28. Devinsky O: Fear and epilepsy, in Carbamazepine: A Bridge Between Epilepsy and Psychiatric Disorders, edited by Canger R, Saccheti E, Perini E, et al. Origgio, Italy, Ciba-Geigy Edizioni 1990, pp 41–48
29. Sheehan DV: Current concepts in psychiatry: panic attacks and phobias. N Engl J Med 1982; 307:156–158
30. Roth M: Anxiety and phobic states, in The Bridge Between Neurology and Psychiatry, edited by Reynolds EH, Trimble MR. London, Churchill Livingstone, 1989, pp 177–196
31. Messner E: Covert complex partial seizures in psychotherapy. Am J Orthopsychiatry 1986; 56:323–326
32. Sheehan DV, Bellenger J, Jacobsen G: Treatment of endogenous anxiety with phobic, hysterical and hypochondriacal symptoms. Arch Gen Psychiatry 1980; 37:51–59
33. Lydiard RB, Bellenger JC: Antidepressants in panic disorder and agoraphobia. J Affective Disord 1987; 13:153–168
34. Bellenger JC: Alprazolam in panic disorder and agoraphobia: results from a multicenter trial. Arch Gen Psychiatry 1988; 45:413–426
35. Noyes R Jr, DuPont RL, Pecknold JC, et al: Usefulness of alprazolam. Arch Gen Psychiatry 1988; 45:423–428
36. Trimble M: Non-monoamine oxidase inhibitor antidepressants and epilepsy: a review. Epilepsia 1978; 19:241–250
37. Pryse-Phillips W: An olfactory reference syndrome. Acta Neurologica Scand 1971; 47:484–509
38. Penfield W, Jasper H: Epilepsy and the Functional Anatomy of the Human Brain. Boston, Little, Brown, 1954
39. Feindel W: Temporal lobe seizures, in Handbook of Clinical Neurology, edited by Vinken PJ, Bruyn GW. Amsterdam, Elsevier, 1974, pp 15:87–106
40. Gloor P: Temporal lobe epilepsy, in The Neurobiology of the Amygdala, edited by Eleftheriou B (Advances in Behavioral Biology). New York, Plenum, 1972, pp 2:423–457
41. McLachlan RS, Blume WT: Isolated fear in complex partial status epilepticus. Ann Neurol 1980; 8:639–641
42. Malamud N: Psychiatric disorders with intracranial tumors of the nervous system. Arch Neurol 1967; 17:113–114
43. Munroe RR: Episodic behavioral disorder and limbic ictus, in The Limbic System: Functional Organization and Clinical Disorders, edited by Doane BK, Livingston KE. New York, Raven, 1986, pp 251–266
44. Crowe RR, Noyes R Jr, Pauls DL, et al: A family study of panic disorder. Arch Gen Psychiatry 1983; 40:1065–1069
45. Noyes R Jr, Crowe RR, Harris EL, et al: Relationship between panic disorder and agoraphobia. Arch Gen Psychiatry 1986; 43:227–233
46. Togersen S: Genetic factors in anxiety disorders. Arch Gen Psychiatry 1983; 40:1085–1092
47. Devinsky O, Sato S, Theodore WH, et al: Fear episodes due to limbic seizures with normal scalp EEG: a subdural electrographic study. J Clin Psychiatry 1989; 50:28–30
48. Papez JW: A proposed mechanism of emotion. Archives of Neurology and Psychiatry 1947; 38:725–743
49. Daly D: Ictal affect. Am J Psychiatry 1958; 115:97–108
50. Meyer G, McElhaney M, Martin W, et al: Stereotactic cingulotomy with results of acute stimulation and serial psychological testing, in Surgical Approaches in Psychiatry, edited by Laitinen LV, Livingston KE. Baltimore, University Park Press, 1973, pp 39–58
51. Strauss E, Risser A, Jones MW: Fear responses in patients with epilepsy. Arch Neurol 1982; 39:626–630
52. Reiman EM, Raichle ME, Butler FK, et al: A focal brain abnormality in panic disorder, a severe form of anxiety. Nature 1984; 310:683–685
53. Reiman EM, Raichle ME, Robins E, et al: Neuroanatomical correlates of lactate-induced anxiety attack. Arch Gen Psychiatry 1989; 46:493–500
54. Reiman EM, Fusselman MJ, Fox PT, et al: Neuroanatomical correlates of anticipatory anxiety. Science 1989; 243:1071–1074
55. Wieser H-G, Williamson PD: Ictal semiology, in Surgical Treatment of the Epilepsies, 2nd edition, edited by Engel J. New York, Raven, 1993, pp 161–171
56. Van Buren JM: The abdominal aura: a study of the abdominal sensations occurring in epilepsy and produced by depth stimulation. Electroencephalogr Clin Neurophysiol 1963; 1:1–19
57. Delgado-Escueta AV, Bascal FE, Treiman DM: Complex partial seizures on closed circuit television and EEG: a study of 691 attacks in 79 patients. Ann Neurol 1982; 11:292–300
58. Penfield W, Rasmussen T: The Cerebral Cortex of Man: A Clinical Study of Localization of Function. New York, Macmillan, 1950, p 248
59. Mishkin M: Analogous neural models for tactual and visual learning. Neuropsychologia 1979; 17:139–151
60. Schneider RJ, Nelson RJ, Friedman DP, et al: The granular insula in the rhesus monkey: somatic sensory properties. Society for Neuroscience Abstracts 1984; 10:496
61. Mesulam M-M (ed): Patterns of behavioral neuroanatomy, in Principles of Behavioral Neurology (Contemporary Neurology Series). Philadelphia, FA Davis, 1985, pp 1–70
62. Laidlaw JDD, Khin-Maung-Zaw: Epilepsy mistaken for panic attacks in an adolescent girl. BMJ 1993; 306:709–710
63. Brant-Zawadzki M, Badami JP, Millms CM, et al: Primary intracranial tumor imaging: a comparison of magnetic resonance and CT. Radiology 1984; 150:435–440
64. Bradley WG, Waluch V, Yadley RA, et al: Comparison of magnetic resonance and CT. Radiology 1984; 152:695–702
65. Ferrante L, Palma L, D'Addetta R, et al: Intracranial cavernous angioma. Neurosurg Rev 1992; 15:125–133

Validity of the Mattis Dementia Rating Scale for Detection of Cognitive Impairment in the Elderly

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The validity of the Mattis Dementia Rating Scale (DRS) for detecting neuropsychological impairment was evaluated in 22 elderly patients with mild cognitive impairment and 48 rigorously screened control subjects. A cutoff score was identified that correctly classified 95% of patients and 100% of control subjects. Results of this prelimi-

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nary study suggest that the DRS may prove useful in screening for mild cognitive impairment in elderly populations. Further validation with a representative elderly sample is needed to establish screening value in primary care or community populations.

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Many older individuals develop subtle deficits in cognitive abilities but may continue to function in the community without obvious impairment of attention, memory, and judgment.[1–3] Neuropsychological assessment is the most rigorous criterion for detecting and quantifying cognitive deficits, but it is usually time-intensive and expensive.[4] Brief screening methodologies that can be applied in the context of providing primary care would permit clinicians to direct at-risk individuals toward more complete neuropsychological testing and diagnostic neuromedical evaluation.

The Mattis Dementia Rating Scale[5] (DRS) is a brief instrument that assesses a variety of cognitive functions. A number of reports have demonstrated the effectiveness of the DRS in staging dementia,[6,7] and a few reports describe the use of the DRS in identifying early cognitive impairment, particularly in community-dwelling elderly individuals.[8–10] This report describes the capacity of the DRS to identify mild cognitive impairment in carefully selected samples of impaired and unimpaired community-dwelling elderly subjects.

METHODS

The subjects in each group were identified separately. Potential subjects were excluded from involvement in the study if they had any history of psychiatric illness, including clinically significant depression by DSM-III-R criteria,[11] or any history of head trauma.

Twenty-two subjects (mean age 72.9 ± 10.3 years, mean education 14.5 ± 2.2 years; all values are means ± SD) were identified as mildly impaired, as defined by a Global Dementia Rating Scale[12] score of 2, 3, or 4. These subjects were selected as the most mildly impaired from a total of 375 patients referred for evaluation to the Emory University/Wesley Woods Memory Assessment Clinic in Atlanta, Georgia. All of the 22 impaired patients were diagnosed with probable Alzheimer's disease[13] (AD) or vascular dementia[14] by standard criteria.

Forty-eight control subjects (mean age 69.1 ± 4.8 years, mean education 15.4 ± 2.3 years) were recruited from among volunteers solicited by word of mouth and by newspaper advertisement. Because an unknown and potentially substantial proportion of elderly persons who consider themselves normal may actually have subtle neurological disease or cognitive impairments,[15] control subjects were required to score within 1 standard deviation for age on the Verbal and Performance IQ measures from the Wechsler Adult Intelligence Scale–Revised[16] (WAIS-R) and the Logical Memory and Visual Reproduction subtests from the Wechsler Memory Scale–Revised[17] (WMS-R) and to exhibit unimpaired performance on the Wisconsin Card Sorting Test.[18,19] For subjects older than the upper limit of available age norms, "normal" was defined as within 1.5 standard deviations of the mean for the oldest age norms. In addition, control subjects underwent EEG screening. Of 92 persons who volunteered to be control subjects, 34 were excluded as appropriate control subjects on the basis of history or examination as described above; 2 others could not complete the MR scan because of claustrophobia; and 8 subjects dropped out of the testing protocol because of family illness or for personal reasons. All subjects signed informed consent, and where there was any doubt about the capacity of the subject to understand consent, proxy consent was also obtained.

The 70 recruited subjects all underwent the neurological, neuropsychological, and radiographic evaluation that constitutes the current "gold standard" for the evaluation of dementia.[20] In addition to obtaining a medical history and performing a neurological examination, we administered to every subject the following neuropsychological measures: the WAIS-R,[16] the California Verbal Learning Test,[21] and the Logical Memory subtest and Visual Reproduction subtests from the WMS-R.[17] Every subject (both impaired and control) received either a CT or MR scan of the brain.

Mean number of years of education was statistically comparable between the patient and control groups (t = 1.48, df = 68, P = 0.15). However, the age distributions for the two groups were different, with the patient group having greater variance and disproportionate representation of older individuals.

To examine criterion-related validity, we compared DRS scores between impaired and control subjects by using the Mann-Whitney U-test. Threshold analysis of DRS total scores was performed to determine the cutoff score that optimized classification of patients and control subjects in this sample.

RESULTS

The means of the DRS total scores of the control subjects (141.6 ± 2.5) and the impaired patients (120.0 ± 9.9) were

significantly different ($P < 0.0001$). Table 1 shows the classification accuracy of the DRS total score for identification of impairment in the 70 subjects tested. When a cutoff score of 133 and above was used to designate "normal," a minimum number of misclassifications occurred, and 95% of patients and 100% of control subjects were correctly classified. Table 1 demonstrates how changes in the cutoff score affect the proportion of control subjects and patients that are correctly classified.

DISCUSSION

Our analyses revealed that the total DRS score accurately distinguished patients with mild to moderate cognitive impairment from normal control subjects, suggesting that the DRS may have criterion-related validity. This finding supports and extends previous work in which psychometric screening has been used to identify persons with mild cognitive impairment that is likely to progress.[22]

It is generally agreed that screening tests with excellent efficiency when applied to carefully selected individuals can be much less efficient in an unselected population.[23] This may occur because "normal" populations are not carefully screened with available diagnostic tests to rule out unsuspected pathology that might cause subtle cognitive impairment. Even among our "normal" volunteers, over one-third were rejected because of cerebral abnormalities. This finding suggests that in older age groups in which the prevalence of cognitive impairments is high,[2,3,24] potential subjects must have extensive evaluation before being included in a "normal" control group that is being used to validate clinical instruments or to establish norms.

In this study, the exclusion of patients with subtle cognitive impairment favorably biases the results, for these are the subjects for whom clinical presentation is likely to be most ambiguous, and thus errors of classification most frequent. Consequently, the proportion of patients classified correctly as shown in Table 1 may overestimate the sensitivity in an unselected population and the proportion of control subjects classified correctly may overestimate the specificity in an unselected population. However, evaluation of a test on a highly selected sample is a valuable and necessary precursor to designing more formal and extensive tests of validity, for if such a test was not very accurate in a selected sample, it could not be accurate at all in an unselected sample.

There was a disproportionate representation of older individuals in our impaired group. Age has recently been shown to be a significant but surprisingly subtle moderator variable on the DRS in normal subjects.[25] Nevertheless, investigators conducting future validation studies of the DRS on larger samples should consider analyzing age and education variables to determine how these may affect classification accuracy. We recognize that racial and socioeconomic heterogeneity, limited education, test anxiety, lifelong learning disabilities, static neurologic impairment, depression, and medication effects are far more common in the general population than in this study sample and would almost certainly increase the error variance of the DRS. Additional validation studies based on a representative sample of patients presenting to primary care providers or a representative sample of community-dwelling elderly persons would be necessary before the DRS or any new screening test could be accepted for general clinical use. These findings, however, add to the accumulating evidence that relatively brief psychometric testing may be remarkably useful as a screening tool for cognitive impairment.

TABLE 1. Classification accuracy of the Dementia Rating Scale (DRS) with various cutoff scores

DRS Totals Cutoff Score <	Proportion Classified Correctly: Patients ($n = 22$)	Proportion Classified Correctly: Control Subjects ($n = 48$)	Number of Misclassifications
123	0.59	1.00	9
127	0.68	1.00	7
128	0.73	1.00	6
130	0.82	1.00	4
132	0.86	1.00	3
133	0.95	1.00	1
134	0.95	0.98	3
138	0.95	0.94	4
139	1.00	0.85	7
140	1.00	0.83	8

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References

1. Rocca WA, Amaducci LA, Schoenberg BS: Epidemiology of clinically diagnosed Alzheimer's disease. Ann Neurol 1986; 19:415–424
2. Katzman R, Aronson M, Fuld P, et al: Development of dementing illnesses in an 80-year-old volunteer cohort. Ann Neurol 1989; 25:317–324
3. Evans DA, Funkenstein HH, Albert MS, et al: Prevalence of Alzheimer's disease in a community population of older persons. JAMA 1989; 262:2551–2556

4. Putnam SH, DeLuca JW: The TCN Professional Practice Survey, part 1: general practices of neuropsychologists in primary employment and private practice settings. Clin Neuropsychol 1990; 4:199–244
5. Mattis S: Dementia Rating Scale Professional Manual. Odessa, FL, Psychological Assessment Resources, 1973
6. Salmon DP, Thal LJ, Butters N, et al: Longitudinal evaluation of dementia of the Alzheimer type: a comparison of 3 standardized mental status examinations. Neurology 1990; 40:1225–1230
7. Shay KA, Duke LW, Conboy T, et al: The clinical validity of the Mattis Dementia Rating Scale in staging Alzheimer's dementia. J Geriatr Psychiatry Neurol 1991; 4:18–25
8. Horn L, Cohen CI, Teresi J: The EASI: A self-administered screening test for cognitive impairment in the elderly. J Am Geriatr Soc 1989; 37:848–855
9. Kovner R, Lazar JW, Lesser M, et al: Use of the Dementia Rating Scale as a test for neuropsychological dysfunction in HIV-positive IV drug abusers. J Subst Abuse Treat 1992; 9:133–137
10. Nelson A, Fogel BS, Faust D: Bedside cognitive screening instruments: a critical assessment. J Nerv Ment Dis 1986; 174:73–83
11. American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, 3rd edition, revised. Washington, DC, American Psychiatric Association, 1987
12. Reisberg B, Ferris SH, De Leon MJ, et al: The Global Deterioration Scale for the assessment of primary degenerative dementia. Am J Psychiatry 1982; 139:1136–1139
13. McKhann GM, Drachman D, Folstein MF, et al: Clinical diagnosis of Alzheimer's disease: report of the NINCDS-ADRDA work group. Neurology 1984; 34:939–944
14. Román GC, Tatemichi TK, Erkinjuntti T, et al: Vascular dementia: diagnostic criteria for research studies. Neurology 1993; 43:250–260
15. Calne DB, Eisen A, Meneilly G: Normal aging of the nervous system. Ann Neurol 1991; 30:206–207
16. Wechsler D: Wechsler Adult Intelligence Scale–Revised. San Antonio, TX, Psychological Corporation, 1981
17. Wechsler D: Wechsler Memory Scale–Revised. San Antonio, TX, Psychological Corporation, 1987
18. Grant DA, Berg EA: A behavioral analysis of degree of reinforcement and ease of shifting to new responses in a Weigl-type card-sorting problem. J Exp Psychol 1948; 38:404
19. Haaland KY, Vranes LF, Goodwin JS, et al: Wisconsin Card Sort Test performance in a healthy elderly population. J Gerontol 1987; 42:345–346
20. Cummings JL, Benson DF: Dementia: A Clinical Approach. Boston, Butterworth-Heinemann, 1992
21. Delis DC, Kramer J, Kaplan E, et al: The California Verbal Learning Test. San Antonio, TX, Psychological Corporation, 1986
22. Tröster AI, Moe KE, Vitiello MV, et al: Predicting long-term outcome in individuals at risk for Alzheimer's disease with the Dementia Rating Scale. J Neuropsychiatry Clin Neurosci 1994; 6:54–57
23. Albert M, Smith LA, Scherr PA, et al: Use of brief cognitive tests to identify individuals in the community with clinically diagnosed Alzheimer's disease. Int J Neurosci 1991; 57:167–178
24. Jorm AF, Korten AE, Henderson AS: The prevalence of dementia: a quantitative integration of the literature. Acta Psychiatr Scand 1987; 76:465–479
25. Schmidt R, Freidl W, Fazekas F, et al: The Mattis Dementia Rating Scale: normative data from 1,001 healthy volunteers. Neurology 1994; 44:964–966