashless transactions are becoming much more commonplace. In the Managing Home and Transportation subscale, participants address an envelope, look up a number in a telephone book, and are asked to dial the operator. Future tests that evaluate activities of daily living will need to become more aligned with the current society (Sikkes et al., 2012). Second, dementia is a global problem (Chiu & Lam, 2007), and relevant scales need to consider cultural variations in the tasks and appropriate responses. The ILS was developed for and standardized within the United States, with the tasks being specifically geared for older Americans. However, in other parts of the world, societal and cultural demands are different. For example, as noted in Chui and Lam, men are not expected to do household chores in many Asian countries, Thai women may appear to show more decline in dressing since their attire is more complex than men in that country, and the demands on the elderly are less in some countries as the society tends to be more protective of them. When evaluating individuals for dementia with traditional Western scales, Karim et al. (2011) noted that older adults from Pakistan reported more severe changes in activities of daily living than their peers in the United Kingdom. Although some rating scales for activities of daily living have been revised to be more culturally appropriate (Cintra et al., 2017; Reisberg et al., 2001; Sousa et al., 2010), objective functional measures have lagged behind.

In conclusion, while the ILS seems well-suited for assisting in the diagnosis of MCI/mild neurocognitive disorder versus dementia/major neurocognitive disorder, its scant literature in patients with MCI/mild neurocognitive disorder has limited its impact. By providing more information about the impact of demographic and cognitive variables on the ILS in patients with MCI, it is hoped that such objective measures of daily functioning become more commonplace in neuropsychological evaluations to assist in the diagnostic process.

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References

Ahmed FS, & Miller LS (2015). Adequate proverb interpretation is associated with performance on the independent living scales. Neuropsychol Dev Cogn B Aging Neuropsychol Cogn, 22(3), 376–387. doi:10.1080/13825585.2014.952613 [PubMed: 25313441]

Albert MS, DeKosky ST, Dickson D, Dubois B, Feldman HH, Fox NC, … Phelps CH (2011). The diagnosis of mild cognitive impairment due to Alzheimer's disease: recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. Alzheimers Dement, 7(3), 270–279. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=21514249 [PubMed: 21514249]

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders *(5th ed.)* Arlington, VA: Author.

Baird A (2006). Fine tuning recommendations for older adults with memory complaints: using the Independent Living Scales with the Dementia Rating Scale. Clin Neuropsychol, 20(4), 649–661. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=16980252 [PubMed: 16980252]

Baird A, Podell K, Lovell M, & McGinty SB (2001). Complex real-world functioning and neuropsychological test performance in older adults. Clin Neuropsychol, 15(3), 369–379. doi:10.1076/clin.15.3.369.10270 [PubMed: 11778775]

Baird AD, Solcz SL, Gale-Ross R, & Blake TM (2009). Older adults and capacity-related assessment: promise and caution. Exp Aging Res, 35(3), 297–316. doi:10.1080/03610730902922085 [PubMed: 19449243]

Bangen KJ, Jak AJ, Schiehser DM, Delano-Wood L, Tuminello E, Han DS, Delis DC, & Bondi MW (2010). Complex Activities of Daily Living Vary by Mild Cognitive Impairment Subtype. J Int Neuropsychol Soc, 16(4), 630–639. [PubMed: 20374675]

Brunette AM, Calamia M, Black J, & Tranel D (2019). Is Episodic Future Thinking Important for Instrumental Activities of Daily Living? A Study in Neurological Patients and Healthy Older Adults. Arch Clin Neuropsychol, 34(3), 403–417. doi:10.1093/arclin/acy049 [PubMed: 29893785]

Duff K, Atkinson TJ, Suhrie KR, Dalley BC, Schaefer SY, & Hammers DB (2017). Short-term practice effects in mild cognitive impairment: Evaluating different methods of change. J Clin Exp Neuropsychol, 39(4), 396–407. doi:10.1080/13803395.2016.1230596 [PubMed: 27646966]

Emmert NA, Schwarz LR, Vander Wal JS, & Gfeller JD (2019). Neuropsychological predictors of health and safety abilities in dementia. Appl Neuropsychol Adult, 1–13. doi:10.1080/23279095.2019.1599893

Farias ST, Harrell E, Neumann C, & Houtz A (2003). The relationship between neuropsychological performance and daily functioning in individuals with Alzheimer's disease: ecological validity of neuropsychological tests. Arch Clin Neuropsychol, 18(6), 655–672. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=14591439 [PubMed: 14591439]

Farias ST, Mungas D, Reed BR, Harvey D, Cahn-Weiner D, & Decarli C (2006). MCI is associated with deficits in everyday functioning. Alzheimer Dis Assoc Disord, 20(4), 217–223. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=17132965 [PubMed: 17132965]

Jak AJ, Bondi MW, Delano-Wood L, Wierenga C, Corey-Bloom J, Salmon DP, & Delis DC (2009). Quantification of Five Neuropsychological Approaches to Defining Mild Cognitive Impairment. Am J Geriatr Psychiatry, 17(5), 368–375. [PubMed: 19390294]

Loeb PA (1996). Independent Living Scales Manual. San Antonio, TX: Psychological Corporation.

Mcalister C, & Schmitter-Edgecombe M (2016). Executive function subcomponents and their relations to everyday functioning in healthy older adults. J Clin Exp Neuropsychol, 38(8), 925–940. doi:10.1080/13803395.2016.1177490 [PubMed: 27206842]

McKhann GM, Knopman DS, Chertkow H, Hyman BT, Jack CR Jr., Kawas CH, … Phelps CH (2011). The diagnosis of dementia due to Alzheimer's disease: recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. Alzheimers Dement, 7(3), 263–269. doi:10.1016/j.jalz.2011.03.005 [PubMed: 21514250]

Mills WL, Regev T, Kunik ME, Wilson NL, Moye J, McCullough LB, & Naik AD (2014). Making and Executing Decisions for Safe and Independent Living (MED-SAIL): development and validation of a brief screening tool. Am J Geriatr Psychiatry, 22(3), 285–293. doi:10.1016/j.jagp.2012.08.016 [PubMed: 23567420]

Petersen RC, Doody R, Kurz A, Mohs RC, Morris JC, Rabins PV, … Winblad B (2001). Current concepts in mild cognitive impairment. Arch Neurol, 58(12), 1985–1992. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=11735772 [PubMed: 11735772]

Quickel EJ, & Demakis GJ (2013). The Independent Living Scales in civil competency evaluations: initial findings and prediction of competency adjudication. Law Hum Behav, 37(3), 155–162. doi:10.1037/lhb0000009 [PubMed: 22906190]

Rabin LA, Borgos MJ, & Saykin AJ (2008). A survey of neuropsychologists' practices and perspectives regarding the assessment of judgment ability. Appl Neuropsychol, 15(4), 264–273. doi:10.1080/09084280802325090 [PubMed: 19023743]

Randolph C (1998). Repeatable Battery for the Assessment of Neuropsychological Status. San Antonio, TX: The Psychological Coporation.

Stern Y (2012). Cognitive reserve in ageing and Alzheimer's disease. Lancet Neurol, 11(11), 1006–1012. doi:10.1016/S1474-4422(12)70191-6 [PubMed: 23079557]

Thompson B (1995). Stepwise regression and stepwise discriminant analysis need not apply here: A guidelines editorial. Educational and Psychological Measurement, 55(4), 525–534.

Tsoi KK, Chan JY, Hirai HW, Wong SY, & Kwok TC (2015). Cognitive Tests to Detect Dementia: A Systematic Review and Meta-analysis. JAMA Intern Med, 175(9), 1450–1458. doi:10.1001/jamainternmed.2015.2152 [PubMed: 26052687]

Wadley VG, Crowe M, Marsiske M, Cook SE, Unverzagt FW, Rosenberg AL, & Rexroth D (2007). Changes in everyday function in individuals with psychometrically defined mild cognitive impairment in the Advanced Cognitive Training for Independent and Vital Elderly Study. J Am Geriatr Soc, 55(8), 1192–1198. doi:10.1111/j.1532-5415.2007.01245.x [PubMed: 17661957]

Winblad B, Palmer K, Kivipelto M, Jelic V, Fratiglioni L, Wahlund LO, … Petersen RC (2004). Mild cognitive impairment--beyond controversies, towards a consensus: report of the International Working Group on Mild Cognitive Impairment. J Intern Med, 256(3), 240–246. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=15324367 [PubMed: 15324367]

Ziemnik RE, & Suchy Y (2019). Ecological validity of performance-based measures of executive functions: Is face validity necessary for prediction of daily functioning? Psychol Assess, 31(11), 1307–1318. doi:10.1037/pas0000751 [PubMed: 31282702]

Table 1.

Descriptive data on the ILS and RBANS in this sample.

Test	M (SD)
ILS	
Managing Money	51.30 (8.83)
Managing Home and Transportation	50.73 (5.87)
Health and Safety	51.59 (7.67)
RBANS	
Immediate Memory	82.23 (16.73)
Visuospatial/Constructional	98.18 (14.78)
Language	90.71 (12.22)
Attention	96.26 (15.43)
Delayed Memory	77.37 (21.37)
Total Scale	85.29 (13.31)

Note. ILS = Independent Living Scales, RBANS = Repeatable Battery for the Assessment of Neuropsychological Status, ILS scores are T-scores (M = 50, SD = 10), RBANS scores are standard scores (M = 100, SD = 15).

Table 2.

Correlations between predictor and outcome variables.

	MM	HT	HS
Age	−0.18	−0.14	−0.23 *
Sex	0.13	0.16	0.16
Education	0.15	0.30 *	0.22
RBANS Total Scale	0.41 *	0.27 *	0.41 *

Note. MM = Managing Money, HT = Home and Transportation, HS = Health and Safety.

* = $p<0.01$.

Table 3.

Predicting the ILS subscales from demographic variables and RBANS Total Scale.

ILS Subscale	F(df) p	R^2	SE_{est}	Normative equation[a]
Managing Money	10.36 (4,131) <0.001	0.25	7.79	46.35 − (age*0.32) + (sex*1.98) + (educ*0.18) + (Total*0.29)
Managing Home and Transportation	6.92 (4,131) <0.001	0.18	5.41	43.45 − (age*0.16) + (sex*0.26) + (educ*0.53) + (Total*0.12)
Health and Safety	12.71 (4,131) <0.001	0.29	6.58	49.49 − (age*0.35) + (sex*1.08) + (educ*0.37) + (Total*0.25)

Note. ILS = Independent Living Scales, RBANS = Repeatable Battery for the Assessment of Neuropsychological Status, SE_{est} = Standard error of the estimate,

[a]Age is in years; sex is coded as 0 = female, 1 = male; education (educ) is coded as years; and Total is the age-corrected standard score from the test manual.

Table 4.

Predicting Managing Money from demographic variables and RBANS Indexes.

Index	F(df) p	R^2	SE_{est}	Normative equation[a]
Immediate Memory	8.83 (4,131) <0.001	0.22	7.93	54.95 − (age*0.34) + (sex*1.70) + (educ*0.22) + (Index*0.21)
Visuospatial/Constructional	3.17 (4,131) 0.016	0.09	8.55	51.68 − (age*0.22) + (sex*1.06) + (educ*0.30) + (Index*0.11)
Language	7.31 (4,131) <0.001	0.19	8.09	36.43 − (age*0.21) + (sex*2.49) + (educ*0.38) + (Index*0.26)
Attention	5.36 (4,131) <0.001	0.15	8.29	52.11 − (age*0.30) + (sex*2.70) + (educ*0.22) + (Index*0.17)
Delayed Memory	4.01 (4,131) 0.004	0.11	8.45	57.77 − (age*0.25) + (sex*1.77) + (educ*0.27) + (Index*0.10)

Note. ILS = Independent Living Scales, RBANS = Repeatable Battery for the Assessment of Neuropsychological Status, SE_{est} = Standard error of the estimate,

[a] Age is in years; sex is coded as 0 = female, 1 = male; education (educ) is coded as years; and Index is the age-corrected standard score from the test manual.

Table 5.

Predicting Managing Home and Transportation from demographic variables and RBANS Indexes.

Index	F(df) p	R^2	SE_{est}	Normative equation[a]
Immediate Memory	7.10 (4,131) <0.001	0.18	5.39	46.70 − (age*0.17) + (sex*0.14) + (educ*0.54) + (Index*0.10)
Visuospatial/Constructional	3.94 (4,131) 0.005	0.11	5.63	47.54 − (age*0.12) + (sex*0.01) + (educ*0.58) + (Index*0.02)
Language	4.64 (4,131) 0.002	0.13	5.57	43.02 − (age*0.11) + (sex*0.36) + (educ*0.60) + (Index*0.07)
Attention	5.72 (4,131) <0.001	0.15	5.49	45.12 − (age*0.15) + (sex*0.63) + (educ*0.54) + (Index*0.08)
Delayed Memory	4.90 (4,131) <0.001	0.13	5.55	47.94 − (age*0.13) + (sex*0.17) + (educ*0.56) + (Index*0.05)

Note. ILS = Independent Living Scales, RBANS = Repeatable Battery for the Assessment of Neuropsychological Status, SE_{est} = Standard error of the estimate,

[a] Age is in years; sex is coded as 0 = female, 1 = male; education (educ) is coded as years; and Index is the age-corrected standard score from the test manual.

Table 6.

Predicting Health and Safety from demographic variables and RBANS Indexes.

Index	F(df) p	R^2	SE_{est}	Normative equation[a]
Immediate Memory	11.81 (4,131) <0.001	0.27	6.65	56.72 − (age*0.37) + (sex*0.84) + (educ*0.39) + (Index*0.20)
Visuospatial/Constructional	3.56 (4,131) 0.009	0.10	7.39	64.70 − (age*0.26) + (sex*1.03) + (educ*0.50) − (Index*0.02)
Language	12.05 (4,131) <0.001	0.28	6.63	36.99 − (age*0.26) + (sex*1.64) + (educ*0.55) + (Index*0.27)
Attention	7.77 (4,131) <0.001	0.20	6.98	53.90 − (age*0.33) + (sex*1.77) + (educ*0.40) + (Index*0.16)
Delayed Memory	8.24 (4,131) <0.001	0.21	6.94	57.98 − (age*0.30) + (sex*0.91) + (educ*0.42) + (Index*0.12)

Note. ILS = Independent Living Scales, RBANS = Repeatable Battery for the Assessment of Neuropsychological Status, SE_{est} = Standard error of the estimate,

[a] Age is in years; sex is coded as 0 = female, 1 = male; education (educ) is coded as years; and Index is the age-corrected standard score from the test manual.