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# The Clock Drawing Test: Utility for Dementia Detection in Multiethnic Elders

Soo Borson,[1,2] Michael Brush,[1,3] Eric Gil,[1] James Scanlan,[2] Peter Vitaliano,[2] Jim Chen,[1,2] Judy Cashman,[1] Mary M. Sta Maria,[1] Ross Barnhart,[1] and Jose Roques[1]

[1]Alzheimer's Disease Research Center Satellite Diagnostic Clinic and
[2]Department of Psychiatry and Behavioral Sciences, University of Washington, Seattle.
[3]Saint Louis University School of Medicine, Saint Louis, Missouri.

***Background.*** Disproportionate increases in dementia morbidity in ethnic minorities challenge established screening methodologies because of language and culture barriers, varying access to health services, and a relative paucity of cross-cultural data validating their use. Simple screening techniques adapted to a range of health and social service settings would accelerate dementia detection and social and health services planning for demented minority elders.

***Methods.*** The effectiveness of the Clock Drawing Test (CDT) for dementia detection was compared with that of the Mini-Mental State Examination (MMSE) and the Cognitive Abilities Screening Instrument (CASI) in community-dwelling elders of diverse linguistic, ethnic, and educational backgrounds. Subjects ($N = 295$) were tested at home in their native languages (English, $n = 141$; another language, $n = 154$). An informant-based clinical dementia history and functional severity index derived from the Consortium to Establish a Registry for Alzheimer's Disease (CERAD) protocols were used to classify subjects as probably demented ($n = 170$), and probably not demented ($n = 125$).

***Results.*** All tests were significantly affected by education ($p < .001$) but not by primary language ($p > .05$). Sensitivities and specificities for probable dementia were 82% and 92%, respectively, for the CDT; 92% and 92% for the MMSE; and 93% and 97% for the CASI for subjects completing each test. However, in poorly educated non-English speakers, the CDT detected demented subjects with higher sensitivity than the two longer instruments (sensitivity and specificity 85% and 94% for the CDT, 46% and 100% for the MMSE, and 75% and 95% for the CASI). *Moreover, less information was lost due to noncompletion of the CDT than the MMSE or CASI (severe dementia or refusal: CDT 8%, MMSE 12%, and CASI 16%).*

***Conclusions.*** Overall, the CDT may be as *effective* as the MMSE or CASI as a first-level dementia screen for clinical use in multiethnic, multilingual samples of older adults. Its brevity (1–5 minutes), minimal language requirements, high acceptability, and lack of dependence on specialized testing materials are well adapted for screening of non–English-speaking elderly persons in settings where bilingual interpreters are not readily available and screening time is at a premium.

ETHNIC minorities are the fastest growing segment of the older United States population, with a projected increase from 3.3 to 14.1 million between 1992 and 2040 (1). Mortality from neurodegenerative diseases, mainly dementias, in minorities is predicted to exceed that in mainstream Caucasian populations by three- to fivefold (2). The long-term dependency of demented older adults will impose a substantial social and economic burden in minority communities that calls for a simple and effective mechanism for screening persons at risk, as a basis for projecting need for dementia care services (3). Although a number of screening instruments are known to be valid for dementia screening in English speakers, the problem has received much less attention in non–English-speaking ethnic minorities, many of whom are cared for by families relatively uneducated about dementia and by physicians who do not speak their language.

Even when language and cultural barriers do not impede assessment, primary care physicians may be ill-equipped to diagnose and treat demented persons and often fail to recognize it in their patients (4–6). Physicians in the majority culture do not routinely employ screening tests even when they strongly suspect cognitive impairment (7), and recent research indicates that knowledge about dementia among primary health care providers remains inadequate in spite of wide dissemination of information to practitioners (8). Currently, the Mini-Mental State Examination [MMSE (9)] is the most widely used screening instrument. However, this test is heavily weighted toward verbal performance (10,11), which poses special challenges for ethnic minorities who often have poor English verbal skills and whose formal educational experience may not prepare them effectively for tests of this type. A brief cognitive screening test that can be administered to both English and non-English speakers, with a minimum requirement for bilingual interpretation and relative freedom from education effects, would have significant advantages over longer tests such as the MMSE that are not widely available for clinical use in languages other than English. Moreover, a screening test that requires little training and no additional paperwork or advance preparation by the physician might be more likely to be included in routine assessment of older patients in clinical practice settings.

A number of studies support the utility of the Clock Drawing Test (CDT) as a potential screening tool for cognitive dysfunction due to dementing diseases (12–19) and as a useful measure of severity on its own or in combination with other tests such as the MMSE (20). This is an improvement over other highly simplified approaches to assessment of mental status (such as ori-

entation to time, person, and place), which are well-known to be insensitive to mild and moderate dementia (20,21). In addition, although its scoring requires a degree of familiarity, the CDT can be administered by persons with minimal formal training in cognitive assessment, requires less than 5 minutes of testing time, and is psychologically nonthreatening, allowing primary care physicians and other providers to administer it without fear of insult or embarrassment.

The value of a cognitive screening procedure depends on its robustness in the presence of confounding influences not directly related to the presence of dementia, such as low education, spoken language, and variable clinical settings and intended uses. Many studies of the CDT either failed to control for the educational level of subjects(12,13,15–17) or excluded those with less than an eighth grade education (14,18). Although some investigators have commented that the CDT is relatively free of language and education bias (12,15,17), others have shown that education affects CDT performance in both demented and nondemented persons (22). Performance on other screening tests such as the MMSE is well known to be significantly affected by educational experience (23,24), and its single test of visuospatial skills (figure copying) is among its most educationally sensitive items (23).

No studies have examined the effects of language and ethnicity on CDT performance. In comparison, cross-ethnic studies of the MMSE have yielded conflicting results. Murden (25) and Anthony (26) and their colleagues found that differences in MMSE scores among blacks and whites were attributable to differences in education, not race. In Hispanic populations, some investigators have identified MMSE items that are sensitive to ethnicity and language as well as to education (27,28) but its visuoconstructive task appears to be stable in samples of mixed ethnicity (23).

The Cognitive Abilities Screening Test [CASI (29)], initially developed as a screening instrument for use in cross-cultural research on dementia, has been used successfully in epidemiological studies of Japanese-Americans (29–31) and rural Taiwanese (32). This test, a composite of items from existing instruments [the MMSE (9), the Hasagawa scale (33), and the Modified Mini-Mental State (34)] designed to minimize cultural bias, yields a maximum score of 100 points and can be administered in 20 to 30 minutes. Like the MMSE, CASI performance is significantly influenced by education and adjustment of cutting scores has been proposed for poorly educated subjects in samples of uniform language and ethnicity (32). Thus far, the performance of the CASI has not been evaluated in samples of highly diverse ethnolinguistic background and countries of origin, such as may be encountered in clinical practice in the United States. In such samples, the effects of education can fairly be expected to vary as a function not only of formal educational exposure, but also of differences in educational systems, quality, values, and historical context that cannot be readily compared. Therefore, education-adjusted cutoff scores that have been generated from studies of linguistically and ethnically homogeneous populations may not be applicable to mixed populations with considerable linguistic, ethnic, and educational differences.

There is currently no consensus regarding the choice of screening instruments in multiethnic, linguistically diverse samples. The present work was designed to compare the performance of the CDT, MMSE, and CASI in a group of community-dwelling elderly persons with diverse geographic origins and linguistic and educational backgrounds, who were evaluated using a structured protocol for dementia classification. The overall purpose was to identify a screening tool that might be readily utilized in clinical practice settings for detection of dementia in persons at potentially high risk for missed diagnosis owing to non–English-speaking status and low educational attainment. We proposed the following research hypotheses:

(i) All three cognitive measures will perform acceptably as screening tests when administered in the native language of the subjects.
(ii) The MMSE and CASI will perform better than the CDT in better educated (>8 years) native English speakers, the population on which these tests were originally developed.
(iii) The combination of low education and non–English-speaking status will reduce the effectiveness of the MMSE and CASI as dementia screens, due to the greater difficulty of administering them and low specificity for identification of demented persons, unless cut-off scores are individualized for age and education (24,32), a procedure that is difficult to implement outside research settings. The CDT, because of its minimal language and educational requirements, will be a more effective screen because of greater ease of administration and sensitivity/specificity in this difficult-to-test group.

## METHODS

### *Subjects*

Subjects were 295 (200 female, 95 male) elderly persons enrolled in the University of Washington's Alzheimer's Disease Research Center Satellite Registry for underserved poor or minority elderly persons. Ethnicity was reported by subjects or their proxies, and all but one (of multiple mixed heritage) classified themselves as a member of a conventional census-derived classification grouping: white (Euro-American; $n = 34$ ), white (Hispanic; $n = 28$), Asian-Pacific Islander ($n = 139$), African American ($n = 71$), and Native American ($n = 22$). One hundred forty-one spoke English as their primary language, and 154, all foreign-born immigrants, spoke either Spanish, Korean, or a Chinese or Filipino dialect. Most demented subjects were referred by social service agencies serving ethnic minorities or socioeconomically disadvantaged Caucasian elders. Nondemented subjects were recruited from the same agencies and a variety of community sources and advertisements. Potential participants were prescreened by a telephone interview with the subject and/or a caregiver to exclude those patients with a history of severe brain injury, a clear-cut episode of central nervous system infection, active alcohol abuse, or an uncontrolled medical illness that might cause cognitive impairment (e.g., poorly controlled diabetes, renal, heart, or respiratory failure). All subjects (or, for demented persons, their proxies) gave written informed consent using a multiple-language protocol approved by the University of Washington Institutional Research Review Board.

### *Evaluation*

Subjects were evaluated in their homes or adult day centers using a structured assessment procedure based on the protocol

developed by the Consortium to Establish a Registry for Alzheimer's Disease [CERAD (35)], employing its expanded dementia history format and cognitive tasks modified to permit uniform assessment of subjects in their primary spoken languages. Background information was given by a knowledgeable informant, usually a family member. The MMSE, CASI, and CDT were used in place of the full CERAD neuropsychological battery, which is not available in all languages represented in the present sample. The research team included geriatric psychiatrists, a research nurse, a psychometrist, and, when necessary, a bilingual interpreter specifically trained for the project. All bilingual interpreters were foreign-born native speakers of the language or dialect used for evaluation of non–English-speaking subjects, and were also fluent in English. Training in administration of all three cognitive tests was provided to interpreters for each language, first in groups and then individually, by the project psychometrist. Interpreters then observed a series of testing sessions conducted by the psychometrist with English-speaking subjects, and were required to pass a uniform written test of competence in administration of the CASI (the test most complex and difficult to give) designed by its author (E. Teng, project consultant). Retraining was conducted until all interpreters were certified competent. Each newly qualified bilingual tester performed a series of six subject assessments under supervision by the psychometrist before being permitted to administer cognitive tests independently.

Subjects were classified as having probable dementia or no dementia, based solely on an informant's detailed history of the presence or absence of cognitive deterioration across a broad range of domains (CERAD expanded dementia history) and the informant-rated Clinical Dementia Rating scale [CDR (36)], which measures functional impairment attributable to cognitive deficits. Classification was performed blind to actual performance on cognitive tests, as utilization of test scores would vitiate analysis of their use as screening measures. The CERAD medical evaluation (history, physical examination, and laboratory tests) was combined with prior medical records to capture disorders that might contribute to a clinical dementia diagnosis. Subjects with CDR scores ≥1 were classified as probably demented. All controls (CDR = 0) were free of neurologic disease.

*Administration and Scoring of the Clock Test*

The CDT was administered and scored using CERAD templates (35). Subjects were instructed to draw a clock by first drawing a circle, then adding numbers, and then setting the time to show 8:20. Instructions could be repeated and, if necessary, the subject was told to draw a larger circle. There were no additional instructions, and no time limit was imposed.

Clocks were scored by two independent raters blind to the scores of the other and to any information regarding the subject, using the 4-point CERAD scale (0 = normal clock; 3 = severe impairment). Clocks published in the CERAD protocol exemplifying each level of impairment were used to anchor scoring, and any score > 0 was considered abnormal for purposes of classification. Examples of clocks drawn by subjects are included in the Appendix for illustration.

*Data Analyses*

Six separate one-way analyses of variance (ANOVAs) were used to compare nondemented with demented subjects on age, education, primary language, and performance on the three cognitive tests (CDT, MMSE, and CASI). All analyses were done using SPSS PC+ 4.0 (SPSS Inc., Chicago, IL), with $p < .05$ considered significant. Inter-rater reliability for CDT scores was assessed using an intraclass correlation coefficient. Sensitivity and specificity for probable dementia were obtained for each test. Subjects were then stratified into four combinations: English versus non-English by high versus low levels of education (9 years and above vs 8 years and below). Three calculations of sensitivity and specificity were made for each test within each of the resulting four subgroups, based on data from subjects actually completing the tests and an "intent-to-test" analysis based on 100% of the sample. Subjects refusing or unable to complete a test due to severe cognitive impairment were assumed to be incorrectly classified, a procedure designed to yield a "worst-case" performance analysis for each test; an additional alternative analysis treated these subjects as all demented.

## Results

Of the 295 subjects, 125 were clinically classified as nondemented, and 170 as demented. Among subjects with probable dementia, 117 (68.4%) had a clinical history and medical evaluation supporting a likelihood of Alzheimer's Disease (AD) (gradual cognitive and functional decline without evidence of other causes). Twenty-two (12.9%) had an AD-like presentation and course plus another factor possibly related to dementia (vascular risk factors, a history of possible stroke, or radiographic evidence of cerebrovascular disease on computed tomography [CT] or magnetic resonance imaging [MRI]). Eighteen (11.1%) had a definite history and CT evidence of prior cortical strokes and a stepwise course of cognitive decline, and 13 (7.6%) had features more characteristic of another type of dementia (e.g., frontal dementia with amyotrophic lateral sclerosis). The gender distribution, mean age, and years of education for demented and nondemented groups are summarized in Table 1. The clinical groups were comparable in gender composition, but differed significantly by age (ANOVA, $F[2,326] = 30.21$, $p < .001$) and education ($F[2,327] = 6.17$, $p < .01$); subjects with dementia were older and less educated than nondemented participants. Comparison of subjects by racial/ethnicity groups revealed no significant differences in mean age, years of education, or percent demented.

Inter-rater scoring reliability was excellent for the CDT (intraclass correlation = .97). Correlations between CDT scores and MMSE and CASI were statistically significant ($r = -.80$ between CDT and CASI, $r = -.79$ between CDT and MMSE, $r = .94$ between MMSE and CASI; all $p < .001$). Mean scores on the CDT, MMSE, and CASI, shown in Table 1, were significantly different for the two diagnostic groups ($p < .001$). When age and education were entered as covariates, the differences between demented and nondemented groups remained significant (all $p < .001$). Within diagnostic groups, mean CDT scores were significantly lower in poorly educated subjects ($p < .001$) but did not differ as a function of primary language (English vs non-English, $p > .05$). English and non-English speakers within diagnostic groups did not differ in mean years of education ($p = .19$), and no significant differences were found in the distribution of probable dementia subtypes as a function of primary language ($p = .31$; data not shown). Age had no effect on

CDT performance in controls, but among demented patients, older subjects performed less well than younger ($p < .03$).

The sensitivity and specificity for a diagnosis of probable dementia in the sample as a whole were calculated for the CDT, using a cut-off score of ≥1 (at least mild impairment); the MMSE, using the conventional cut-off score of 24 (9), uncorrected for age or education; and the CASI, using a cut-off score of 80 (29). Test sensitivity and specificity in subjects who completed all three screens were 82% and 92%, respectively, for the CDT; 92% and 92% for the MMSE; and 93% and 97% for the CASI. Subjects were divided into two groups based on formal education (≥ 9 years, $n$ = 197 [60%]; and ≤ 8 years, $n$ = 98 [30%]). One hundred forty-one subjects (48%) spoke English as their primary language and 154 (52%) did not. Sensitivity and specificity for each test in these four subgroups, based on actual test completers and "intent-to-test" analyses, are shown in Table 2.

Table 1. Demographic and Cognitive Characteristics of the Sample by Clinical Dementia Classification

| | No Dementia ($n$ = 125) | Probable Dementia ($n$ = 170) |
|---|---|---|
| Age (yr) | 68.9 ± 8.9 | 77.2 ± 9.4 |
| Education (yr) | 13.5 ± 8.8 | 9.8 ± 11.0 |
| % Female | 66 | 60 |
| CDT | 0.13 ± 0.5 | 2.1 ± 1.2 |
| MMSE | 27.5 ± 2.4 | 13.1 ± 6.9 |
| CASI | 90.0 ± 9.3 | 50.0 ± 20.0 |

*Notes:* Values are means ± *SD*. CDT = Clock Drawing Test; MMSE = Mini-Mental State Examination; CASI = Cognitive Abilities Screening Instrument.

*Non-English Speakers: 8 or fewer years of Education*

The CDT was superior to the CASI, particularly when subjects who could not or would not complete the CASI were included in the calculations. In this group considered potentially most difficult to test and to classify on cognitive performance measures (low education/non-English), the CDT was completed by 61 of 65 subjects (94%) and identified probable dementia cases with a specificity of 85% and a sensitivity of 94%. The MMSE was highly sensitive (100% of demented subjects correctly classified), but, as expected, much less specific, as only 46% of controls were correctly identified using the conventional cut-point established in better educated English-speaking populations. Five subjects in this group who completed the CDT were unable to complete the MMSE, even when tested by a highly trained, native speaker fluent in their own language, and all five were demented. *This suggests that the CDT can be used to test some of the most difficult patients, poorly educated, non–English-speaking, demented older adults, to whom the MMSE may not be successfully administered even under optimal testing circumstances (at home, testing by trained bilingual case managers who knew the subjects and their families).* Similar difficulties were encountered with the CASI. The CASI showed good sensitivity (95% of demented persons tested were correctly classified) but less specificity (75% of controls tested correctly classified). However, six sub-

Table 2. Sensitivity and Specificity of Three Dementia Screens: Effect of Language, Education, and Test Completion

| | | Language | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Non-English | | | | | | English | | | | | |
| | | Test Classification | | | | | | Test Classification | | | | | |
| Education (yr) | Clinical Classification | 0 | 1 | miss | SS1% | SS2% | SS3% | 0 | 1 | miss | SS1% | SS2% | SS3% |
| | | CDT | | | | | | CDT | | | | | |
| ≤ 8 yr | Not demented | 11 | 2 | 0 | 85 | 85 | 85 | 3 | 2 | 0 | 60 | 60 | 60 |
| | Demented | 3 | 45 | 4 | 94 | 86 | 94 | 3 | 23 | 2 | 88 | 82 | 89 |
| | | MMSE | | | | | | MMSE | | | | | |
| | Not demented | 7 | 6 | 0 | 46 | 46 | 46 | 5 | 0 | 0 | 100 | 100 | 100 |
| | Demented | 0 | 43 | 9 | 100 | 83 | 100 | 2 | 23 | 3 | 92 | 92 | 93 |
| | | CASI | | | | | | CASI | | | | | |
| | Not demented | 9 | 3 | 1 | 75 | 69 | 69 | 4 | 1 | 0 | 80 | 80 | 80 |
| | Demented | 2 | 41 | 9 | 95 | 79 | 96 | 1 | 21 | 6 | 95 | 75 | 96 |
| | | CDT | | | | | | CDT | | | | | |
| ≥ 9 yr | Not demented | 48 | 0 | 1 | 100 | 98 | 98 | 51 | 6 | 1 | 89 | 88 | 88 |
| | Demented | 11 | 26 | 3 | 70 | 65 | 73 | 11 | 38 | 1 | 78 | 76 | 78 |
| | | MMSE | | | | | | MMSE | | | | | |
| | Not demented | 44 | 4 | 1 | 92 | 90 | 92 | 57 | 0 | 1 | 100 | 98 | 98 |
| | Demented | 3 | 35 | 2 | 92 | 88 | 93 | 7 | 43 | 0 | 86 | 86 | 86 |
| | | CASI | | | | | | CASI | | | | | |
| | Not demented | 47 | 2 | 0 | 96 | 96 | 96 | 57 | 0 | 1 | 100 | 98 | 98 |
| | Demented | 3 | 31 | 6 | 91 | 78 | 93 | 4 | 41 | 5 | 91 | 82 | 92 |

*Notes:* Clinical classification = CERAD history of cognitive decline in multiple domains and CDR. Test classification: 0 = not demented; 1 = demented; Miss = subjects ($n$) not testable or refusing. SS1% = % correctly classified based on subjects actually tested. SS2% = % correctly classified based on all subjects, assuming that untested subjects are incorrectly classified; this produces a "worst-case" performance value for each test. SS3% = % correctly classified based on all subjects, assuming that failure to complete a test indicates the presence of dementia. CDT = Clock Drawing Test; MMSE = Mini-Mental State Exam; CASI = Cognitive Abilities Screening Instrument.

jects (five demented, one control who refused) not testable with the CASI successfully completed the CDT. Evaluation of sensitivity and specificity, including all subjects in "intent to test" analyses (including those who could not complete the MMSE or CASI), showed that the CDT performed better than either of the other two tests when subjects were assumed incorrectly classified by the missing test (SS2%). When test noncompletion was considered indicative of dementia (SS3%), this overall superiority was retained.

*Nine or More Years of Education*

In better educated non-English speakers, all three tests showed good specificity (100% for CDT, 92% for MMSE, and 96% for CASI), whereas sensitivity was better for the MMSE (92%) and CASI (91%) but considerably less for the CDT (70%), as expected. As in the less educated group, these figures are also affected by subjects who could not be tested with a given instrument. The CASI was most vulnerable, as six demented subjects could not be tested because of severity of impairment. Incorporating these into the analysis, the overall sensitivity of the CASI was reduced to 78% when untested subjects were considered incorrectly classified. When noncompleters were assumed to be demented, the performance of all three tests approximated that found in analyses limited to test completers in this protocol designed to eliminate confounding effects of language barriers on testing effectiveness.

*English Speakers*

In contrast to non-English speakers, the MMSE and CASI both performed better than the CDT in the better educated group. The small number of English-speaking subjects with 8 or fewer years of education who were clinically classified as nondemented made formal analyses unreliable in that group. However, in the poorly educated English-speaking group as a whole, the CDT was completed by 31 of 33 subjects, whereas the CASI was completed by only 27.

## Discussion

Data from this study supported our three research hypotheses. Across all subjects, sensitivity and specificity of all three instruments were adequate (Hypothesis 1), although the MMSE and CASI performed better when only test completers were included in the analyses. In subjects with 9 or more years of education, the MMSE and CASI had clear advantages in sensitivity (Hypothesis 2). However, in the most difficult group, poorly educated non-English speakers, the CDT had similar sensitivity and better specificity relative to both the MMSE and the CASI (Hypothesis 3). The CDT's performance as a single test was comparable to that reported for English-speaking patients with varied dementia diagnoses (13).

The conventional approach to improving the performance of the MMSE and CASI in subjects with low education has been to lower the cut-off score for classification of cognitive impairment (27,32). In the present sample, exploratory analyses using a range of cut-off scores (e.g., MMSE = 20, CASI = 60) indeed correctly classified a larger percentage of nondemented subjects, but sensitivity for dementia was much reduced, yielding no overall improvement in classification rates. For clinical screening purposes, high sensitivity is preferred to high specificity to maximize detection.

In contrast to the CASI and the MMSE, the CDT, using a straightforward dichotomous scoring system for classification (normal vs not), showed excellent feasibility in all groups, regardless of education level or language. Additionally, it showed very good sensitivity and specificity with the group most difficult to test, poorly educated non-English speakers. The data provide evidence that the CDT may be the most effective single choice for dementia screening of multiethnic elders when the objective is detection of established dementing disease for the purpose of improving patient management. We suggest that the utility of screening measures should be analyzed not only in terms of their sensitivity and specificity, but also in terms of feasibility in a population. Our conceptual approach to feasibility was similar to that known as the "intent-to-treat" analysis, now widely accepted as a standard of effectiveness in psychopharmacological research. Like a drug, a test is only as good as its ability to be administered to completion; in this respect, the CDT was superior to the MMSE and CASI in its lower rates of test noncompletion, even when testing was performed by native speakers in the subjects' primary languages. This CDT advantage may be particularly useful in settings where patients and providers speak different languages and skilled translators experienced in the subtleties of cognitive testing are not readily available. Such settings are common in the medical treatment of non–English-speaking minority elders; failure to complete longer tests that rely heavily on verbal skills may be due to language, trust, and cultural barriers in the context of care as well as to the presence of dementia. In the present study, these barriers were eliminated by the use of skilled bilingual testers known to the subjects. Using this approach, not available to most clinicians, the presumption that test noncompletion signifies dementia indeed holds true and results in improved identification of demented subjects (but no improvement in correct classification of nondemented subjects). Whether it would be similarly valid in practice-based applications should be tested in future studies of heterogeneous samples of patients in primary care and social service settings, in which ethnolinguistic barriers between patients and providers may be problematic.

The superior performance of the CDT, a seemingly "visuospatial" task, in non–English-speaking subjects with low educational attainment is particularly interesting in light of the report that the MMSE visuospatial task is highly education-sensitive (23). Several relevant considerations may illuminate these contrasting findings. Clock faces and the telling of time are familiar in all major cultures and civilizations in the 20th century, whereas abstract figure copying, a skill most familiar to persons educated in conventional "western" settings, lacks contextual validity in everyday life. Unlike figure copying, accurate clock drawing "from scratch" requires simultaneous use of multiple cognitive abilities that call upon diverse cerebral regions impaired in dementing diseases. Long-term memory and information retrieval, auditory comprehension, visuospatial representation, visuoperceptive and visuomotor skills, global and hemispheric attention, simultaneous processing, and executive functions are all essential components of successful completion of the CDT, and all, in various applications, are deployed in diverse life activities in all cultures.

The simple CDT scoring system we employed here deserves comment. We selected a binary "intuitive" approach in

preference to more fully quantified rating systems designed for psychometric research and recommended by other investigators for use in clinical practice applications (13–16,37). This choice was based on several rationales. The equivalent effectiveness of extremely brief and longer screens for depression in primary care settings (38), prompting their adoption in a number of studies in "real-world" practices where incorporation of formal instruments has failed the test of physician acceptability, suggests that a similar strategy should be examined for dementia screening. Primary care physicians rarely employ screening tests for dementia even when they are acquainted with their value (6,7). Furthermore, non-specialist practitioners outside research environments are unlikely to keep at hand the set of complex rules needed to generate detailed CDT scores. A screen requiring nothing more than intent to test, simple instructions, a blank piece of paper, and a pencil might be more acceptable to physicians and other health personnel working under time pressures in general practice situations. A similar approach found the CDT effective for screening hospitalized elderly persons for cognitive impairment (39). Additional work is needed to test its acceptability in actual clinical practices and to validate the use of scoring methods that are easily learned, remembered, and used by community service providers.

The CDT can be rapidly and easily administered by nonprofessional testers such as family members and office assistants, an advantage that could accelerate inclusion of preliminary dementia screening procedures for clinical populations at risk. Our data suggest that a simple scoring system yields reliable results with minimal training and that this test may be most helpful in identifying dementia in poorly educated, non-English speakers whose physicians may need to communicate with them through an interpreter. In contrast, the MMSE and CASI are considerably more time- and labor-intensive, demand much more experience to administer reliably, depend upon the willingness of practitioners to incorporate detailed paper-and-pencil tests into their practice routines, and are outside the expertise of medical interpreters or patients' relatives. Additional validation of the CDT using both practice- and population-based epidemiological sampling methods could make a significant contribution to early detection of dementia in a wide variety of clinical populations and to formulation of public policy for the screening of elderly persons for dementing disease.

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Address correspondence to Soo Borson, MD, Box 356560, University of Washington School of Medicine, 1959 NE Pacific Street, Seattle, WA 98195-6560. E-mail: soob@u.washington.edu

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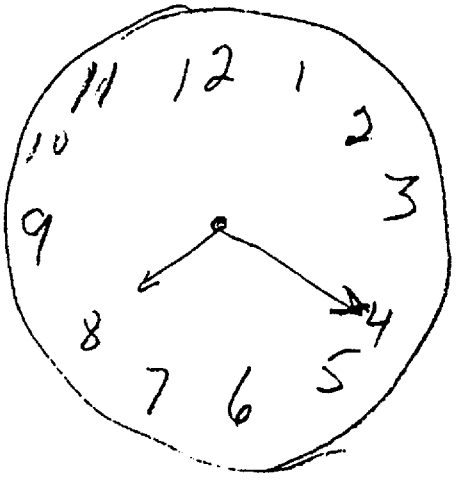
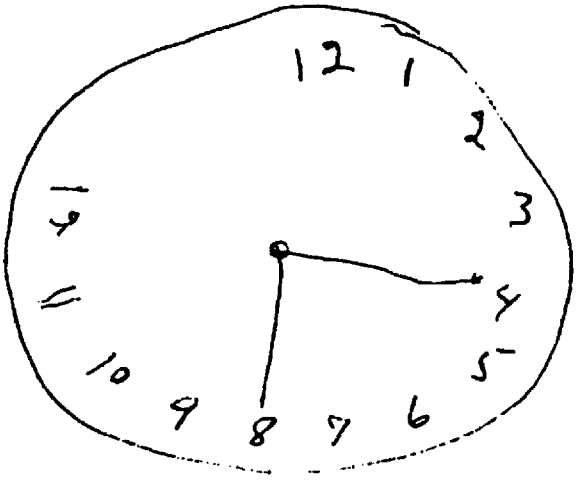
## Appendix

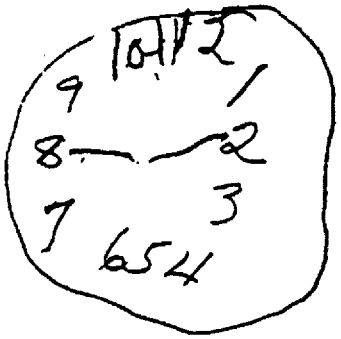
*Clock drawings*



Normal



Mild Impairment



Moderate Impairment

Severe Impairment