Published in final edited form as:

*Alzheimer Dis Assoc Disord*. 2015 ; 29(2): 158–160. doi:10.1097/WAD.0000000000000031.

# The Dementia Severity Rating Scale Predicts Clinical Dementia Rating Sum of Boxes Scores

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**Keywords**

Dementia Severity Rating Scale; Clinical Dementia Rating Scale Sum of Boxes; Alzheimer's disease; Mild Cognitive Impairment

## 1. Introduction

Functional assessment is an indispensable component of dementia evaluations. Functional evaluations are necessary to differentiate normal aging from mild cognitive impairment (MCI) and MCI from Alzheimer's disease (AD), and to track AD progression. While cognitive test performance is an equally important part of this process, functional measures have higher ecological validity, may be better at determining change from previous, higher levels of ability, and are less sensitive to the effects of education and premorbid intelligence [1].

The Clinical Dementia Rating Scale (CDR), a commonly used dementia staging instrument, employs a semi-structured interview format to collect detailed information from an informant regarding the patient's ability to function in various domains. The CDR offers a global characterization of everyday functions that may be affected by neurodegenerative disease [2]. The value of global characterizations has been questioned, however, especially during the assessment of MCI[3]. The wider range of scores provided by the CDR sum of

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Portions of this work were presented at the 2012 Alzheimer's Association International Conference (AAIC), Vancouver, Canada.

**Conflicts:** The authors report no conflicts of interest

boxes (CDR-SB) score may enable a more refined analysis of subtle changes associated with very mild disease or between stages in later AD [4, 5],

The CDR is the most well known, well studied dementia staging instrument [6]. The scale, however, is not without limitations. Primary concerns include a lengthy rater certification process, approximately 30-minute administration time, and clinical judgment required during administration and scoring [2]. The Dementia Severity Rating Scale (DSRS) is a brief informant-rated, multiple-choice questionnaire made up of 12-items that measure functional abilities and parallel CDR content [7]. The DSRS requires minimal staff training to administer, takes five minutes to complete, and can be completed via mail, Internet, or phone. Similar to the CDR-SB, the DSRS incorporates a broad range of scores, making this instrument useful for quantifying all levels of functional impairment, and permitting the detection of fine increments of change over time [8]. Reliability and validation studies have shown that the DSRS has high reliability, as well as a constant linear rate of change throughout the entire course of AD. The original version demonstrated high concurrent validity with the CDR and the Mini Mental State Examination [7, 8]. To improve its utility, however, further analysis of the association between the DSRS and the CDR is required. With this in mind, the goal of the present study was to examine the ability of the DSRS to predict scores on the CDR-SB.

## 2. Methods

A retrospective analysis was performed on data collected from 952 patients from the Penn Memory Center, the clinical core of the University of Pennsylvania's Alzheimer's Disease Center. Subjects (N = 952) had diagnoses of probable or possible AD (64%, n = 612), non-AD Dementia (10%, n = 97), MCI (14%, n = 133), or were healthy older adults (12%, n = 110). Participants were 61% female and predominantly non-Hispanic whites (80%). Demographic and clinical variables are presented in Table 1. Participants were randomly assigned in halves to a training sample (n = 476) or a validation sample (n = 476); the clinical and demographic characteristics of each of these sub-samples were consistent with the whole study population.

On the basis of all available data, a consensus diagnosis was established using standardized clinical criteria for AD, MCI, or other neurological or psychiatric conditions presenting with cognitive impairment. As part of each evaluation, a knowledgeable informant (usually a spouse or adult child) was asked to complete the DSRS. The instrument is described in detail in the original publication [7] and is available upon request from the Penn Memory Center http://www.pennadc.org/contact. The total score is derived from the sum of scores in 12 functional areas, and ranges from zero (i.e., no impairment,) to 54, extreme impairment[8]. The CDR was administered according to established criteria [2]. The information collected during the CDR parallels that which is gathered on the DSRS and DSRS scores were available to the clinician completing the CDR.

## 3. Results

Linear regression analysis was performed with SAS Software (v 9.1, SAS Institute, Cary, NC) to determine the strength of association between the scales and the formula for

predicting CDR-SB. We first performed the linear regression in the training sample, using the DSRS total score to predict CDR-SB. This analysis yielded an R-squared value of 0.8, indicating that 80% of the variance in scores on the CDR-SB was explained by scores on the DSRS. The regression equation to determine a predicted CDR-SB score was *Predicted CDR-SB = -0.068 + 0.39(DSRS total score)*. Thus, the CDR-SB score increases at a linear rate of 0.39 with each 1 point increase in the DSRS score.

The regression equation from the training sample was subsequently applied in the independent validation sample to examine the robustness of the prediction equation obtained from the training sample. In the validation sample, the mean CDR-SB score = 6.28 ± 5.2 [Range = 0 - 18]. The *predicted* CDR-SB based on DSRS total scores in the same sample had a mean CDR-SB of 6.29 ± 4.6 [Range = 0 – 20.5]. The Pearson correlation between DSRS-*predicted* CDR-SB and the observed CDR-SB was $r = 0.90$.

We conducted a secondary analysis to confirm the relationship when the range was restricted to participants (n=300) with no to very mild dementia (CDR-SB of 0-2.5). Again, a strong linear relationship was observed in a training sample (n=150) that yielded an R-squared value of 0.5. In the validation sample (n=150), the mean CDR-SB score = 0.96±0.9 [Range=0–2.5] and the *predicted* CDR-SB score based on DSRS total scores had a mean of 1.02±0.7 [Range=0.3–4.5]. The Pearson correlation between the DSRS-*predicted* CDR-SB and the observed CDR-SB was $r = 0.59$.

## 4. Discussion

The results of the linear regressions indicate that scores on the DSRS strongly predict scores on the CDR-SB across a wide range of functional abilities. High Pearson correlations between DSRS-predicted and observed CDR-SB scores lend further support to this result and confirm that DSRS total scores can be used to predict CDR-SB scores in clinical research settings. This finding has implications for situations where a CDR-SB score is desirable but impractical due to cost or examiner or participant burden. The DSRS joins other brief instruments that predict CDR scores or functional impairment through shortened structured interview formats, providing valuable alternatives to the full CDR [9].

We also see value in using the DSRS at more frequent intervals than would be possible with the CDR during the course of clinical care or a research protocol. This has the potential to allow for smoothing of data points in order to better characterize change over time, whether it be rate of decline or stability/gain as a result of an intervention. For instance, we have used DSRS total scores of 0-11 as a screening boundary for identifying participants with no or very mild impairment. DSRS total scores in that range predict CDR-SB scores of 0 to 4.2, scores that may be interpreted as normal to very mild dementia and are consistent with CDR global scores of 0 to 0.5. Moreover, recent results from our center indicate that use of the DSRS in conjunction with cognitive testing improved diagnostic accuracy beyond that found with cognitive or functional instruments alone and that a DSRS cut score of 10 was optimal for distinguishing the transition from MCI to AD [10].

A methodological caveat of this study is that DSRS scores and questionnaires were available to our clinical staff at the time the CDR interview was conducted. As such, our DSRS and

CDR scores cannot be considered independent functional metrics. This characteristic may limit the applicability of our results to similar clinical research settings. In addition, although the instructions for the DSRS request that the person completing the form, note his or her relationship to the patient and extent of weekly contact, the flexibility of administration of the DSRS (i.e., by mail, phone, web, or in-person) also reduces clinician oversight, standardization, and thus introduces a potential bias that may reduce utility in some settings.

We contend that clinical scientists invested in accurately predicting CDR ratings consistent with MCI or AD and subsequently confirming the predicted CDR score will find our results helpful. The investigator may use the DSRS as a technique for enriching samples in larger epidemiological settings where administration of the CDR to all participants may be impractical and as a technique for smoothing functional ratings in longitudinal designs. In addition, use of both measures serves as a validity check; because the DSRS was designed to mirror the CDR, the items on each measure should elicit similar answers and, if this is not the case, a caution may be raised as to the quality of the informant and/or subject responses.

## Acknowledgments

The authors express appreciation to the research participants and staff of the Penn Memory Center/Clinical Core of the University of Pennsylvania Alzheimer's Disease Center, especially Xiaoyan Han, M.S. for her assistance with the analyses. This work is dedicated to our colleague and co-author, the late Christopher M. Clark.

**Funding Sources:** This work was supported by NIA AG10124 and the Marian S. Ware Alzheimer's Program / National Philanthropic Trust.

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## Table 1

Clinical and demographic characteristics (M ± SD) of the full sample (N = 952).

| | AD (n=612) | Non-AD Dementia (n=97) | MCI (n=133) | Controls (n=110) |
|---|---|---|---|---|
| **Age** | 76.9 ± 8.3 | 70.1 ± 9.8 | 74.5 ± 8.6 | 75.5 ± 9.2 |
| **Sex (% female)** | 64% | 46% | 56% | 65% |
| **Race (% white)** | 78% | 93% | 82% | 77% |
| **Education** | 13.5 ± 3.5 | 13.8 ± 3.5 | 14.7 ± 3.2 | 16.4 ± 3.0 |
| **MMSE** | 17.4 ± 7.4 | 17.4 ± 9.0 | 26.4 ± 2.8 | 29.2 ± 1.3 |
| **DSRS** | 19.8 ± 10.5 | 22.9 ± 12.9 | 7.2 ± 5.3 | 1.2 ± 2.1 |
| **CDR-SB** | 8.1 ± 4.6 | 8.7 ± 5.5 | 1.8 ± 1.5 | 0.2 ± 0.4 |

Published in final edited form as:
*Alzheimer Dis Assoc Disord*. 2015 ; 29(3): 222–228. doi:10.1097/WAD.0000000000000057.

# The Utility of the Dementia Severity Rating Scale in Differentiating Mild Cognitive Impairment and Alzheimer's Disease from Controls

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## Abstract

The current study investigated the utility of the Dementia Severity Rating Scale (DSRS) total score to identify individuals at the earliest stage of impairment (i.e., Mild Cognitive Impairment/ MCI). In addition, the authors sought to investigate how well the measure correlates with an expanded battery of cognitive tests and other measures of functional abilities. Of the 320 participants included in this study, 85 were normal controls, 96 had single or multiple domain amnestic MCI, and 139 had possible or probable Alzheimer's disease (AD). Each participant underwent a thorough cognitive, neurological, and physical examination. Results from this study indicated that the DSRS total scores differed significantly between the three groups ($p < .001$) and accurately identified 81% of the control group, 60% of the MCI group, and 78% of the AD group in a post-hoc discriminant analysis. When combined with a brief cognitive measure (i.e., Consortium to Establish a Registry for Alzheimer's Disease Word List 5-minute recall test), the DSRS accurately identified 98% of the control group, 76% of the MCI group, and 82% of the AD group. Implications for clinical practice and proposed areas of future research are discussed.

All-cause dementia is defined as declines in cognitive impairment severe enough to impair a person's ability to conduct instrumental activities of daily living (IADLS).[1] Growing consensus in the field acknowledges that there is a phase of mild cognitive impairment (MCI) that may be noticeable to the individual and family members, but do not affect the individual's ability to conduct their regular activities, which proceeds a formal diagnosis of

Conflicts of Interest: None of the authors report any conflicts of interest.

Alzheimer's Disease (AD).[2] Although not all individuals who present with MCI will develop Alzheimer's Disease (AD), nearly half of all people who visit their primary provider for MCI symptoms will develop dementia within four years.[3]

Early diagnosis of MCI and dementia is recommended because it allows earlier treatment and management. Primary care providers are thus in a unique position to detect cognitive decline over time as they provide continued care for their patients.[4] However, studies have shown that 40-70% of physicians in primary care[5,6] fail to diagnose mild-to-moderate cognitive impairment in elderly patients. Primary care physicians may not detect mild cognitive impairment for a number of reasons, including time constraints, insurance under-reimbursement prohibiting a comprehensive evaluation, lack of valid screening tools, as well as the multidimensionality of cognitive impairment and dementia.[7] There is, therefore, a great need for simple, valid, and brief screening tools to be available to health care professionals in order to make timely and accurate diagnoses more possible.

Instruments that have demonstrated the ability to differentiate between individuals with AD and MCI can be categorized into two groups; 1) cognitive assessments of the patient directly, and 2) informant based questionnaires where a caregiver or other knowledgeable person answers questions regarding the patient. Within the first group, the Mattis Dementia Rating Scale-Second Edition (MDRS-2) has been shown to correctly identify AD (1.0 sensitivity and 1.0 specificity) and amnestic MCI (0.8 sensitivity and 0.68 specificity), but was not specific enough to differentiate between MCI related to Parkinson's disease and amnestic MCI.[8] Another patient assessment, the Montreal Cognitive Assessment (MoCA), is a 10-minute cognitive screening tool, which has shown to have a high sensitivity of identifying people with MCI (0.90) and AD (1.0); and good specificity (0.87) for distinguishing between MCI or AD and normal controls (NC).[9] Individuals with a low MoCA Memory Index Score were also more likely to convert to a diagnosis of AD within an average follow-up time of 18 months.[10]

With the group of informant-based questionnaires, the six-item Disability Assessment for Dementia Scale (DAD-6), was able to differentiate between MCI and mild dementia (MD) with a sensitivity of 0.83 (95% confidence interval 0.74–0.92) specificity of 0.84 (95% confidence interval 0.71-0.94). [11] Another informant-based questionnaire, the 39-item Everyday Cognition scale (ECog), was able to significantly discriminate between normal controls and MCI (0.93 sensitivity, 0.80 specificity), and MCI and persons with dementia (0.75 sensitivity, 0.80 specificity).[12]

When evaluating these different scales for use in differentiating between NC, MCI, and AD, along with measuring symptomatic changes over time, a review by Weinstein and colleagues[13] made the following recommendations: 1) linearity over the range of the scale; 2) ability to detect small changes in observation periods of less than a year; and 3) need for the administration to be brief and able to be completed in a clinic setting. In short, an instrument that easily, reliably, and consistently tracks symptom severity is essential in both the clinical management and research of MCI and AD.[13] In this regard, the Dementia Severity Rating Scale (DSRS) was recommended as potentially being able to meet these criteria.[13]

The DSRS is an 11-item, informant-report questionnaire, assessing a variety of functional and cognitive abilities. It has a brief administration time (about 5 minutes) and has a number of advantages over other widely-used screening instruments. Clark and Ewbank[14] demonstrated the ability of the DSRS to differentiate cognitively healthy individuals from those with AD in a study of 162 subjects with a diagnosis of normal ($n$ = 24), probable AD ($n$ = 135), and definite AD ($n$ = 3). The authors showed the DSRS to be highly correlated with other widely-used functional measures such as the Washington University Clinical Dementia Rating Scale, and certain cognitive measures such as the language, memory, and praxis tests from the Consortium to Establish a Registry for Alzheimer's Disease (CERAD).[15] The authors also demonstrated that the DSRS was a valid and useful measure of disease progression[16] as it was able to stage the disease well into severe dementia without the constraint of a floor effect.

The DSRS also has been shown to be effective in detecting declines in function in a study of 702 patients with AD followed participants from first diagnosis until they became too impaired to return to clinic.[17] The DSRS not only was able to detect gradual declines in ability in test-retest every six months, but the rate of decline remained steady throughout the disease progression, increasing an average of 4.48 points (95% confidence interval: 4.14-4.82). In contrast, the Mini Mental State scores also showed declines, but at varying rates during the disease progression, thus was not shown to be the ideal measure to track changes in symptom functioning.[17]

Despite the many strengths of the DSRS as a useful screening tool to differentiate normal adults from those with dementia, and track rates of decline in AD symptoms over time, its sensitivity in identifying subtle changes in cognition in individuals with MCI and mild dementia remains unexplored. The utility of the DSRS to detect early dementia is of particular interest, especially given that this early period is where treatment is most effective.[18] The current study seeks to determine if the DSRS total score (a) can identify individuals at the MCI stage of impairment from those who are cognitively healthy (i.e., NC), (b) correlates with an expanded battery of cognitive tests, and (c) correlates with measures of activities of daily living (e.g., Pfeffer Functional Activities Questionnaire, Bristol Activities of Daily Living Scale).

## Method

### Participants

Study participants consisted of 362 community-dwelling older adults evaluated at the University of California in Irvine, Alzheimer's Disease Research Center between January 2002 and June 2006. Normal control participants ($n$ = 109) were volunteers enrolled in the "Successful Aging Program" and had no significant cognitive complaints. Participants ($n$ = 24) were excluded from this group when they demonstrated either cognitive and/or functional impairments at their initial or subsequent assessments. The remaining 85 control participants showed no significant cognitive, neurological, functional, or behavioral deficits.

Participants in the MCI group ($n$ = 107) had a subjective memory complaint and met criteria for either the single- or multiple-domain forms of amnestic MCI.[19] Subjects scored at or

below 1.5 standard deviations from the mean for their age on the 30-minute delayed recall measure of either the WMS-III Logical Memory test[20] or the CERAD Word List.[15] MCI participants ($n$ = 11) were excluded when they showed deficits in their basic activities of daily living[21] at initial or subsequent visits.

Finally, the 146 participants in the AD group were evaluated at the clinic and diagnosed as having either probable or possible Alzheimer's disease per the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association criteria.[22] AD patients ($n$ = 7) were removed from this group for having a change in their diagnosis on a subsequent annual visit.

Since problems with depression are fairly common in both healthy and cognitively impaired older adults and can negatively impact functional abilities, participants showing evidence of a major depressive disorder, as defined as scoring 8 or above on the Geriatric Depression Scale (GDS) [23] were excluded. Patients with mild depression, however, were included in the analysis as excluding these individuals would have resulted in highly selective and non-representative groups of MCI and AD patients.

Of the 320 qualifying participants included in the data analyses, 85 (26.6%) were normal controls, 96 (30%) had either Amnestic MCI ($n$ = 50) or Amnestic MCI with multiple domains ($n$ = 46), and the remaining 139 (43.4%) had possible ($n$ = 28) or probable ($n$ = 111) AD. This sample was comprised of approximately equal numbers of men ($n$ = 157) and women ($n$ = 163). Mean scores on the Folstein Mini-Mental State Examination (MMSE) for the control and MCI participants fell in the unimpaired range and were 29.2 ($SD$ = 1.1) and 26.7 ($SD$ = 2.3), respectively. In comparison, the AD patients showed mild to moderately severe dementia with an average MMSE score of 19.3 ($SD$ = 6.0). The mean ages of the control, MCI, and AD patients were 73.6 ($SD$ = 9.4), 75.8 ($SD$ = 7.2), and 77.5 ($SD$ = 8.3) years, respectively. Participants in all three groups were well educated, with a mean number of years of schooling of 16 ($SD$ = 2.2), 15.7 ($SD$ = 2.7), and 14.4 ($SD$ = 3.1) in the control, MCI, and AD groups, respectively.

Across the three groups, the informants providing information about the participants' functional abilities were primarily spouses (53.5%) or adult children (33.7%). For a small number of participants, the primary informants were other relatives (1.7%), friends and/or neighbors (6.7%), or paid caregivers (0.7%). A few ($n$ = 9) of the control participants served as their own informant in the completion of the functional measures. Given that healthy older adults have been shown to provide reliable self-reports,[24] these individuals' reports were deemed valid and therefore included in the present study. None of the participants with MCI or AD served as their own informant. A majority of the informants (i.e., 92%) reported having known the participants for more than 10 years and saw them anywhere from several times a week (11.3%) to one or more times per day (66.3%). All clinical diagnoses were reached by consensus of a board-certified neurologist and licensed clinical neuropsychologist, following clinical interview and review of data. The primary outcome measures in this study were not utilized in making diagnosis determinations.

### Procedures

All participants completed a two-hour neuropsychological test battery that included measures of global mental status, recent verbal memory, recent visual memory, remote (i.e., long-term) memory, attention, language, visual-spatial ability, executive functioning, and psychomotor speed. In addition, a family member, spouse, or knowledgeable informant was asked to complete questionnaires about the patient's daily functional abilities, including the Dementia Severity Rating Scale (DSRS),[14] the Pfeffer Functional Activities Questionnaire (FAQ),[25] and the Bristol Activities of Daily Living Scale (BADLS).[26] The DSRS was administered for the purposes of this study and was not used in making the clinical diagnosis so it can be used to evaluate its ability to measure group differences.

The DSRS[14] is an informant-based questionnaire that provides clinicians with a brief means of assessing the severity of a patient's dementia. Informants are asked to rate the participant's ability in 11 areas of functioning including ADLs, IADLs, and cognitive functioning. Each category is assessed using descriptions extending from normal (i.e., independent) to severely impaired (i.e., dependent) levels of functioning. Total scores range from 0 to 51 points, with lower scores representing higher levels of functioning.

### Data Analyses

Data were analyzed using the statistical software, SYSTAT- Version 11.0.[27] Gender differences between groups were examined using a chi-square analysis while age, education, global mental status, and functional status were compared across the three groups using an Analysis of Variance (ANOVA) test. With these tests, a Bonferroni correction was applied to account for multiple comparisons. To examine group differences on the DSRS, an ANOVA with Bonferroni corrected probabilities was conducted. Partial correlations with Bonferroni corrections were obtained to examine the relationship between the DSRS and the FAQ, BADLS, and neuropsychological measures controlling for significant demographic variables. Test scores were transformed (e.g., square roots, log) in order to make the distributions more symmetrical where appropriate.

## Results

Data from 320 normal control and cognitively-impaired community dwelling older adults were analyzed. Chi-square analyses indicated a significant difference in the number of men ($n = 157$) and women ($n = 163$), $\chi^2(1, N = 320) = 11.4, p < .01$. As shown in Table 1, results indicated the AD participants were significantly older, $F(2, 317) = 5.7, p < .01$, and had slightly lower education, $F(2, 317) = 11.3, p < .001$, than the NC and MCI participants. In addition, the control group reported fewer depressive symptoms, $F(2, 300) = 10.0, p < .001$. As expected, the groups showed significant differences in global mental status (i.e., MMSE), $F(2, 315) = 171, p < .001$, and functional abilities on the DSRS, ($F(2, 317) = 294.9, p < .001$)

### Differences in Functional Status between Groups

It was hypothesized that the DSRS total score would significantly differ between groups of NC, MCI, and AD participants. Because the asymmetrical nature of this sample distribution

violated the assumptions of the parametric procedures, a square-root transformation was conducted on the DSRS total score prior to analysis. An ANOVA with Bonferroni corrected probabilities indicated significant differences in functional abilities among the groups, $F(2, 316) = 292.54$, $p < .001$. A post-hoc analysis was conducted and revealed a significant difference between all three groups ($p < .001$). More specifically, the AD group exhibited significantly greater functional deficits on the DSRS than both the control, $t(2) = 2.90$, $p < .001$, and the MCI group, $t(2) = 1.43$, $p < .001$. Likewise, the MCI group exhibited significantly greater impairment than the control group, $t(2) = 1.46$, $p < .001$.

To further examine the relevance of this finding, a discriminant analysis was conducted to evaluate how well subjects could be classified (diagnostically) by their DSRS total score. A jackknifed classification matrix indicated that the total score of the DSRS accurately identified 81% of the control group, 60% of the MCI group, and 78% of the AD group. Overall, the DSRS accurately classified 72% of the participants thereby misclassifying approximately 1/4 of the total sample.

## DSRS and Neuropsychological Performance

It was hypothesized that the DSRS would correlate significantly to measures of memory, language, praxis, and global mental status, visual-spatial ability, and executive functioning. Gender, age, and education were controlled for in the analyses due to a significant relationship to the DSRS total score. As a result, partial correlations with Bonferroni corrected probabilities were used to examine the relationship between the DSRS total score and the neuropsychological measures.

The specific neuropsychological instruments included in this analysis can be seen in Table 2. For the Trail Making Tests (i.e., TMT-A and TMT-B), 19 scores from TMT-A and 95 scores from TMT-B were excluded from the analyses because of imputed (i.e., floored) values. Partial correlations for the entire sample indicated that the DSRS total score was significantly related to all 15 neuropsychological instruments. In an effort to examine the relationship within each diagnostic group, partial correlations were obtained for each of the three groups. Results from this analysis indicate that the relationship of the DSRS total score to neuropsychological performance was primarily due to the strength of the relationship found in the AD group. As shown in Table 2, the DSRS total score was (a) significantly related to Logical Memory 1 (a measure of verbal memory) in the control group ($p < .001$), (b) not significantly related to any of the cognitive measures in the MCI group, and (c) significantly related to most of the cognitive measures in the AD group ($p < .001$), with the exception of the CWLT-5, CWLT-30, WMS-III LM2, and TMT-B.

## DSRS and Activities of Daily Living

In the present study, the DSRS total score was hypothesized to be significantly related to two other widely-used measures of functional status: the FAQ and the BADLS. Partial correlations were obtained and indicated that the DSRS total score was significantly related to the total scores for both the FAQ and the BADLS ($p < .001$). In an effort to examine the relationships between these measures within groups, partial correlations were obtained for each group controlling for gender, age, and education. As shown in Table 3, the DSRS total

score was significantly related to both the FAQ and the BADLS in all three groups ($p < .001$).

### Post-Hoc Analyses

In light of previous studies reporting the benefit of combining cognitive measures with functional scales to increase diagnostic accuracy,[28,29] previous measures shown to correlate with the DSRS[14] were examined in a discriminant analysis. These measures included several subtests from the CERAD Word List memory test (Note that the 30-minute delay was not used since it had potentially been used to assist in diagnosis; see Table 4). When examined alone, results indicated that the 5-minute recall test (CWLT-5 performed comparably or better than the other three CERAD measures at correctly classifying diagnostic category. The CWLT- 5 was used in conjunction with the DSRS in a discriminant analysis. Results from this analysis indicated that the combined measure was more accurate than both the DSRS and CWLT- 5 used alone. Specifically, the jackknifed classification matrix indicated the total score of the combined CWLT-5 and DSRS accurately identified 98% of the control group, 76% of the MCI group, and 82% of the AD group. For the overall sample, the CWLT-5/ DSRS combination accurately classified 85% of the participants. Results for all models are shown in Table 4.

## Discussion

The purpose of the current study was to address the utility of the DSRS toward better characterizing and distinguishing individuals diagnosed with MCI and AD from those without cognitive impairment. Results indicated that the DSRS would serve as a useful screening tool, able to successfully distinguish NC subjects from both MCI and AD groups. These findings support Clark and Ewbank's[14] original research on the usefulness of the DSRS with groups of normal and demented (i.e., AD) older adults. Identifying cognitive impairment in its earliest stages (i.e., MCI) is critical, as early diagnosis and treatment have been shown to help slow or stabilize cognitive decline, reduce caregiver stress, and delay institutionalization.[18]

The relationship between the DSRS and neuropsychological performance was also examined in the current study. This study expanded upon the Clark and Ewbank[14] study by adding measures of attention and executive functioning to the memory, language, and visual-spatial scales used in the original study. In addition, the current study examined within-group performance which included a MCI group. With the AD group, the majority of the correlations were significant. This is consistent with previous findings that demonstrate the strength of the relationship between cognitive status and functional status for AD patients.[30] For the MCI group, however, none of the neuropsychological measures correlated significantly with the DSRS. There was, however, a strong trend between measures of memory and DSRS total score. This indicates that, while impairment in memory is co-occurring with impairment in functional status, it is not occurring at the same rate for all participants as is more characteristic of the AD group.

One possible explanation for this is that individuals with a MCI diagnosis are not expected to be as severely impaired in as many domains as those diagnosed with AD. As a result,

MCI patients may possess the ability to compensate for loss in a given cognitive domain whereas an AD patient may have multiple domains significantly impaired. For example, a patient with severe memory impairment may compensate using their executive skills by setting alarms, taking notes, and taking other creative measures to counteract the memory loss. The AD patient may lack the initiative, creativity, and executive control to compensate for the memory loss. Therefore, the AD patient will have significant cognitive impairment adversely affecting everyday living while the MCI will present with less impairment in IADLs.

Researchers[28] have demonstrated that combining a brief test of episodic memory (i.e., Word List recall) with a functional measure proved to be a discriminant combination in separating individuals with MCI from those in the earliest stages of AD. Likewise, the current study combined the DSRS with the CWLT- 5. Results indicated that using the two measures in conjunction as a brief screening tool correctly enhanced diagnostic accuracy, identifying 98% of the controls, 76% of the MCI group, and 82% of the AD group (see Graph 1 for comparisons).

The DSRS was also highly related to both the FAQ and the BADLS, demonstrating good construct reliability. Although other measures have been shown to also be able to differentiate between AD and MCI, the DSRS has a number of advantages including its brevity, comprehensiveness, sensitivity to early changes in cognition and functional impairment, and ability to track disease progression over time.[17]

## Limitations and Future Directions

One finding that warrants further discussion is that the AD group was found to have more symptoms of depression than the NC or MCI groups. Since dementia is associated with a higher risk for depression,[31] occurring in 11-54% of individuals with MCI[32,33] and 30-50% of early AD patients, [34,35] this finding is not unanticipated and is most likely representative of the AD population. Additionally, while the mean GDS score of the AD patients (M=2.5, SD=2.5) was higher than that of the MCI patients (M=2.3, SD=2.5) and NC (M=1.3, SD=1.8), all three averages were quite low and fell below the generally-accepted cutoff for mild depression of 5 out of 15 points (see Table 1). As reported earlier, all individuals in the NC, MCI, and AD groups with significant levels of depression were excluded from the study. Future studies may wish to look at whether higher levels of depression negatively impact the ability of the DSRS to distinguish between AD, MCI and normal aging.

As with any study, it is important that the findings be replicated with other samples to further ascertain the generalizability of the results. While the age and gender demographics were similar to other studies, the level of education for the participants in this study exceeded both state and national averages. That is, 96.6% of the participants in this study had at least 12 years of education and 56.9% had at least 16 years of education. This is relatively high when compared to the national averages of the time which indicated that 73.1% of individuals age 65 and older had 12 or more years 18.7% had 16 or more years of education,[36] though the educational levels in the study were consistent with those found in the sample location (in Orange County, California, 90.1% of adults over age 65 had at least 12 years and 46.8% had at least 16 years of education).[37]

This sample was additionally limited to individuals fluent in the English language resulting in a relatively homogenous ethnic sample. The lack of multiculturally and multilinguistically sensitive neuropsychological instruments presents a significant deficit in the field at large as opposed to being a limitation unique to this study.

It might also be useful to examine a more heterogeneous MCI diagnostic group with both amnestic and non-amnestic participants, and/or solely examine the non-amnestic subtype. This does not take away from the contribution of this study, however, given that the majority of people with an MCI diagnosis have memory impairment.[38] Given that both the MCI and AD groups in this study shared memory impairment, incorporating a non-amnestic diagnostic group may result in a change in some of the data. For example, adding a non-amnestic MCI group could possibly increase the overlap between NC and MCI groups on memory tasks, and potentially decrease the overlap between the MCI and AD groups, since non-amnestic MCI patients have been shown to convert at a lower rate than the amnestic subtype.[39]

In conclusion, the brief and easy-to-administer DSRS has demonstrated a high level of accuracy in differentiating between older adults with NC, MCI, or mild AD. Since the DSRS takes only five minutes to administer, it could easily be incorporated into annual exams for older adults. . Even if there is no cognitive impairment present during the first visit, results from that testing would provide an invaluable baseline for changes in memory and functioning over time. In addition, routine evaluations of the DSRS provide a useful measure of disease progression which can aid in treatment and diagnostic decisions.[17] This is particularly important given the demand for ways to quickly and effectively identify cognitive impairment among older adults in the primary care setting.

## Acknowledgments

Source of Funding

This research was supported by the National Institute on Aging (NIA) [grant number P50 AG16573 to the University of California at Irvine, Alzheimer's Disease Research Center].

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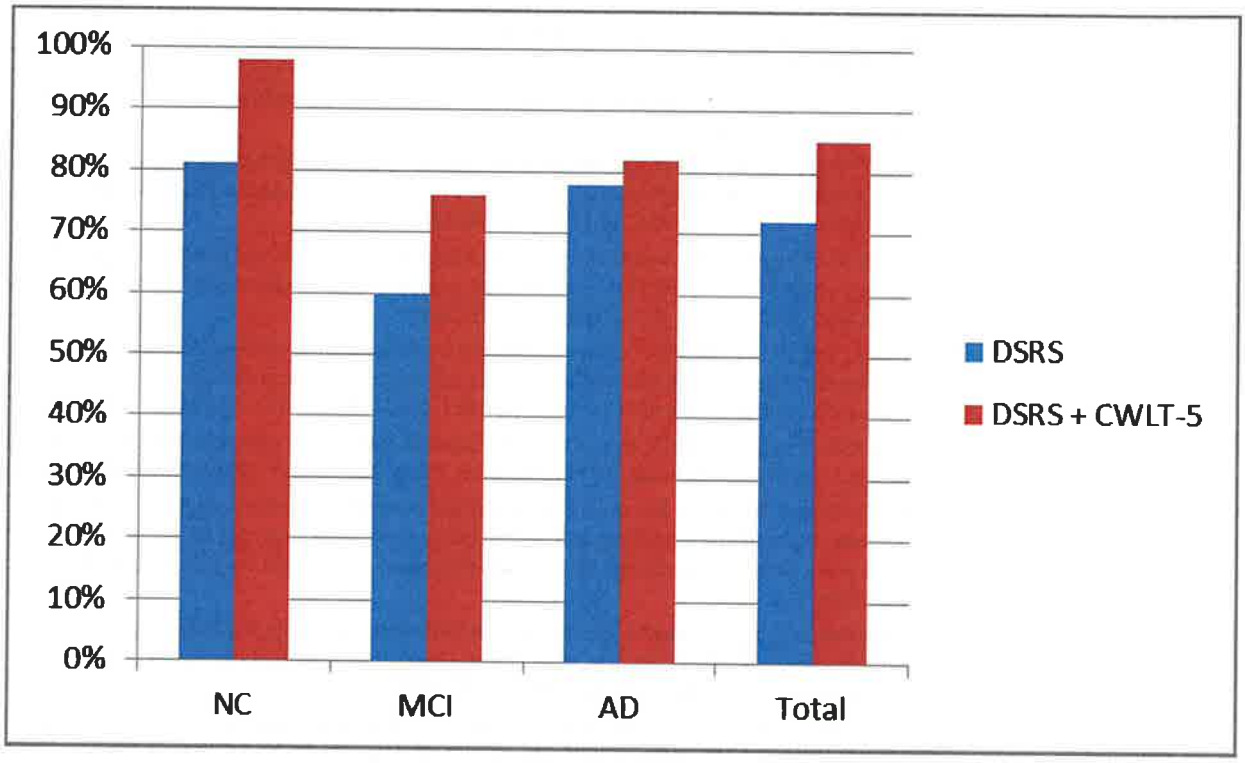


**Graph 1.**
Diagnostic predictability of the DSRS and DSRS plus CWLT-5.
*Note*. NC = Normal Controls; MCI = Mild Cognitive Impairment; AD = Alzheimer's Disease; CWLT-5 = CERAD Word List 5-minute recall test

**Table 1**

Demographics by Sample and Diagnostic Group

| | Sample | | NC | | MCI | | AD | | Chi-Square | |
|---|---|---|---|---|---|---|---|---|---|---|
| **N** | **320** | | **85** | | **96** | | **139** | | | |
| **% Female** | **50.9** | | **64.7** | | **39.6** | | **50.4** | | 11.4* | |
| | **Mean** | **SD** | **Mean** | **SD** | **Mean** | **SD** | **Mean** | **SD** | ***F*** | ***t*** |
| Age | 75.9 | 8.5 | 73.6 | 9.4 | 75.8 | 7.2 | 77.5 | 8.3 | 5.7* | AD < NC, MCI |
| Education | 15.2 | 2.9 | 16.0 | 2.2 | 15.7 | 2.7 | 14.4 | 3.1 | 11.3** | AD < NC, MCI |
| MMSE | 24.2 | 6.0 | 29.2 | 1.1 | 26.7 | 2.3 | 19.3 | 6.0 | 241.0** | AD < MCI < NC |
| DSRS | 9.9 | 8.3 | 2.0 | 2.3 | 7.1 | 4.0 | 16.7 | 7.5 | 294.9** | AD < MCI < NC |
| FAQ | 8.5 | 9.3 | 0.7 | 1.6 | 4.0 | 4.1 | 16.6 | 8.5 | 306.2** | AD < MCI < NC |
| BADLS | 5.4 | 8.1 | 0.5 | 1.5 | 1.6 | 2.6 | 11.5 | 9.3 | 159.2** | AD < MCI < NC |
| GDS | 2.1 | 2.4 | 1.3 | 1.8 | 2.3 | 2.5 | 2.5 | 2.5 | 10.0** | NC < MCI, AD |

*Note*. NC = Normal Controls; MCI = Mild Cognitive Impairment; AD = Alzheimer's Disease; MMSE = Folstein Mini-Mental State Examination; DSRS = Dementia Severity Rating Scale; FAQ = Pfeffer Functional Abilities Questionnaire; BADLS = Bristol Activities of Daily Living Scale; GDS = Geriatric Depression Scale

* $p < .01$

** $p < .001$

**Table 2**

Partial Correlations between DSRS and Neuropsychological Measures by Sample and Diagnostic Group with Bonferroni Corrections

| | Sample | | NC | | MCI | | AD | |
|---|---|---|---|---|---|---|---|---|
| **Instrument** | ***N*** | **Coef** | ***n*** | **Coef** | ***n*** | **Coef** | ***n*** | **Coef** |
| **Memory** | | | | | | | | |
| CERAD Word List- 5 min. recall | 311 | -.73** | 81 | -.19 | 93 | -.07 | 137 | -.23 |
| WMS-III Logical Memory 1 | 317 | -.74** | 84 | -.39** | 96 | -.19 | 137 | -.32** |
| WMS-III Logical Memory 2 | 317 | -.72** | 84 | -.32 | 96 | -.17 | 137 | -.10 |
| **Attention** | | | | | | | | |
| WAIS-III Digit Span | 267 | -.44** | 46 | -.02 | 86 | .01 | 135 | -.41** |
| WAIS-III Symbol Digit Modality | 261 | -.63** | 46 | .22 | 86 | -.14 | 129 | -.44** |
| **Language** | | | | | | | | |
| Boston Naming Test | 317 | -.65** | 84 | -.22 | 96 | .03 | 137 | -.39** |
| COWAT | 317 | -.57** | 84 | -.03 | 96 | -.11 | 137 | -.45** |
| Category Fluency | 317 | -.66** | 84 | -.04 | 96 | -.07 | 137 | -.42** |
| **Visual-Spatial** | | | | | | | | |
| Constructional Praxis | 317 | -.45** | 84 | -.19 | 96 | .00 | 137 | -.21** |
| Block Design | 309 | -.56** | 84 | -.08 | 96 | -.04 | 129 | -.39** |
| **Executive Functioning** | | | | | | | | |
| Trail Making Test- A | 299 | .52** | 85 | -.06 | 96 | .01 | 118 | .31* |
| Trail Making Test- B | 221 | .48** | 85 | .05 | 82 | .03 | 54 | .02 |
| WAIS-III Similarities | 315 | -.62** | 84 | -.16 | 96 | -.03 | 135 | -.39** |
| **Global Mental Status** | | | | | | | | |
| Folstein Mini-Mental State Examination | 317 | -.69** | 84 | .05 | 96 | .04 | 137 | -.47** |

*Note.* NC = Normal Controls; MCI = Mild Cognitive Impairment; AD = Alzheimer's Disease; CERAD = Consortium to Establish a Registry for Alzheimer's Disease; WMS-III = Wechsler Memory Scale-3rd Edition; WAIS-III = Wechsler AdultIntelligence Scale - 3rd Edition; COWAT = Controlled Oral Word Association Test

* $p < .01$

** $p < .001$

*Alzheimer Dis Assoc Disord*. Author manuscript; available in PMC 2016 July 01.

**Table 3**

Partial Correlations between DSRS and other Functional Measures by Sample and Diagnostic Group with Bonferroni Corrections

| | Sample | | NC | | MCI | | AD | |
|---|---|---|---|---|---|---|---|---|
| **Instrument** | ***N*** | **Coef** | ***n*** | **Coef** | ***n*** | **Coef** | ***n*** | **Coef** |
| FAQ | 311 | .89* | 83 | .61* | 95 | .77* | 133 | .80* |
| BADLS | 279 | .80* | 76 | .34* | 88 | .61* | 115 | .81* |

*Note*. NC = Normal Controls; MCI = Mild Cognitive Impairment; AD = Alzheimer's Disease; FAQ = Pfeffer Functional Activities Questionnaire; BADLS = Bristol Activities of Daily Living Scale

*$p < .001$

**Table 4**

Discriminant Analysis Results for all Models

| Instrument | NC % Correct | MCI % Correct | AD % Correct | TOTAL % Correct |
|---|---|---|---|---|
| DSRS | 81 | 60 | 78 | 72 |
| FAQ | 82 | 47 | 85 | 73 |
| BADLS | 86 | 36 | 81 | 68 |
| CWLT-5 | 96 | 62 | 79 | 79 |
| CWLT- 3rd Trial | 90 | 41 | 81 | 71 |
| CWLT- Trials 1-3 | 94 | 57 | 72 | 73 |
| CWLT- Composite | 95 | 66 | 78 | 79 |
| CWLT-5 + DSRS | 98 | 76 | 82 | 85 |

*Note.* NC = Normal Controls; MCI = Mild Cognitive Impairment; AD = Alzheimer's Disease; FAQ = Pfeffer Functional Activities Questionnaire; BADLS = Bristol Activities of Daily Living Scale; CWLT-5 = CERAD Word List 5-minute recall test; CWLT- Composite = Total composite score of 5- minute recall, 1st trial, 2nd trial, and 3rd trial

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