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The Effects of Age, Education, and Gender on the Mattis Dementia Rating Scale Performance of Elderly Chinese and American Individuals

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A Chinese version of the Mattis Dementia Rating Scale (DRS) was administered to elderly individuals in Hong Kong (n = 104), and their performance on the test was compared with that of elderly participants in San Diego (n = 150). Age and education, but not gender, were significantly related to DRS performance in both groups. The effect of education was greater in the Hong Kong than in the San Diego participants, but this difference was eliminated when individuals with no formal education were removed from the Hong Kong group. Age- and education-matched groups of Hong Kong and San Diego elderly individuals differed in the pattern of DRS subtest performance they produced, even when they did not differ in total DRS score. The Hong Kong participants scored significantly higher than the San Diego participants on the Construction subscale, whereas the opposite pattern was observed on the Initiation/Perseveration and Memory subscales. These results suggest that some DRS subscales or individual subscale items may be susceptible to cultural differences between elderly Chinese and American individuals.

SEVERAL neuropsychological screening instruments that are widely used in Western countries to detect and track the progression of dementia have been translated and culturally adapted for use in China. Chinese versions of the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) and the Blessed-Roth Information-Memory-Concentration Test (IMCT; Blessed, Tomlinson, & Roth, 1968), for example, were developed and used in a longitudinal study of the prevalence and incidence of dementia and Alzheimer's disease in Shanghai, China (Zhang et al., 1990). These tests were found to be valid and sensitive instruments for detecting cognitive impairment in the Chinese population, but, like their Western counterparts, they were quite susceptible to the effects of age and education. In particular, performance on the tests was strongly related to level of education in nondemented elderly Chinese individuals, and it was only after the adoption of education adjusted cut-off scores that the tests provided reasonably good discrimination between demented and nondemented individuals (i.e., approximately 80% sensitivity and specificity; Jin et al., 1989; Katzman et al., 1988).

Although overall performance on the MMSE and IMCT was found to be similarly effective for detecting cognitive impairment in Chinese and Western cohorts once education was taken into account, direct comparisons of the patterns of performance of elderly Chinese and Western individuals across the individual items of the tests revealed a number of qualitative differences. Jin and colleagues (Jin et al., 1989), for example, found that demented elderly American individuals performed worse than their demented Chinese counterparts when answering questions from the IMCT regarding orientation to time and place, but performed better on items requiring the recall of dates of historical events or the recitation of the months of the year in a reverse order (i.e., from December to January). In addition, Salmon and colleagues (Salmon, Riekkinen et al., 1989) reported that in large community samples, elderly Finnish individuals performed worse than elderly Chinese individuals on the recall item from the MMSE, but performed better on the item that required copying a geometric figure (i.e., intersecting pentagons).

The difference in the performances of elderly Chinese and Western individuals on specific items from these brief mental status examinations has been attributed to cultural and educational factors (Jin et al., 1989; Katzman et al., 1988; Salmon, Riekkinen, et al., 1989; Salmon, Jin, Zhang, Grant, & Yu, 1995). From a cultural perspective, it has been proposed that distinct patterns of performance on various cognitive tasks may arise from differences in the lifestyle of Chinese and Western individuals (Jin et al., 1989; Salmon, Riekkinen, et al., 1989; Salmon et al., 1995). For instance, greater residential stability in China than in the United States may account for the better orientation to place of elderly Chinese compared to their American counterparts (Jin et al., 1989). Educational factors that may influence qualitative aspects of performance include possible differences in the emphasis Chinese and Western education place on specific cognitive abilities (e.g., rote memorization, spelling, conceptual thinking) and the lack of opportunity for elderly Chinese with no formal education to have acquired certain skills (e.g., writing, reading, drawing) that are important for performing neuropsychological tests (Caramelli et al., 1997; Jin et al., 1989; Salmon et al., 1995).

Although the Chinese versions of the MMSE and IMCT have proven to be useful for detecting cognitive impairment in elderly individuals, and for comparing cognitive functioning across Chinese and Western cultures, the tests are limited by their inability to assess a wide variety of cognitive abilities in a detailed manner. In addition, a number of studies have shown that the MMSE and the IMCT are not particularly sensitive for detecting cognitive impairment in its early stages and suffer from floor effects in more severely demented patients (Salmon, Thal, Butters, & Heindel, 1990; Tombaugh & McIntyre, 1992). A mental status examination that is less susceptible to these problems and that might be particularly effective for detecting and characterizing cognitive impairment in elderly Chinese is the Mattis Dementia Rating Scale (DRS; Mattis, 1976, 1988).

The DRS is a standardized, clinical mental status examination that provides a global measure of dementia derived from subscores for five cognitive capacities: attention, initiation and perseveration, construction, conceptualization, and memory. The DRS has been widely used in the United States for detecting and staging dementia (Gardner, Oliver-Munoz, Fisher, & Empting, 1981; Green, Woodard, & Green, 1995; Hersch, 1979; Salmon, Thal, Butters, & Heindel, 1990; Salmon, Kwo-on-Yuen, Heindel, Butters, and Thal, 1989; Shay et al., 1991; Smith et al., 1994; Woodard, Salthouse, Godsall, & Green, 1996) and has been shown to have excellent reliability (Gardner et al., 1981; Smith et al., 1994; Vitaliano et al., 1984) and content validity (Freidl, Schmidt, Stronegger, Fazekas, & Reinhart, 1996; Hofer, Piccinin, & Hershey, 1996; Monsch et al., 1995; Smith et al., 1994; Vitaliano et al., 1984; Woodard et al., 1996). The DRS has a number of advantages over the simpler MMSE and IMCT, including assessment of a greater number of cognitive domains, a wider range of item difficulty, and the ability to differentiate among patients with distinct dementing disorders on the basis of the pattern of subtest scores they achieve (Hersch, 1979; Paolo, Troster, Glatt, Hubble, & Koller, 1995; Paulsen et al., 1995; Rosser & Hodges, 1994; Salmon, Kwo-on-Yuen, et al., 1989; Troster, Moe, Vitiello, & Prinz, 1994).

Given the advantages of the DRS over other brief standardized mental status examinations, we recently translated and culturally adapted the test for use with elderly Chinese in Hong Kong. The purpose of the present study was twofold: (a) to determine if demographic factors such as age, education, and gender have an effect on the DRS performance of nondemented elderly Chinese and, if so, are these effects similar to those in nondemented elderly Americans and (b) to compare the performances of nondemented elderly Chinese and American individuals on the DRS to determine if there are qualitative differences on individual subtests or items that might be related to cultural or educational factors.

Methods

Participants

One hundred four elderly Chinese individuals (44 men, 60 women) and 150 elderly American individuals (84 men, 66 women) participated in the present study. The Chinese participants were volunteers recruited from various community recreational centers for elderly individuals in Hong Kong. All Hong Kong participants denied a history of past or current cognitive impairment, neurological or psychiatric disorder, or head injury, and none were taking psychoactive medications. All were living and functioning independently in the community and were able to travel to the recreational center and participate in its activities without assistance. All participants were permanent residents of Hong Kong.

The nondemented elderly American individuals were participants in an ongoing longitudinal study of dementia at the University of California, San Diego (UCSD), Alzheimer's Disease Research Center (ADRC). These participants were volunteers recruited from newspaper advertisements or were spouses of patients with Alzheimer's disease. The San Diego participants all denied a history of past or current cognitive impairment, neurological or psychiatric disorder, or significant head injury, and all were living and functioning independently.

The mean age of the Chinese (71.14 years, $SD = 7.07$) and the American (72.38 years, $SD = 6.61$) participants was not significantly different, $t(256) = -1.44$, $p > .05$. The Chinese participants had significantly fewer years of education ($M = 7.44$, $SD = 5.38$), on average, than did the American participants ($M = 15.08$, $SD = 3.04$), $t(256) = -14.47$, $p < .05$. Whereas all American participants had education above the elementary level (more than 7 years of education), the Hong Kong sample included 35 individuals with elementary level and 9 individuals with no formal education.

Material

The Mattis DRS (Mattis, 1976) consists of 36 tasks that are divided among five subtests: Attention, Initiation/Perseveration, Construction, Conceptualization, and Memory. The individual items that comprise each subtest and the items' maximum possible scores are presented in Table 1.

A Chinese version of the DRS was developed by directly translating most of the scale's items from English. The initial direct translation was reviewed by a second translator and discrepencies were discussed and approved by a third translator. Modifications necessary to culturally adapt the DRS were suggested by a bilingual neuropsychologist who was very familiar with the test and with psychometric test development. Changes were reviewed by the translation team for linguistic accuracy. Pilot data demonstrating the effectiveness of the translation and modifications were obtained from five undergraduate students.

The Chinese version of the DRS has the following modifications of the original version: (a) The number 7 was substituted for the letter A in the counting task of the Attention subtest, because most elderly individuals in Hong Kong are not familiar with the English alphabet; (b) the differences question *cat*, *dog*, *car* from the Conceptualization subscale was changed to *cat*, *dog*, *face*, because the Chinese word for *face* sounds like *cat*, and the differences question *fish*, *car*, *train* was changed to *fish*, *car*, *ship*, because the Chinese word for *train* consists of two characters, one of which is the character for *car*; and (c) the questions in the orientation portion of the Memory subscale were changed to suit the societal background in Hong Kong, for example, the participants were asked to recall the name of the present chief executive of the Hong Kong Special Administration Region instead of the President of the United States.

Table 1. Individual Items of the Chinese Version of the Dementia Rating Scale (DRS)

DRS Items	Maximum Score
Attention Subtest	
Digit span (forward and backward)	8
Two successive commands	2
Single verbal commands	4
Imitation	4
Counting 7s	6
Counting randomly arranged 7s	5
Reading a list of words	4
Matching figures	4
Total	37
Initiation/Perseveration Subtest	
Fluency for supermarket items	20
Fluency for articles of clothing	8
Verbal repetition (e.g., *bee*, *ba*, *bo*)	2
Double alternating movements	3
Graphomotor (copying of alternating figures)	4
Total	37
Construction Subtest	
Reproduction of stimulus designs	6
Conceptualization Subtest	
Similarities	8
Priming inductive reasoning	3
Differences	3
Similarities—multiple choice	8
Identities and oddities	16
Generate a sentence	1
Total	39
Memory Subtest	
Recall a presented sentence	4
Recall the self-generated sentence	3
Orientation	9
Verbal recognition	5
Figure recognition	4
Total	25
Total Score	144

Procedures

The Chinese participants were tested individually in a quiet room in the community recreational center with which they were affiliated. Testing was performed by trained examiners from the Chinese University of Hong Kong. The American participants were tested at the UCSD ADRC by trained psychometrists. The DRS was administered to each participant following the procedures of Mattis (1988), with the modifications noted above and with the exception that all items were administered to all participants. Written informed consent was obtained prior to the test session.

Results

The mean scores achieved by the Hong Kong and San Diego participants on the DRS and each of its subscales are presented in Table 2. The Hong Kong participants scored significantly lower than the San Diego participants on the total DRS score and on the Initiation/Perseveration, Conceptualization, and Memory subscales. It should be noted, however, that the Hong Kong participants were significantly less educated than the San Diego participants, with a number of individuals having no formal education. Because level of education and possibly other demographic factors may influence DRS performance, the effects of education, age, and gender on test performance of both Hong Kong and San Diego participants were explored further.

Table 2. Mean (and Standard Deviation) Dementia Rating Scale (DRS) Total and Subscale Scores Achieved by the Total Hong Kong and San Diego Samples

DRS Subscales (Maximum Score)	Hong Kong ($N = 104$)	San Diego ($N = 150$)	t^a
Attention (37)	35.45 (3.81)	36.17 (0.97)	1.87
Initiation/Perseveration (37)	32.57 (5.34)	36.06 (1.91)	6.39*
Construction (6)	5.66 (1.09)	5.56 (0.69)	0.39
Conceptualization (39)	35.02 (3.97)	36.91 (2.28)	4.39*
Memory (25)	22.99 (1.87)	24.15 (1.09)	5.71*
Total DRS (144)	132.30 (8.51)	138.85 (3.72)	7.38*

[a]df = 252.
*$p < .01$.

The Effects of Age and Education on DRS Performance

The effects of age and education on DRS performance were examined with multiple regression analyses that were performed separately for the Hong Kong and San Diego participants. A significant multiple regression model was obtained for the Hong Kong sample that accounted for 23% of the variance in DRS scores, $F(2,101) = 15.25$, $p < .01$. Both age ($\beta = -0.299$, $p < .01$, $r = -0.38$) and education ($\beta = 0.302$, $p < .01$, $r = 0.38$) were significant factors in the model. A significant multiple regression model was also obtained for the San Diego sample, but the model only accounted for 18% of the variance in DRS scores, $F(2,147) = 15.63$, $p < .01$. As was found with the Hong Kong sample, both age ($\beta = -0.380$, $p < .01$, $r = -0.38$) and education ($\beta = 0.170$, $p < .05$, $r = 0.18$) were significant factors in the model derived with the San Diego sample.

Given the relatively high degree of variability in the DRS performance of the elderly Hong Kong participants with no formal education, the multiple regression analysis for the Hong Kong sample was repeated with only those participants who had some formal education (elementary or higher). A significant multiple regression model that accounted for 17% of the variance in DRS scores was obtained, $F(2,90) = 9.00$, $p < .01$. Both age ($\beta = -.255$, $p < .01$) and education ($\beta = .293$, $p < .01$) were significant factors in the model.

The Effect of Gender on DRS Performance

The mean scores achieved on the DRS and its subtests by male and female participants are presented separately for the Hong Kong and San Diego samples in Table 3. The male and female participants in the Hong Kong sample differed significantly on the Construction and Memory subtests, but these groups also differed significantly in age (men: $M = 69.34$, $SD = 6.33$; women: $M = 72.38$, $SD = 7.33$; $p < .01$) and years of education (men: $M = 10.73$, $SD = 4.44$; women: $M = 5.19$, $SD = 4.80$; $p < .01$). When age- and education-matched groups of male ($n = 35$) and female ($n = 19$) Hong Kong participants were compared (mean

Table 3. Mean (and Standard Deviation) Dementia Rating Scale (DRS) Total and Subscale Scores Achieved by Male and Female Hong Kong and San Diego Participants

DRS subscales (maximum score)	Men[a] (n = 128)	Women[b] (n = 126)	t^c
Hong Kong Participants			
Attention (37)	36.05 (1.68)	34.81 (4.76)	1.65
Initiation/Perseveration (37)	32.61 (5.41)	31.88 (6.05)	0.65
Construction (6)	6.00 (0.00)	5.25 (1.59)	3.76*
Conceptualization (39)	35.11 (3.88)	34.09 (5.43)	1.07
Memory (25)	23.45 (1.47)	22.19 (2.73)	3.11*
Total DRS (144)	133.23 (8.63)	129.20 (12.70)	1.83
San Diego Participants			
Attention (37)	36.30 (0.85)	36.00 (1.10)	1.88
Initiation/Perseveration (37)	36.35 (1.41)	35.70 (2.36)	1.97
Construction (6)	5.62 (0.56)	5.48 (0.83)	1.13
Conceptualization (39)	36.90 (2.22)	36.92 (2.38)	−0.05
Memory (25)	24.17 (1.13)	24.14 (1.05)	0.17
Total DRS (144)	139.33 (3.41)	138.24 (4.03)	1.80

*$p < .01$.
[a]Hong Kong (n = 44); San Diego (n = 84).
[b]Hong Kong (n = 60); San Diego (n = 66).
[c]Hong Kong (df = 102); San Diego (df = 148).

age: men = 68.57, SD = 5.77; women = 70.37, SD = 6.73; mean education: men = 12.26, SD = 3.54; women = 11.47, SD = 2.65), there were no significant differences in total DRS or subtest scores.

The male and female participants in the San Diego sample did not differ significantly on DRS total score or any of the subtest scores (see Table 3), but, as in the Hong Kong sample, the male and female participants differed significantly in age (men: M = 71.43, SD = 6.46; women: M = 73.59, SD = 6.65; $p < .05$) and years of education (men: M = 14.44, SD = 2.98; women: M = 15.89, SD = 2.94; $p < .01$). As in the total sample, however, no significant differences in total DRS scores or subtest scores were evident when age- and education-matched groups of male (n = 32) and female (n = 22) San Diego participants were compared (mean age: men = 70.44, SD = 4.98; women = 72.73, SD = 9.13; mean years of education: men = 12.25, SD = 2.55; women = 13.64, SD = 3.00).

Table 4. Mean (and Standard Deviation) Age, Years of Education, and Total Dementia Rating Scale (DRS) Score of the Hong Kong and San Diego Participants

Variable	Hong Kong participants (N = 49)	San Diego participants (N = 49)
Age (years)	68.82 (6.06)	71.35 (6.87)
Education (years)	12.18 (3.25)	12.47 (2.57)
Total DRS Score	137.08 (5.18)	138.41 (3.83)

Comparison of the DRS Performance of Elderly Chinese and American Participants

To directly compare the performance of elderly Chinese and American participants on the DRS while controlling for differences in the demographic characteristics of the two groups, we created age- and education-matched subgroups (n = 54 for each group). Despite equivalent age and education, the mean DRS score for the Hong Kong sample (M = 135.06, SD = 8.09) was signficantly lower than that of the San Diego sample (M = 138.76, SD = 3.84), $t(106) = -3.04$, $p < .01$.

To compare the pattern of performance produced by the elderly Chinese and American participants on the various DRS subtests, the groups were also matched for average total DRS score to ensure that qualitative differences in subtest performance were due to factors other than general level of performance. These subgroups consisted of 49 Hong Kong participants (32 men, 17 women) and 49 San Diego participants (30 men, 19 women). The demographic characteristics of the two subgroups are shown in Table 4, and as planned, the subgroups did not differ significantly in age, years of education, or total DRS score (all ps > .05).

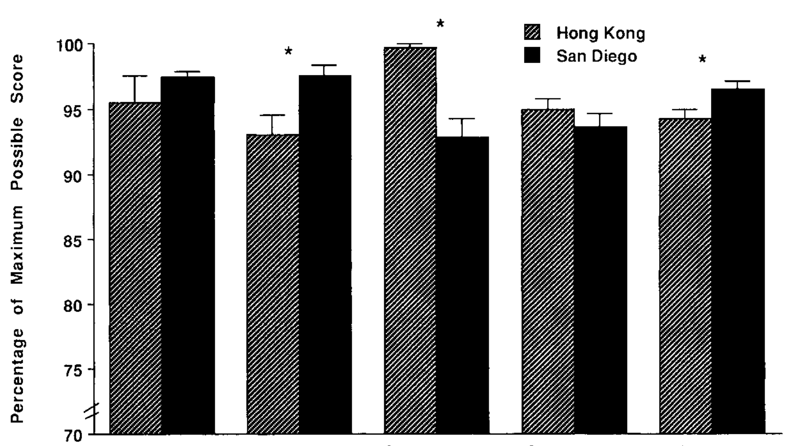

Figure 1. The mean percentage of the maximum possible score achieved on each Dementia Rating Scale (DRS) subtest by the Hong Kong and San Diego participants. The participant groups were matched on age, years of education, and total DRS score. The groups differed significantly on the Initiation/Perseveration, Construction, and Memory subscales. Conceptual. = Conceptualization.

The performances of the two subgroups on the various DRS subtests are presented in Figure 1. The scores are presented as a percentage of the total possible score on each subtest, so that all subtests can be presented on the same scale. A multivariate analysis of variance comparing the subtest performance of the two subgroups was significant, $F(1,96) = 6.69$, $p < .01$, Wilks's lambda = .73, justifying further univariate analyses. The Hong Kong participants scored significantly higher than the San Diego participants on the Construction subscale (Hong Kong: $M = 5.98$, $SD = 0.14$; San Diego: $M = 5.57$, $SD = 0.61$; $p < .01$), but scored significantly lower on the Initiation/Perseveration (Hong Kong: $M = 34.45$, $SD = 3.84$; San Diego: $M = 36.10$, $SD = 2.15$; $p < .05$) and Memory (Hong Kong: $M = 23.57$, $SD = 1.32$; San Diego: $M = 24.14$, $SD = 1.02$; $p < .05$) subscales. The subgroups did not differ significantly on the Attention (Hong Kong: $M = 35.33$, $SD = 5.39$; San Diego: $M = 36.04$, $SD = 1.14$; $p > .05$) and Conceptualization (Hong Kong: $M = 34.45$, $SD = 3.84$; San Diego: $M = 36.10$, $SD = 2.15$; $p > .05$) subscales.

Differences in the performances of the matched Hong Kong and San Diego subgroups were further investigated by comparing scores on the individual items of the Memory and Initiation/Perseveration subscales. Scores on the individual items from the Memory subscale are shown in Table 5. Nonparametric analyses (Mann-Whitney U test) showed that the Hong Kong participants scored significantly lower than the San Diego participants on recall of the presented sentence and recognition of the figures, but scored significantly higher on recall of the self-generated sentence and the orientation items.

On the Initiation/Perseveration subscale, shown in Table 5, the Hong Kong participants performed significantly worse than the San Diego participants only on the supermarket fluency item. To examine the underlying nature of the groups' performance on the supermarket fluency task, the qualitative analysis used by Troster, Salmon, McCullough, and Butters (1989) was used to categorize the types of responses generated by the Hong Kong and San Diego participants. The number of superordinate category labels (e.g., meat, vegetables) and specific exemplars (e.g., pork, peas) generated were counted, as were the number of different categories sampled and the number of words produced per category. The Hong Kong participants generated items from as many different categories as the San Diego participants (Hong Kong: $M = 6.78$, $SD = 1.81$; San Diego: $M = 6.98$, $SD = 1.23$), $t(96) = -0.65$, $p > .05$, and a similar number of words per category (Hong Kong: $M = 2.84$, $SD = 1.38$; San Diego: $M = 2.85$, $SD = 0.62$), $t(96) = -0.02$, $p > .05$. The ratio of category exemplars to total words produced, $t(96) = -0.20$, $p > .05$, and the ratio of category labels to total words produced, $t(96) = 0.48$, $p > .05$, did not significantly differ for the two groups. Thus, the San Diego and Hong Kong participants differed in the number of items produced on the supermarket fluency task, but the styles of responses (i.e., types of items generated) were similar.

Table 5. Mean (and Standard Deviation) Scores Achieved on the Individual Items of the Dementia Rating Scale (DRS) Memory and Initiation/Perseveration Subscales by Hong Kong and San Diego Subgroups Matched on Age, Education, and Total DRS Score

Subscale Item (Range)	Hong Kong Participants ($n = 49$)	San Diego Participants ($n = 49$)	p
Memory			
Recall of the Given Sentence (0–4)	3.35 (0.35)	3.80 (0.65)	0.002*
Recall of Own Sentence (0–3)	3.00 (0.20)	2.84 (0.37)	0.009*
Orientation (0–9)	8.90 (0.37)	8.55 (0.71)	0.003*
Word Recognition (0–5)	4.90 (0.37)	4.96 (0.20)	0.392
Figure Recognition (0–4)	3.43 (0.84)	4.00 (0.00)	0.000*
Initiation/Perseveration			
Supermarket Fluency (0–20)	17.67 (3.59)	19.31 (2.12)	0.006*
Clothing Fluency (0–8)	7.94 (0.32)	8.00 (0.00)	0.155
Verbal Repetition (0–2)	1.86 (0.36)	1.96 (0.20)	0.082
Double Alternating (0–3)	2.98 (0.14)	2.96 (0.20	0.560
Graphomotor (0–4)	4.00 (0.00)	3.88 (0.39)	0.022

*$p < .01$.

Discussion

The results of the present study indicate that performance on the Mattis DRS is similarly influenced by age and education in nondemented elderly Chinese and American individuals. The magnitude of the simple negative correlation between age and overall DRS performance for the Chinese participants ($r = -.38$) was identical to that of the American participants and was very similar to those reported in several previous studies of nondemented American individuals ($r = -.31$ to $-.44$; Bobholz & Brandt, 1993; Lucas et al., 1998; Paolo et al., 1995; Smith et al., 1994). Years of formal education was also significantly correlated with DRS performance in both cohorts, although the magnitude of this correlation was greater for Chinese than for American participants. This difference most likely reflects the more restricted range of DRS scores and years of education obtained by the American participants than by the Chinese participants. As in previous studies (Katzman, 1993; Lucas et al., 1998; Monsch et al., 1995; Schmidt et al., 1994), multiple regression analyses indicated that age and education exerted independent effects on DRS performance. Furthermore, when these analyses were limited to groups of Chinese and American individuals with similar levels of education, age and education accounted for similar amounts of variance in the DRS scores of the two cohorts (approximately 17%).

In contrast to age and education, gender appeared to have little effect on DRS performance. There were no significant differences (after correcting for age and education) in total DRS score, or any subtest score, between male and female participants in either the Chinese or American cohorts. This result is consistent with previous studies that have reported no significant effect of gender on DRS performance (Lucas et al., 1998; Monsch et al., 1995; Schmidt et al., 1994; Smith et al., 1994).

The significant relationship between performance on the DRS and age and education suggests that these factors must be taken into account when using the test to detect mild dementia in elderly Chinese or American individuals. This conclusion has also been reached by a number of other investigators who have presented normative data for the DRS in Western populations that are stratified by age and/or education (Lucas et al., 1998; Marcopulos, McLain, & Giuliano, 1997; Schmidt et al., 1994) or have derived age and education adjustments on the basis of the results of multiple regression analyses (e.g., Lucas et al., 1998). Lucas and colleagues (1998), for example, developed normative scaled scores for the DRS total and subtest scores that are adjusted for age within 3-year time bands from age 69 to 89. As age increased, the DRS scores that corresponded to average performance (i.e., a scaled score of 10) decreased from 137–139 in 69- to 71-year-olds to 132–134 in 87- to 89-year-olds. These investigators also presented a regression formula for adjusting the age-corrected scaled score for level of education. The results of the present study suggest that similar adjustments based on extensive normative data will be necessary to develop the Chinese version of the DRS into an effective dementia screening instrument.

When the performances of subgroups of elderly Chinese and American individuals with similar age and education were compared, the Chinese participants scored significantly lower on the DRS than their American counterparts. This result suggests that cultural differences beyond simple demographic factors may contribute to some aspects of DRS performance. Qualitative differences in the performances of the two subgroups on individual DRS subtests and subtest items provide some information regarding the possible nature of these contributions. The Chinese participants performed significantly worse than the American participants on the Initiation/Perseveration and Memory subscales, but significantly better on the Construction subscale. The difference on the Initiation/Perseveration subscale was driven primarily by the poorer performance of elderly Chinese than elderly American individuals on the verbal fluency item that required them to generate items found in a supermarket. This discrepancy appears to be due to a difference in speed of retrieval rather than to a fundamental difference in the organization of semantic knowledge in the two cohorts because a qualitative analysis of their responses revealed no significant difference in the ratios of category exemplars or category labels to total words produced or in the number of categories they sampled. The slower retrieval of elderly Chinese may occur because they are less familiar with the supermarket than their American counterparts because the primary grocery shopping site for elderly individuals in Hong Kong is the open-air market. This reduced familiarity may require elderly Chinese to engage in a more effortful retrieval process than Americans when performing the supermarket fluency task. This suggests that elderly Chinese and American individuals would perform similarly on a less culturally biased fluency task such as generating names of animals or vegetables. If this is the case, the Initiation/Perseveration subscale of the DRS could be modified with one of these fluency tasks.

Differences in the performances of the elderly Chinese and American individuals on the individual items of the Memory subscale were quite inconsistent. The Chinese participants performed better than the American participants on the orientation item and in delayed recall of a self-generated sentence after a delay, but performed worse on the figure recognition item and in delayed recall of a presented sentence that they read aloud. It may be the case that elderly Chinese have greater difficulty than their American counterparts in the initial encoding of information. Reading a sentence aloud (or simply matching figures) may not have been sufficient to ensure effective encoding by elderly Chinese participants and resulted in poorer delayed recall than that of the elderly American participants. Self-generation of a to-be-remembered sentence, on the other hand, may provide a greater opportunity for effective encoding than simply reading the sentence, and the elderly Chinese participants were able to better recall this sentence than their American counterparts. These possibilities could be assessed using clinical memory tests, such as the California Verbal Learning Test (Delis, Kramer, Kaplan, & Ober, 1987), that are designed to differentiate among encoding, retrieval, retention, and other learning processes.

Alternatively, the observed differences in the performances of the elderly Chinese and American participants on certain memory items may be due to nonspecific factors such as item difficulty. For example, if the presented sentence was more meaningful for the American than for the Chinese participants, it may have been more easily encoded and better remembered by the former group. Conversely, equally meaningful sentences may have led to similar levels of performance. This possibility is supported by the finding that the groups did not differ in remembering their presumably very meaningful self-generated sentences. In any event, the present results suggest that a more detailed comparison of the processes underlying learning and memory of elderly individuals in the two cultures may be clinically and theoretically warranted.

The better performance of the elderly Chinese than the elderly American participants on the DRS Construction subscale may be related to the nature of writing in the two cultures. Unlike the English alphabetic writing system, Chinese writing is orthographic and consists of characters composed of evenly spaced strokes and box-like elements (Chen, 1996). Having been trained in writing Chinese characters may give elderly Chinese individuals an advantage in drawing the simple geometric figures that comprise the Construction subtest. This possibility could be tested by examining the correlation between Construction subtest performance and some independent measure of the ability of elderly Chinese individuals to write with Chinese characters.

The advantage on the Construction subtest enjoyed by the elderly Chinese participants in the present study stands in contrast to the report of Salmon and colleagues (Salmon, Riekkinen, et al., 1989) who found that elderly Chinese individuals in Shanghai performed poorer than elderly individuals in Finland and the United States in copying a complex geometric design (overlapping pentagons) as part of the MMSE. One possible reason for this discrepancy may be the difference in the complexity of the stimuli used in the two tests. The ability to draw the relatively simple box-like designs of the DRS may be enhanced by training in writing Chinese characters, whereas this training may confer little benefit for drawing the more complex geometric design of the MMSE. It is also possible that training in the simplified form of Chinese writing advocated in Shanghai may provide less advantage for drawing geometric designs than the more complex form of writing used in Hong Kong. Finally, it is possible that the early educational systems in Hong Kong and Shanghai differed in the emphasis that was placed on the development of visuospatial skills and the use of a pen or pencil, rather than brushes, to write or draw. A westernization of these early educational practices in Hong Kong may account for the advantage of elderly individuals in Hong Kong, but not in Shanghai, in drawing geometric forms.

Taken together, the results of the present study suggest that age and level of education must be taken into account when using the DRS to detect abnormal cognitive performance in elderly Chinese individuals. Further research with a larger sample of elderly individuals in Hong Kong is necessary to confirm the validity of the subscales and specific items of the DRS and to develop age- and education-adjusted normative scaled scores for this population. Furthermore, research directly comparing the performances of normal individuals and patients with independently documented cognitive impairment is necessary in order to determine cut-off scores on the DRS that are sensitive and specific for cognitive dysfunction in the elderly Chinese population. The present results also suggest that comparisons of DRS performance across cultures, and inferences based on the pattern of performance on DRS subscores, must take the potential influence of cultural factors into account.

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