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Confirmatory Factor Analysis of the Mattis Dementia Rating Scale in Patients With Alzheimer's Disease

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Recent factor analyses of the Mattis Dementia Rating Scale (DRS; S. Mattis, 1973) have questioned the validity of its subscales, raising questions regarding their interpretation. This study examined the measurement structure of the standard DRS and of an abbreviated DRS form in a homogenous sample of 171 patients with Alzheimer's disease using (a) confirmatory factor analysis and (b) correlation of factors identified in the best fitting model with supplementary neuropsychological tests. We found confirmation of the validity of the Construction, Conceptualization, and Memory subscales associated with both the standard and abbreviated DRS. Correlations between these factors and supplementary neuropsychological measures supported the validity of the identified factors. The variability in DRS factor composition reported in previous studies appears to be related to sample heterogeneity, which is critically important to the resulting factor structure.

The Mattis Dementia Rating Scale (DRS; Mattis, 1973) was designed to provide a brief assessment of cognitive abilities in patients "with known cortical impairment, particularly of the degenerative type" (Mattis, 1973, p. 1). Since its development, this measure has become one of the most popular instruments used to track cognitive changes in dementia patients. The test takes approximately 20–45 min to administer (Vitaliano et al., 1984). Reliability is high (van Belle, Uhlmann, Hughes, & Larson, 1990; Vitaliano et al., 1984) and portions of the DRS have been used to screen for dementia (Green, Woodard, & Green, 1995; Shay et al., 1991; Vitaliano et al., 1984). When combined with scores from the Instrumental Activities of Daily Living scale (IADL), patient assessments have been reported to closely approximate clinical judgments of dementia severity based on full clinical evaluation (Shay et al., 1991).

The DRS includes items and provides cut-off scores for assessing specific cognitive domains including attention, initiation and perseveration, construction, conceptualization, and memory. Domain-specific scoring has the advantage of differentiating the strengths and weaknesses of an individual patient (Schmitt, Ranseen, & DeKosky, 1989). However, these items appear to have been grouped on the basis of face validity, and statistical approaches to scale construction were not reported to have been used (Mattis, 1973). Recent studies have started to examine the factor structure of the DRS to determine the extent to which various cognitive dimensions are tapped by this instrument. These initial studies generally have failed to confirm the validity of the five subscales traditionally reported with the DRS.

Kessler, Roth, Kaplan, and Goode (1994) performed a confirmatory factor analysis of the DRS that compared six competing but theoretically justifiable models in a heterogeneous sample, approximately one third of which carried psychiatric diagnoses. They studied the original five-factor model described by Mattis (1973), a four-factor model (Memory, Verbal Skills, Spatial Skills, and Executive Functioning), a three-factor model (Memory, Verbal–Cognitive Skills, and Visual–Motor Skills), two separate two-factor models (Motor versus Nonmotor and Verbal versus Nonverbal), and a single-factor model. They found that a two-factor solution consisting of verbal and nonverbal dimensions fit the data as well as or better than other competing models. They concluded that when the DRS is used for screening purposes and with heterogeneous dementia populations, a two-factor model will minimize interpretive errors, but at the expense of diminished explanatory power. However, they noted that alternative factor structures might emerge with more homogeneous populations, and they called for a replication of their analyses on homogeneous patient groups.

Colantonio, Becker, and Huff (1993) performed a principal components analysis on a homogeneous sample of 219 patients with probable Alzheimer's disease according to National Institute of Neurological and Communicative Disorders and Stroke/Alzheimer's Disease and Related Disorders Association (NINCDS/ADRDA) criteria (McKhann et al., 1984). Their analysis revealed three components, which they labeled

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Conceptualization/Organization, Visual–Spatial, and Memory and Orientation. Of particular interest was their identification of a subset of DRS items that "loaded heavily" (Colantonio et al., 1993, p. 316) on the obtained components, which were then summed to create a composite score. On the basis of their analyses, they suggested that this briefer version of the DRS consisting of only 86 points could potentially be used for the purposes of screening for possible dementia. Nevertheless, the authors cautioned that the abbreviated scale's sensitivity, specificity, and predictive power needed to be determined before the scale could be accepted for general use.

In summary, the two reported factor analyses of the DRS both point to a reduced number of dimensions that are tapped by the DRS than the five domains originally proposed by Mattis (1973). This issue is particularly important because it raises questions regarding the validity of interpreting performance on the five standard DRS subscales. The purpose of the present study was to evaluate the factor structure of the DRS in a confirmatory fashion using a homogenous sample of patients with probable or possible Alzheimer's disease. We also used confirmatory factor analysis to investigate the validity of the abbreviated DRS model (Colantonio et al., 1993). We first compared the six models described by Kessler et al. (1994): the original five-factor model described by Mattis (Model 5: Attention, Initiation–Perseveration, Construction, Conceptualization, and Memory), a four-factor model (Model 4: Memory, Verbal Skills, Spatial Skills, and Executive Functioning), a three-factor model (Model 3: Memory, Verbal–Cognitive Skills, and Visual–Motor Skills), two separate two-factor models (Model 2M: Motor versus Nonmotor; and Model 2V: Verbal versus Nonverbal), and a single-factor model (Model 1). Next, using the subset of items reported by Colantonio et al. (1993), we studied their original three-factor model, a two-factor model with motor and nonmotor dimensions, a two-factor model with verbal and nonverbal dimensions, and a single-factor (General Dementia) model. We also examined the correlations among the factors associated with the best fitting models and a variety of additional neuropsychological measures administered to a subset of probable Alzheimer's disease patients in order to assess concurrent validity of these factors.

Method

Participants

The participants included 171 patients with well-documented probable (n = 147) or possible (n = 24) Alzheimer's disease according to NINCDS/ADRDA criteria (McKhann et al., 1984). These patients represent a convenience sample of patients with probable or possible Alzheimer's disease defined by explicit criteria who were seen for neuropsychological evaluation as part of the Emory Alzheimer's Disease Center. The DRS was administered to all patients, although some patients received a comprehensive neuropsychological evaluation, whereas other patients were administered a short cognitive screening battery that included the DRS, depending on the clinical referral question. Women composed 67% of the sample, the majority of evaluations were performed on an outpatient basis (79%), and the sample contained a relatively high representation of minorities (26% African American and 74% Caucasian). The mean age was 75.0 years (SD = 7.6) and the mean education was 11.1 years (SD = 4.0). The mean DRS Total Score was 101.4 (SD = 20.1), and the mean subscale scores (with standard deviations in parentheses) were as follows: Attention = 32.5 (3.8), Initiation–Perseveration = 25.0 (7.9), Construction = 4.3 (1.7), Conceptualization = 27.2 (6.7), and Memory = 12.5 (4.6). The mean abbreviated DRS total score (Colantonio et al., 1993) was 57.4 (12.3). Abbreviated subscale scores according to their scoring system (and standard deviations in parentheses) were Construction = 26.1 (4.9), Conceptualization = 26.4 (6.5), and Memory = 4.9 (3.7). These means are strikingly similar to the means reported by Colantonio et al.

Procedure

The DRS was administered according to the standardized instructions in the manual (Mattis, 1973) by a trained psychometrist. Patients' responses to individual DRS items were recorded. Responses were first aggregated into the 20 variables described by Kessler et al. (1994) in order to test their six models. Patients' responses were then aggregated into the variables described by Colantonio et al. (1993) with two exceptions. The original variable based on counting, distraction, verbal recognition, and visual matching (items AD + AE + AH + AJ) was split into two items in order to produce two separate verbal (counting, distraction, verbal recognition) and nonverbal (visual matching) items. The second modification involved dropping name writing from the construction variable, resulting in a sum of the first five construction items. This modification was performed in order to remove the single verbal component from the largely visual–spatial scale. These modifications produced a total of 12 DRS variables that were subsequently submitted to confirmatory factor analysis.

Results

A series of confirmatory factor analyses were performed using Version 4.04 of EQS for Windows (Bentler, 1994). Each DRS variable was constrained to load on one and only one factor, and the remaining factor loadings for a given variable were assigned to be zero. Thus, each variable's factor loading was estimated, in addition to the residual variance associated with each variable and the covariances among factors. Factor variances were fixed at 1.0. The entire correlation matrix for the DRS variables is available from John L. Woodard on request.

The six models previously described by Kessler et al. (1994) were tested first. The initial attempt to fit these models revealed significant departures from multivariate (normalized estimate of multivariate kurtosis was 34) and univariate normality caused largely by restriction of range on three variables. These three variables were subsequently eliminated from the analysis to reduce the departure from multivariate normality: imitate commands (only 3 participants were unable to achieve a perfect score), write name (only 8 participants were unable to perform this task), and design recognition (only 15 participants scored less than 3). A slight departure from multivariate normality was still indicated by a normalized estimate of multivariate kurtosis of 9.4. Therefore, a robust maximum likelihood extraction procedure was used (Hu, Bentler, & Kano, 1992).

Second, we studied the factor structure of the abbreviated DRS reported by Colantonio et al. (1993), comparing their three-factor model with simpler models. With the reduced set of variables, there were minimal departures from multivariate normality (normalized estimate of multivariate kurtosis was 3.4). Therefore, a standard maximum likelihood extraction procedure was used.

Table 1
Summary Fit Indexes for Standard and Abbreviated Mattis Dementia Rating Scale (DRS) Confirmatory Factor Analyses

Model	χ^2 (N = 171)	*df*	χ^2/df	CFI	AIC	GFI	AGFI	RMS
			Standard DRS					
Single factor	262.67**	119	2.21	.808	41.38	.826	.776	.080
Motor vs. Nonmotor	207.98**	118	1.76	.874	−13.05	.868	.829	.084
Verbal vs. Nonverbal	202.53**	118	1.72	.882	−19.27	.866	.826	.066
Memory, Verbal–Cognitive, Visual–Motor	206.10**	116	1.78	.873	−10.03	.866	.823	.070
Memory, Verbal, Visual, Executive Functioning	182.40**	113	1.61	.889	−20.27	.873	.829	.064
Attention, Initiation–Perseveration, Construction, Conceptualization, Memory	170.59**	109	1.57	.909	−32.83	.885	.838	.070
			Abbreviated DRS					
Single factor	169.30**	54	3.13	.817	61.30	.840	.769	.047
Motor vs. Nonmotor	131.52**	53	2.48	.875	25.52	.877	.818	.044
Verbal vs. Nonverbal	111.50**	53	2.10	.907	5.49	.896	.847	.033
Visual–Spatial, Conceptualization, Memory	75.25*	51	1.48	.962	−26.75	.927	.889	.030

Note. CFI = comparative fit index (Bollen, 1989); AIC = Akaike's information criterion; GFI = goodness of fit index; AGFI = adjusted goodness of fit index; RMS = standardized root mean squared residual.
* $p < .015$. ** $p < .001$.

Standard DRS

Table 1 illustrates the summary statistics for the six analyses using the standard DRS after dropping the three variables with overly restricted range (imitate commands, write name, and design recognition). In the four-factor model (Memory, Executive Functioning, Verbal Skills, and Visuospatial Skills), a perfect correlation (+1.00) was observed between the Memory and Executive Functioning factors, suggesting that these two dimensions were not separable in this model. Thus, the four-factor model actually reduced to a three-factor model by virtue of this perfect overlap. In like manner, an extremely high correlation (r = .97) initially was observed between the Attention and Initiation–Perseveration factors in the five-factor (Mattis) model. The 95% confidence interval around this correlation includes +1.0, indicating that the five-factor model reduces to a four-factor model in which Attention and Initiation–Perseveration are combined into a single factor. Although the combined Attention–Initiation–Perseveration factor had a high correlation with Conceptualization (r = .85), the 95% confidence interval around this correlation did not include +1.0. This finding suggests that these dimensions are not measuring exactly the same construct but nevertheless are very highly related. We will henceforth refer to this latter model as the "modified Mattis" model.

As is evident in Table 1, the modified Mattis model demonstrated the lowest χ^2 and χ^2/df ratio relative to the other models. Other indexes of model parsimony, including Akaike's Information Criterion, and indexes of model fit, including the comparative fit index (CFI; Bollen, 1989) and the goodness of fit index (GFI) and adjusted goodness of fit index (AGFI; Jöreskog & Sörbom, 1988), suggest that the modified Mattis model fits the data better than other models tested. Hierarchical χ^2 tests are possible only between the single-factor model and the more complex models, because the simpler single-factor model is "nested" within the more complex models. These tests reveal that the data fit the more complex models significantly better than the single-factor model, although it is not possible to determine whether the data fit the modified Mattis model significantly better than any of the remaining multifactorial models because it is not perfectly nested within any of the more complex models. Factor loadings associated with the modified Mattis model are depicted in Table 2. The factor intercorrelations, presented in Table 3, demonstrate an appreciable overlap among many of the DRS factors.

Table 2
Factor Loadings for the Modified Mattis Model Obtained From Robust Maximum Likelihood Confirmatory Factor Analysis

Items	AIP	Construc.	Concept.	Memory
Digit span	.58	0	0	0
Follow commands	.31	0	0	0
Match designs	.65	0	0	0
Search *A*s	.51	0	0	0
Read list	.51	0	0	0
Fluency	.69	0	0	0
Repetition	.61	0	0	0
Alternating movement	.43	0	0	0
Graphomotor	.62	0	0	0
Complex copy	0	.86	0	0
Simple copy	0	.77	0	0
Verbal reasoning	0	0	.81	0
Identities–oddities	0	0	.59	0
Create sentence	0	0	.51	0
Verbal recall	0	0	0	.49
Orientation	0	0	0	.79
Word recognition	0	0	0	.46

Note. AIP = Attention–Initiation–Perseveration; Construc. = Construction; Concept. = Conceptualization. All *p*s < .01.

Table 3
Factor Intercorrelations for Modified Mattis Model Obtained From Robust Maximum Likelihood Confirmatory Factor Analysis

Factor	1	2	3	4
1. Attention–Initiation–Perseveration	—			
2. Construction	.69	—		
3. Conceptualization	.85	.61	—	
4. Memory	.73	.34	.76	—

Because of the large number and diversity of items contained on the Attention–Initiation–Perseveration scale, it is possible that this scale may be tapping a "general dementia" construct that may be affected by deterioration in multiple cognitive domains. This possibility was investigated in a post hoc fashion by performing Lagrangian multiplier (LM) tests following the best fitting (modified Mattis) model to identify relationships not postulated in the tested model that could potentially improve model fit. LM tests suggested that the fit of the modified Mattis model would be improved by (a) constraining the graphomotor item (i.e., copying ramparts, copying alternating *X*s and *O*s, or copying a single *X* and a single *O*) to load on both the Attention–Initiation–Perseveration factor and on the Construction factor, and (b) by constraining the fluency item to load on both the Attention-Initiation-Perseveration factor and on the Memory factor. This finding suggests that the graphomotor and fluency items are complex variables (i.e., they load on multiple factors) and are not discrete measures of the constructs underlying the standard DRS. When these relationships were added to the modified Mattis model, the χ^2 dropped to 148.35 with 111 *df*, and the CFI, GFI, and AGFI were .940, .903, and .867, respectively, suggesting a dramatic improvement in overall model fit. It should be emphasized that the purpose of this analysis was to evaluate the effects of variables that may load on more than one factor on the subsequent model fit in our sample. Because the use of post hoc LM tests may increase the possibility of Type I error and may produce results that are sample-specific, cross-validation of the results obtained from the post hoc LM tests is recommended.

Abbreviated DRS

The summary fit indexes for the abbreviated DRS analyses are presented in Table 1. Using the subset of DRS items, the original three-factor model described by Colantonio et al. (1993) produced an excellent fit in our sample. The three simpler competing models did not fit as well. The factor intercorrelations for the abbreviated DRS were not as high as those seen in the standard DRS, suggesting greater factor specificity. The factor intercorrelations were as follows: Visual–Spatial with Conceptualization = .63, Visual–Spatial with Memory–Orientation = .42, Conceptualization with Memory–Orientation = .57. The factor loadings associated with the three-factor model are depicted in Table 4.

Correlations Between Model Factors and Neuropsychological Variables

The DRS items that were hypothesized to load on the factors identified in the modified Mattis model were summed to obtain a composite score for each of the four factors (Attention–Initiation–Perseveration, Construction, Conceptualization, and Memory) for each participant. These factor scores were then correlated with a number of neuropsychological measures that were administered to a subset of patients in addition to the DRS, depending on the nature of the clinical referral question. There was no systematic relationship between a patient's degree of impairment and the number of supplementary neuropsychological measures administered to a given patient. These measures included the Block Design and Digit Symbol subtests from the Wechsler Adult Intelligence Scale—Revised (Wechsler, 1981), the Mental Control, Digit Span, Logical Memory I and II, and Visual Reproduction I and II subtests from the Wechsler Memory Scale—Revised (Wechsler, 1987), the Visual Naming, Token Test, and Controlled Oral Word Association subtests from the Multilingual Aphasia Examination (Benton & Hamsher, 1989), number of animal names verbally generated in 60 seconds, and the Wide Range Achievement Test—Revised Reading subtest (Jastak & Jastak, 1984). These correlations are presented in Tables 5 and 6 for the standard DRS and abbreviated DRS, respectively. In order to control for compounding error rate, a Bonferroni adjustment was made. Thus, only correlations that were significant at $p \leq .001$ were considered to be indicative of a significant relationship between the variable and factor score in question.

Discussion

The tests of six possible factor structures underlying the standard DRS revealed that the best and most parsimonious fit to our sample of probable and possible Alzheimer's disease patients was obtained with a variant of the original factor structure proposed by Mattis in which the Attention and Initiation–Perseveration subscales are combined into a single factor. These results provide empirical support for the Construction, Con-

Table 4
Factor Loadings for Abbreviated DRS Obtained From Maximum Likelihood Confirmatory Factor Analysis

Item	Visual–Spatial	Concept.	Memory
List reading, count *A*s	.56	0	0
Design matching	.69	0	0
Alternating movement	.50	0	0
Graphomotor	.73	0	0
Construction	.69	0	0
Similarities	0	.85	0
Identities–oddities	0	.52	0
Priming inductive reasoning	0	.77	0
Differences	0	.65	0
Similarities (multiple choice)	0	.65	0
Verbal recall	0	0	.47
Orientation	0	0	.97

Note. DRS = Mattis Dementia Rating Scale; Concept. = Conceptualization. All *p*s < .01.

Table 5
Correlations of Modified Mattis Model DRS Factors With Neuropsychological Measures

Measure	n	AIP	Constr.	Concept.	Memory
Mental Control	98	.53**	.21	.45**	.31
Digit Span	89	.55**	.30	.42**	.45**
Digit Symbol	43	.43	.19	−.05	.20
Block Design	66	.37	.50**	.34	.14
Judgment of Line Orientation	33	.08	.14	.18	.24
Logical Memory I	71	.20	.12	.36	.50**
Logical Memory II	71	.12	.03	.17	.49**
Visual Reproduction I	69	.26	.44**	.18	.34
Visual Reproduction II	69	.24	.30	.19	.46**
Animal Fluency	101	.56**	.38**	.41**	.43**
Controlled Oral Word Association	76	.56**	.26	.37**	.29
Visual Naming	71	.28	.18	.28	.21
Token Test	72	.40**	.43**	.34	.25
WRAT-R Reading	63	.40**	.41**	.46**	.39

Note. DRS = Mattis Dementia Rating Scale; AIP = Attention–Initiation–Perseveration; Constr. = Construction; Concept. = Conceptualization; WRAT-R = Wide Range Achievement Test—Revised.
** $p \leq .001$.

ceptualization, and Memory subscales, which reflect three of the five factors originally proposed by Mattis in patients with probable and possible Alzheimer's disease. The contrast between our results and the results of Kessler et al. (1994) highlights the fact that the characteristics of the population to be studied are critically important to the resulting factor structure. Given the previous finding of a two-factor (Verbal–Nonverbal) DRS structure when applied in the context of screening patients for dementia when diagnosis is not known a priori (Kessler et al., 1994), the interpretation of the individual subscales is questionable at best. Thus, when using the DRS in such settings, reliance on the total DRS score, rather than on the subscale scores, would be a wise practice. This practice also makes intuitive sense, because the goal of screening is to identify patients with possible cognitive compromise rather than to characterize the specific nature of such deficits, which is accomplished through detailed neuropsychological assessment. In contrast, when the DRS is applied to patients with probable or possible Alzheimer's disease in the context of initial assessment and tracking of cognitive changes, the results of our study support the interpretation of the Construction, Conceptualization, and Memory subscales as representing discrete constructs.

The overlap between the Attention and Initiation–Perseveration constructs warrants further discussion. It is tempting to speculate that the significant overlap between the two domains may be due to measurement of a similar construct, or due to parallel changes in Attention and Initiation–Perseveration, perhaps through similar neuropathological deterioration (e.g., impairment of frontal lobe or subcortical circuits). However, the Initiation–Perseveration scale has been reported to differentiate between controls and participants with mild dementia (Vitaliano et al., 1984), while attentional deployment declines steadily with progression of Alzheimer's disease but tends to be relatively preserved during early phases of the disease (Bondi, Salmon, & Butters, 1994; Moss & Albert, 1988; Petersen, Smith, Ivnik, Kokmen, & Tangalos, 1994). Thus, this inconsistency argues against the hypothesis that these two scales measure a similar construct, unless they reflect opposite ends of a continuum that is related to dementia severity.

A more likely explanation for the overlap between Attention and Initiation–Perseveration may be related to the measurement characteristics of the scales and item heterogeneity. The Initiation–Perseveration scale has been reported to be the least reliable subscale on the DRS (Smith et al., 1994). Our post hoc LM analysis suggests that the Attention–Initiation–Perseveration factor in the modified Mattis model contains variables that have significant overlap with other factors. That is, impairment on the fluency item may be due to Attention–Initiation–Perseveration deficits or deficits related to memory functioning, whereas impairment on the graphomotor item (i.e., copying ramparts, copying alternating Xs and Os, and copying a single X and a single O) may be related to Attention–Initiation–Perseveration deficits or diminished visuoconstructional functioning. Given the results of our post hoc LM tests, it is possible that the inclusion of items that load on multiple cognitive factors (e.g., verbal fluency and graphomotor copying) may contribute to the lack of internal consistency seen on the Initiation–Perseveration scale. In the modified Mattis model, the combination of the Attention and Initiation–Perseveration scales might improve the internal consistency to some degree, by virtue of the increased number of items, although the problem of inclusion of heterogeneous items still persists. The absence of an Attention–Initiation–Perseveration scale in the abbreviated DRS avoids the issue of this scale's potentially poor internal consistency altogether and appears to improve overall model fit.

We were also able to confirm the three-factor model underlying the abbreviated DRS suggested by Colantonio et al. (1993). The three-factor solution for the abbreviated DRS produced an excellent fit overall, and none of the more parsimonious models

Table 6
Correlations of Abbreviated DRS Factors With Neuropsychological Measures

Measure	n	VS	Concept.	MO
Mental Control	98	.44**	.45**	.30
Digit Span	89	.40**	.41**	.44**
Digit Symbol	43	.29	−.05	.23
Block Design	66	.55	.34	.11
Judgment of Line Orientation	33	.24	.18	.17
Logical Memory I	71	.17	.35	.47**
Logical Memory II	71	.12	.17	.47**
Visual Reproduction I	69	.39**	.18	.28
Visual Reproduction II	69	.30	.18	.43**
Animal Fluency	101	.45**	.41**	.38**
Controlled Oral Word Association	76	.35	.36**	.25
Visual Naming	71	.17	.28	.19
Token Test	72	.49**	.33	.22
WRAT-R Reading	63	.53**	.45**	.40**

Note. DRS = Mattis Dementia Rating Scale; VS = Visual-Spatial; Concept. = Conceptualization; MO = Memory–Orientation; WRAT-R = Wide Range Achievement Test—Revised.
** $p \leq .001$.

afforded a better fit to the data. The reduced item set for the abbreviated DRS appears to be optimized for assessing more specific cognitive deficits associated with Alzheimer's disease because of its ability to identify the constructs of visual–spatial functioning, conceptualization ability, and memory functioning in an independent sample of Alzheimer's patients. It is of particular interest that these three factors correspond closely to those identified in the standard DRS analyses, while deemphasizing the role of the relatively heterogeneous Attention–Initiation–Perseveration factor.

The correlations between the DRS factors and other neuropsychological variables supported the validity of the DRS factors for both the standard and abbreviated DRS. Some neuropsychological measures (e.g., Animal Fluency, WRAT-R Reading, and Digit Span) correlated highly on all or nearly all DRS factors. This pattern of correlations suggests that these neuropsychological measures might be considered to be general measures of neurocognitive functioning in this population.

The Memory factor had the strongest relationships with Logical Memory I and II (immediate and delayed recall of verbal thematic material), Visual Reproduction II (delayed recall of visually presented designs), Digit Span (short-term memory and concentration), and Animal Fluency (a measure of semantic memory retrieval). Each of these measures taps an aspect of memory that is impaired in Alzheimer's disease and to which the DRS Memory factor appears to be sensitive. The finding that Visual Reproduction I correlated with the Construction factor and not with the Memory factor is consistent with numerous other studies (Ivinskis, Allen, & Shaw, 1971; Larrabee, Kane, & Schuck, 1983; Larrabee, Kane, Schuck, & Francis, 1985; Ryan, Rosenberg, & Heilbronner, 1984; Trahan & Larrabee, 1984) that have reported Visual Reproduction I to be more related to a "Performance" factor than to a "Memory" factor.

The Construction or Visual–Spatial factor had a similar pattern of relationships in the standard and abbreviated DRS versions. It was not surprising to see strong relationships between this factor and Block Design and Visual Reproduction I. The Token Test also correlated highly with this factor, which again might be expected given the visuospatial–visuomotor demands of the task. However, the Judgment of Line Orientation Test did not correlate with this factor. Given the absence of a motor response, together with the lack of a need to process geometric designs, the Judgment of Line Orientation Test may place more of an emphasis on visual–spatial reasoning. In the abbreviated DRS version, this factor did have strong relationships with measures of attention (e.g., Mental Control and Digit Span).

The Attention–Initiation–Perseveration factor, present only in the standard DRS analyses, exhibited virtually the same pattern of relationships with neuropsychological variables as the Conceptualization factor, suggesting that these two factors may be assessing similar constructs. The high correlation of 0.85 between the two factors indicates that they have considerable overlap, although because this correlation was significantly different from +1.0, there are likely to be small but unique cognitive features tapped by each factor. Interestingly, the strongest relationships with the Conceptualization and Attention–Initiation–Perseveration factors were observed with attentional measures (e.g., Mental Control and Digit Span) and with verbal fluency (Animal Fluency and Controlled Oral Word Association Test). Frontal lobe damage frequently affects performance on these measures (Benton, 1968; Miceli, Caltagirone, Gainotti, Masullo, & Silveri, 1981; Tow, 1955), as well as performance on concept formation tasks such as those represented on the Conceptualization factor (Newcombe, 1969; Sheer, 1956). Although the Attention–Initiation–Perseveration and Conceptualization factors may assess higher order functions thought to be subserved by the frontal lobe, the sensitivity and specificity of these factors to frontal lobe damage should be investigated more systematically in future studies.

In summary, the results of our study support the validity of the Construction, Conceptualization, and Memory subscales associated with the standard DRS. We also found support for the validity of modifications of these same three subscales in an abbreviated DRS in terms of reflecting discrete constructs in an independent sample as well as by demonstrating concurrent validity with supplementary neuropsychological measures. The utility of the standard or abbreviated DRS items for differentiating between diagnostic groups remains to be determined. Nevertheless, it is quite clear that the diagnostic characteristics of the patient sample have a considerable effect on the resulting DRS factor structure. It is also possible that the factor structure would change in accordance with the severity of impairment. The factor structure in patients with mild to moderate Alzheimer's disease may be multifactorial, whereas it may reflect a single factor (e.g., general dementia) in severely demented patients. These issues would be important to investigate in future research.

References

Bentler, P. (1994). *EQS for Windows: Version 4.04* [computer program]. Los Angeles: BMDP Statistical Software.

Benton, A. (1968). Differential behavioral effects in frontal lobe disease. *Neuropsychologia, 6,* 53–60.

Benton, A. L., & des Hamsher, K. (1989). *Multilingual Aphasia Examination* (2nd ed.). Iowa City, IA: AJA Associates.

Bollen, K. A. (1989). *Structural equations with latent variables.* New York: Wiley.

Bondi, M. W., Salmon, D. P., & Butters, N. (1994). Neuropsychological features of memory disorders in Alzheimer disease. In R. D. Terry, R. Katzman, & K. L. Bick (Eds.), *Alzheimer disease* (pp. 41–63). New York: Raven Press.

Colantonio, A., Becker, J. T., & Huff, F. J. (1993). Factor structure of the Mattis Dementia Rating Scale among patients with probable Alzheimer's disease. *The Clinical Neuropsychologist, 7,* 313–318.

Green, R. C., Woodard, J. L., & Green, J. (1995). Validity of the Mattis Dementia Rating Scale for detection of cognitive impairment in the elderly. *Journal of Neuropsychiatry and Clinical Neuroscience, 7,* 357–360.

Hu, L., Bentler, P. M., & Kano, Y. (1992). Can test statistics in covariance structure analysis be trusted? *Psychological Bulletin, 112,* 351–362.

Ivinskis, A., Allen, S., & Shaw, E. (1971). An extension of Wechsler Memory Scales norms to lower age groups. *Journal of Clinical Psychology, 27,* 354–357.

Jastak, J., & Jastak, S. (1984). *The Wide Range Achievement Test—Revised Manual.* Wilmington, DE: Jastak Associates.

Jöreskog, K. G., & Sörbom, D. (1988). *LISREL 7: A guide to the program and applications.* Chicago: SPSS.

Kessler, H. R., Roth, D. L., Kaplan, R. F., & Goode, K. T. (1994). Confirmatory factor analysis of the Mattis Dementia Rating Scale. *The Clinical Neuropsychologist, 8,* 451–461.

Larrabee, G., Kane, R., & Schuck, J. (1983). Factor analysis of the WAIS and Wechsler Memory Scale: An analysis of the construct validity of the Wechsler Memory Scale. *Journal of Clinical Neuropsychology, 5,* 159–168.

Larrabee, G. J., Kane, R. L., Schuck, J. R., & Francis, D. J. (1985). Construct validity of various memory testing procedures. *Journal of Clinical and Experimental Neuropsychology, 7,* 239–250.

Mattis, S. (1973). *Dementia Rating Scale professional manual.* Odessa, FL: Psychological Assessment Resources.

McKhann, G. M., Drachman, D., Folstein, M. F., Katzman, R., Price, D., & Stadlan, E. M. (1984). Clinical diagnosis of Alzheimer's disease: Report of the NINCDS-ADRDA work group. *Neurology, 34,* 939–944.

Miceli, G., Caltagirone, C., Gainotti, G., Masullo, C., & Silveri, M. C. (1981). Neuropsychological correlates of localized cerebral lesions in nonaphasic brain-damaged patients. *Journal of Clinical Neuropsychology, 3,* 53–63.

Moss, M. B., & Albert, M. S. (1988). Alzheimer's disease and other dementing disorders. In M. Albert & M. Moss (Eds.), *Geriatric Neuropsychology* (pp. 145–178). New York: Guilford Press.

Newcombe, F. (1969). *Missile wounds of the brain.* London: Oxford University Press.

Petersen, R. C., Smith, G. E., Ivnik, R. J., Kokmen, E., & Tangalos, E. G. (1994). Memory function in very early Alzheimer's disease. *Neurology, 44,* 867–872.

Ryan, J. J., Rosenberg, S. J., & Heilbronner, R. L. (1984). Comparative relationships of the Wechsler Adult Intelligence Scale—Revised (WAIS-R) and the Wechsler Adult Intelligence Scale (WAIS) to the Wechsler Memory Scale (WMS). *Journal of Behavioral Assessment, 6,* 37–43.

Schmitt, F. A., Ranseen, J. D., & DeKosky, S. T. (1989). Cognitive mental status examinations. *Clinical and Geriatric Medicine, 5,* 545–564.

Shay, K. A., Duke, L. W., Conboy, T., Harrell, L. E., Callaway, R., & Folks, D. G. (1991). The clinical validity of the Mattis Dementia Rating Scale in staging Alzheimer's dementia. *Journal of Geriatric Psychiatry and Neurology, 4,* 18–25.

Sheer, D. E. (1956). Psychometric studies. In N. D. C. Lewis, C. Landis, & H. E. King (Eds.), *Studies in topectomy.* New York: Grune & Stratton.

Smith, G. E., Ivnik, R. J., Malec, J. F., Kokmen, E., Tangalos, E., & Petersen, R. C. (1994). Psychometric properties of the Mattis Dementia Rating Scale. *Assessment, 1,* 123–131.

Tow, P. M. (1955). *Personality changes following frontal leucotomy.* London: Oxford University Press.

Trahan, D. E., & Larrabee, G. J. (1984, February). *Construct validity and normative data for some recently developed measures of visual and verbal memory.* Paper presented at the Twelfth Annual Meeting of the International Neuropsychological Society, Houston, TX.

van Belle, G., Uhlmann, R. F., Hughes, J. P., & Larson, E. B. (1990). Reliability of estimates of changes in mental status test performance in senile dementia of the Alzheimer type. *Journal of Clinical Epidemiology, 43,* 589–595.

Vitaliano, P. P., Breen, A. R., Russo, J., Albert, M., Vitiello, M. V., & Prinz, P. N. (1984). The clinical utility of the Dementia Rating Scale for assessing Alzheimer's patients. *Journal of Chronic Disease, 37,* 743–753.

Wechsler, D. (1981). *Wechsler Adult Intelligence Scale—Revised.* San Antonio: Psychological Corporation.

Wechsler, D. (1987). *Wechsler Memory Scale—Revised.* San Antonio: Psychological Corporation.

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New Editor Appointed

The Publications and Communications Board of the American Psychological Association announces the appointment of Kevin R. Murphy, PhD, as editor of the *Journal of Applied Psychology* for a six-year term beginning in 1997.

As of March 1, 1996, submit manuscripts to Kevin R. Murphy, PhD, Department of Psychology, Colorado State University, Fort Collins, CO 80523-1876.