

# Performance of 7- to 95-year-old individuals in a Chinese version of the category fluency test

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## Abstract

A version of the category fluency test including the categories of animal and transportation, was administered to 316 Chinese native speakers ranging in age from 7 to 95. Results indicated that the number of items generated in the category fluency test increases with age from childhood to adulthood with a peak performance in adults aged from 19 to 30, and then declines subsequently into late life. All participants, regardless of their age, generated more animal than transportation names. Educational level, but not gender, was a significant factor affecting their performance. The participants in all age groups committed very few intrusion and perseveration errors. The results of the present study were in general consistent with those reported in the western countries. Thus, it seems to be appropriate to apply the category fluency test, which was originally developed in western countries, for clinical use in Hong Kong. (*JINS*, 1999, 5, 525–533.)

**Keywords:** Living and nonliving concepts, Chinese neuropsychological assessment

## INTRODUCTION

The verbal fluency test has been widely used in clinical settings, and is one of the few assessment tools that can be administered to individuals of various ages. It has been reported that the verbal fluency test is useful in assessing the cognitive deficits in children with various developmental or genetic disorders, including attention deficit hyperactivity disorders (Koziol & Stout, 1992; Sandler et al., 1993), early onset hydrocephalus (Brookshire et al., 1995; Holler et al., 1995), Turner's syndrome (Temple et al., 1996), and dyslexia (Bunn, 1995; Decker, 1989; Levin, 1990).

The verbal fluency test has also been used in the elderly population, specifically for differentiating the demented elderly from healthy ones (Bentham et al., 1997; Crossley et al., 1997; Diesfeldt, 1985; Salmon et al., 1995; Solomon et al., 1998), and for differentiating dementia of the Alzheimer type from other types of dementia. Specifically, patients with Alzheimer's disease exhibit disproportionate impairment on category fluency tests compared to letter fluency tests (Butters et al., 1987; Hodges et al., 1992; Mick-

anin et al., 1994; Monsch et al., 1992, 1994; Tröster et al., 1989).

Another common clinical use of verbal fluency test is in differentiating various types of psychiatric and brain-damaged patients. Significant impairment in category fluency has been reported in schizophrenic patients (Chen et al., 1996; Gourovitch et al., 1996; Harvey et al., 1997; Ratcliff et al., 1998; Robert et al., 1997; Sautter et al., 1997) and depressive patients (Geffen et al., 1993; Kuzis et al., 1997; Norris et al., 1995; Trichard et al., 1995; Wolfe et al., 1987). Diminished verbal fluency scores were also observed in patients with AIDS or HIV infection (Di Sclafani et al., 1997; Levin et al., 1992; Villa et al., 1990), with frontal lobe lesions (Baldo & Shimamura, 1998; Miller, 1984; Vilkki & Holst, 1994) and with head injury (Ruff et al., 1986; Winogron et al., 1984).

While the category fluency test has been widely utilized in western countries, some Asian countries have just begun to adopt this test for clinical use. For instance, two studies utilizing the category fluency test have been conducted in Hong Kong to study dementia (Chiu et al., 1997) and schizophrenia (Chen et al., 1996), and suggested that the category fluency test was a sensitive clinical assessment tool in both geriatric (Chiu et al., 1997) and psychiatric (Chen et al., 1996) populations. Since the results of these studies sug-

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gest that it seems appropriate to adopt the category fluency test for clinical use in a Chinese-speaking society, it is clinically important to establish normative data that can represent the local population.

The purpose of the present study is to establish normative data for a version of the category fluency test that can be used in Chinese society. Two categories, *animals* and *transportation*, were included in the test, with the former representing a category of living things and the latter representing nonliving things.

These two categories were chosen for the purpose of detecting category-specific impairment. Previous research demonstrated that patients with brain damage of various etiologies, such as herpes simplex encephalitis (De Renzi & Lucchelli, 1994; Moss et al., 1997; Pietrini et al., 1988; Sartori et al., 1993; Silveri & Gainotti, 1988; Warrington & Shallice, 1984), traumatic injury (Powell & Davidoff, 1995), dementia of Alzheimer's type (Garrard et al., 1998; Hodges et al., 1992), cerebrovascular accident (Basso et al., 1997; Crosson et al., 1997), and neurosurgery (Devinsky et al., 1997), demonstrated a dissociation of performance for living and nonliving things. Specifically, patients with herpes simplex encephalitis whose CT scans demonstrated bitemporal damage (Warrington & Shallice, 1984) were found to have impaired performance in naming and/or recognizing living things but not nonliving things, but a patient with a left temporal lobe lesion (Hillis & Caramazza, 1991) showed a reverse pattern of performance. Although many findings suggest that category-specific semantic impairment is related to neuropathological change of the brain, some data suggest that this discrepancy may be attributable to task difficulty level (Farah et al., 1991; Gaffan & Heywood, 1993). Regardless, given that the examining of the semantic knowledge of living and nonliving things was found to be clinically useful, the present study included categories of both living and nonliving things.

## METHODS

### Research Participants

Participants were recruited on a voluntary basis through advertisements in schools, community centers and hospitals in Hong Kong, including both the city and suburban areas. They were all Cantonese speakers. There were 316 participants and none of them reported having histories of any psychiatric or neurological disease. All children and adolescents were either elementary or high-school students, and all adult participants were holding a full-time job. All elderly participants were retired but still able to live independently; they all were able to travel alone to their local community centers and participated actively in the programs of the centers. All received a small gift (e.g., a towel, a pencil or a cake coupon) as a token of appreciation for their participation. It should be noted that there were significantly more female ( $N = 183$ ) than male ( $N = 133$ ) participants in the study ( $\chi^2 = 7.9, p < .01$ ).

The participants were divided into 10 age groups. Children and adolescents were divided into age groups according to their developmental stages; that is, from 7 to 11 years, 12 to 14 years, and 15 to 18 years of age. Adults were divided into groups by decade: 19 to 30, 31 to 40, 41 to 50, 51 to 60, 61 to 70, 71 to 80, and 81 to 95 years of age. Most participants, except the groups of children and older adults (see Table 1), had received a high-school education. Hence, there was a significant group difference in terms of education level [ $F(9,306) = 9.59, p < .001$ ], with individuals in the age ranges of 15 to 18, 19 to 30, and 61 to 70 having a significantly higher level of education than individuals in the age ranges of 7 to 11 and 81 to 95 (Table 1). The distribution of educational level within this sample seems to represent the general trend observed in the general population. That is, the older generation in Hong Kong tends to have a lower level of education when compared with the younger generation given that their education was interrupted by wars.

### Procedures

Each participant was tested in a quiet room, and written consent was obtained prior to testing. First, the participant was told that he/she was going to be asked to generate examples of some categories, and an example of how to generate items of vegetables was given. The participant was also reminded to give the name of each item only once, and to generate as many items as he/she could. After indicating that he/she understood the instructions, the participant was told to generate as many animal names as he/she could think of in 1 min. The experimenter then recorded the responses, and did not provide any feedback. After finishing this task, the participant was given 1 min again to generate names of transportation.

It should be noted that only category, but not letter, fluency task was examined in this study primarily because Chinese is an ideographic language. Some attempts were made to use the radical or phoneme of the Chinese characters to develop a task that may be analogous to letter fluency but the results were not conclusive because both radical and phoneme of most Chinese characters signify some semantic meaning.

## RESULTS

### Effect of Age

The mean total number of items generated in each task and in the two tasks together was shown in Table 2.

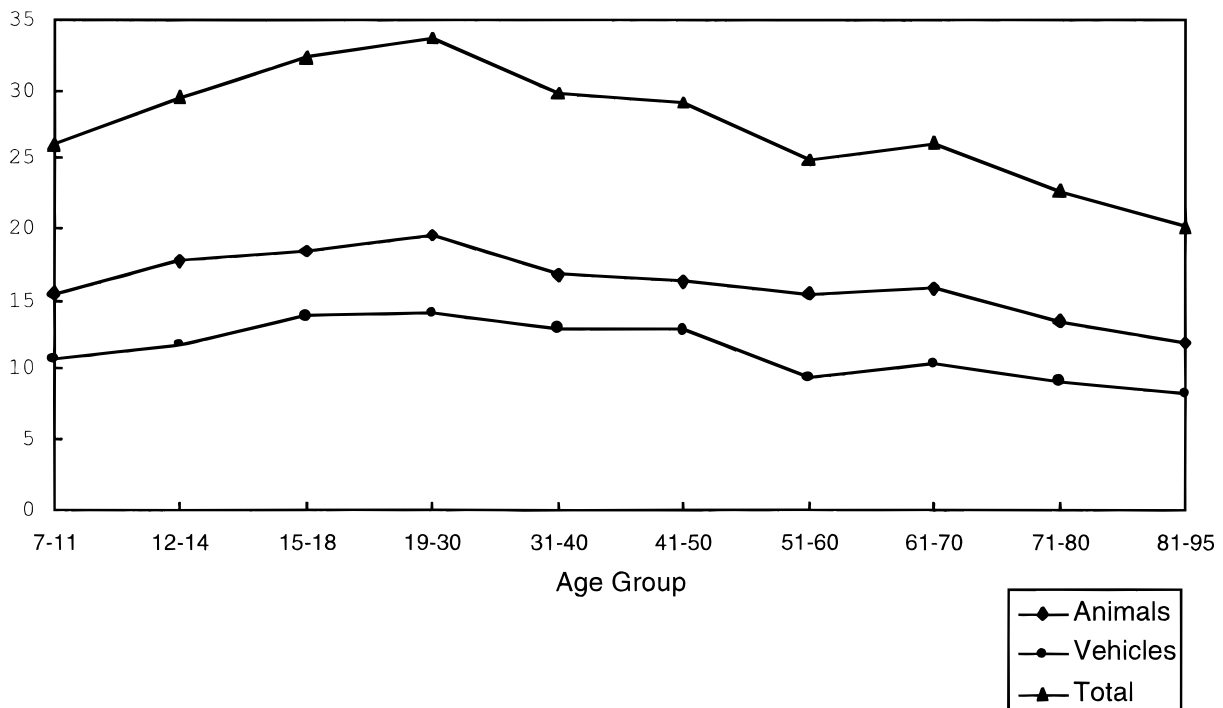
The total number of items generated was analyzed in a 2 (animal and transportation)  $\times$  10 (10 age groups) repeated measures ANOVA. The performances of the groups on the fluency tasks were significantly different [ $F(9,306) = 11.36, p < .001$ ], but all groups generated more items in the animal than the transportation fluency tasks [ $F(1,306) = 2511.20, p < .001$ ]. Effect sizes as measured

**Table 1.** Demographic characteristics of the sample

Variable	Age group (years)									
	7–11 <i>N</i> = 44	12–14 <i>N</i> = 19	15–18 <i>N</i> = 27	19–30 <i>N</i> = 19	31–40 <i>N</i> = 11	41–50 <i>N</i> = 19	51–60 <i>N</i> = 21	61–70 <i>N</i> = 80	71–80 <i>N</i> = 58	81–95 <i>N</i> = 18
Male/female	29/15	9/10	13/14	12/7	2/9	7/12	6/15	30/50	22/36	3/15
Age (years); <i>M</i> ( <i>SD</i> )	9.64 (.99)	12.53 (.61)	16.67 (1.07)	22.84 (2.43)	36.09 (3.45)	46.26 (2.49)	58.00 (2.83)	65.70 (2.98)	75.34 (2.64)	84.17 (3.59)
Education (years); <i>M</i> ( <i>SD</i> )	4.16 (1.16)	6.74 (.99)	10.56 (2.26)	12.00 (2.31)	10.27 (1.68)	8.74 (2.86)	7.76 (5.11)	9.04 (6.13)	6.64 (5.96)	3.17 (5.01)

**Table 2.** The total number of items generated by the participants in the animal and transportation fluency tasks

Measure	Age group (years)									
	7–11 <i>N</i> = 44	12–14 <i>N</i> = 19	15–18 <i>N</i> = 27	19–30 <i>N</i> = 19	31–40 <i>N</i> = 11	41–50 <i>N</i> = 19	51–60 <i>N</i> = 21	61–70 <i>N</i> = 80	71–80 <i>N</i> = 58	81–95 <i>N</i> = 18
Animal; <i>M</i> ( <i>SD</i> )	15.41 (3.20)	17.74 (4.21)	18.48 (3.85)	19.58 (4.00)	16.82 (4.62)	16.32 (3.35)	15.48 (5.36)	15.81 (4.30)	13.55 (3.74)	11.89 (3.74)
Transportation; <i>M</i> ( <i>SD</i> )	10.64 (3.10)	11.84 (3.40)	13.89 (4.28)	14.05 (3.29)	13.00 (3.00)	12.84 (3.59)	9.38 (3.28)	10.30 (3.49)	9.14 (3.15)	8.28 (2.37)
Animal and transportation; <i>M</i> ( <i>SD</i> )	26.05 (5.29)	29.58 (6.69)	32.37 (7.16)	33.63 (5.88)	29.82 (6.59)	29.16 (4.79)	24.86 (6.98)	26.11 (6.23)	22.69 (5.87)	20.17 (4.71)



**Fig. 1.** Mean numbers of items correctly generated on the animal and transportation category fluency tasks across different age groups.

by partial eta-squared ( $\eta^2$ ) for the effects of group and condition were .26 and .48 respectively. The Group  $\times$  Condition interaction was insignificant.

As shown in Figure 1, the total number of words generated by the individuals did not seem to increase linearly with age. There appeared to be a trend of increasing total fluency scores with age in children and adolescents, followed by a trend of decreasing total scores with age in adults and elderly. Thus, the performances of children and adolescents (7–18 years old), adults (19–60 years old), and elderly (61–95 years old) were analyzed separately.

#### Children and adolescents

The performances of children and adolescents ( $N = 90$ ) were analyzed by a  $2 \times 3$  repeated measures ANOVA. The main effect of group was significant [ $F(2, 87) = 8.95, p < .001$ ], and a *post-hoc t* test demonstrated that the 15- to 18-year-old adolescents generated significantly more items than the 7- to 11-year-old children. On the other hand, all groups generated more items on the animal than the transportation fluency tasks [ $F(1, 87) = 157.56, p < .001$ ]. The partial  $\eta^2$  for the effect of group was .17, and for the effect of condition was .64. The Group  $\times$  Fluency task interaction was not significant.

#### Adults

The repeated measures ANOVA on the performance of adults ( $N = 70$ ) indicated a significant effect of group [ $F(3, 66) = 6.96, p < .001$ ] with the younger adults (19–30 years old)

performing significantly better than the 51- to 60-year-old individuals. Similar to the findings on the performance of children and adolescents, all groups of adults generated more items on the animal than the transportation fluency tasks [ $F(1, 66) = 61.26, p < .001$ ]. The partial  $\eta^2$  for the effects of group and condition was .24 and .48 respectively.

#### Elderly

The repeated measures ANOVA on the performance of the elderly ( $N = 156$ ) demonstrated significant effects of group [ $F(2, 153) = 10.15, p < .001$ ; effect size = .11] and condition [ $F(1, 153) = 115.82, p < .001$ ; effect size = .43]. The elderly aged 61 to 70 performed significantly better than those aged 81 to 95. In addition, all groups generated more items on the animal than the transportation fluency tasks.

#### Effect of sex

Generally, male participants generated more items than female participants on both the animal ( $t = 3.04, p < .01$ ) and the transportation ( $t = 3.30, p < .01$ ) fluency tasks. When the effect of sex was examined in the groups of children and adolescents, adults, and elderly, the results indicated that the effect of sex was observed only in the elderly participants on the transportation fluency task ( $t(154) = 2.48, p < .05$ ). However, when the effect of education was entered as a covariate, the effect of sex became insignificant. It should be noted that the male participants in the present study in general had higher level of education than the female par-

ticipants ( $t = 4.11, p < .001$ ). In particular, among the elderly participants, about 23% were illiterate, and among them, 87% were female.

### Effect of Education

The effect of education was examined in the groups of children and adolescents, adults, and elderly by three separate regression analyses. The educational level was a significant factor in affecting the total number of words generated in the fluency task for children and adolescents ( $r^2 = .21, p < .01$ ), adults ( $r^2 = .10, p < .05$ ) and elderly ( $r^2 = .24, p < .01$ ). These results show that the educational level of children, adolescents and elderly, when compared with that of adults, accounted for about twice as much variance in the regression analyses.

This discrepancy may be related to the distribution of educational level within the different cohorts. That is, the mean (*SD*) years of education for children and adolescents, adults and elderly were 6.73 (3.18), 10.35 (2.79) and 7.50 (6.02), respectively. Given that the years of education within the adult samples was more homogeneous than that of children and elderly, it is conceivable that the regression analysis on the performance of adults was limited by their relatively restricted range of their educational level.

### The Effect of Age, Gender and Education

Three linear regression analyses were performed to examine the effect of age, gender and education on the performance of children and adolescents, adults, and elderly on the fluency test. For the first and third groups, the three factors accounted for 23% [ $F(3, 86) = 8.58, p < .01$ ] and 27% [ $F(3, 173) = 20.91, p < .01$ ] of the variance of their performance, respectively. For adults, the three factors accounted for only 13% of the variance of their performance, and this result was not significant [ $F(3, 45) = 2.30, p = .09$ ].

Although the effects of age, gender and education were only significant for the group of children and adolescents and the group of elderly, the equations for the three groups were presented as follows:

1. *Children and adolescents*: Score =  $26.15 - 0.23(\text{age}) - 1.71(\text{gender}) + 1.18(\text{edu})$ .
2. *Adults*: Score =  $31.34 - 0.11(\text{age}) - 0.62(\text{gender}) + 0.43(\text{edu})$ .
3. *Elderly*: Score =  $29.89 - 0.12(\text{age}) - 0.40(\text{gender}) + 0.46(\text{edu})$ .

Furthermore, the performances of the three groups were analyzed again by stepwise regression analyses. For the children and adolescents, only *education* was selected for the equation [ $r^2 = .21, F(1, 88) = 23.50, p < .01$ ]. For the adults, *age* was entered into the equation [ $r^2 = .10, F(1, 47) = 5.31, p < .05$ ]. For the elderly, both *age* and *education* were chosen for the equation [ $r^2 = .027, F(2, 174) = 31.42, p < .01$ ]. These results suggested that

the effects of age and education affect the performance of various cohorts differently.

### Intrusion and Perseveration Errors

As shown in Table 3, the average number of intrusion and perseveration errors committed by participants, in either the animal and transportation fluency tasks, was less than 1. A repeated measures ANOVA analysis on the number of intrusion errors showed a significant main effect of condition [ $F(1, 306) = 8.57, p < .01$ ]. Specifically, the participants generated more intrusion errors in the transportation than in the animal fluency tasks. In contrast, the repeated measures ANOVA on the number of perseveration errors showed that the participants generated more perseveration errors in the animal than in the transportation fluency tasks [ $F(9, 306) = 1.92, p = .05$ ].

### DISCUSSION

The present study examined the performance of individuals in category fluency tests ranging in age from 7 to 95 years. Results indicated that the number of items generated in the category fluency test increases with age in children and adolescents, but declines subsequently in adults and elderly, with a peak performance in adults age 19 to 30 years. These results were consistent with the findings of some western countries (Halperin et al., 1989; Tomer & Levin, 1993). Given that the category fluency test was suggested as a test for the integrity of semantic network (Chan et al., 1993), these results may suggest a developmental change of the structure of semantic knowledge. That is, while the increasing trend in children and adolescents may indicate a progressive development in the structure of semantic knowledge, the decreasing trend in adults and the elderly may reflect a change in their semantic networks. Although our findings do not provide any direct evidence on this issue, the relatively poor performance of the older adults is consistent with the notion that some alteration may occur within the semantic memory system in the process of aging (Kozora & Cullum, 1995; Tomer & Levin, 1993).

Comparisons of some previous studies and the present findings suggest that the category fluency test may not be sensitive to cultural difference. For instance, the mean numbers of words generated in the animal fluency task by a group of western children at 6, 7, 8, 9, 10, 11, and 12 years of age were 10.74, 12.43, 12.31, 13.76, 14.27, 15.50, and 18.90, respectively (Halperin et al., 1989). On average, their mean number of words generated was 14.0, which is comparable with that of the children (15.4) in the present study. In addition, according to the data reported by Tombaugh et al. (cited in Spreen & Strauss, 1998 as personal communication), the mean number of animal names generated by a group of 16- to 19-year-old adolescents was 21.5 ( $SD = 4.4$ ), and that generated by the adolescents in the present study was 18.5 ( $SD = 3.9$ ). Given that the results obtained in Hong Kong were comparable with those reported in the western

**Table 3.** The total number of intrusion and perseveration errors committed by the participants in the animal and transportation fluency tasks

Types of errors	Age group (years)									
	7-11 N = 44	12-14 N = 19	15-18 N = 27	19-30 N = 19	31-40 N = 11	41-50 N = 19	51-60 N = 21	61-70 N = 80	71-80 N = 58	81-95 N = 18
<b>Intrusion</b>										
Animal; <i>M (SD)</i>	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.06 (.56)	.02 (.13)	.00 (.00)
Transportation; <i>M (SD)</i>	.11 (.53)	.26 (.56)	.08 (.27)	.11 (.46)	.09 (.30)	.05 (.23)	.05 (.22)	.02 (.16)	.05 (.22)	.11 (.32)
Animal & Transportation; <i>M (SD)</i>	.11 (.53)	.26 (.56)	.08 (.27)	.11 (.46)	.09 (.30)	.05 (.23)	.05 (.22)	.09 (.57)	.07 (.26)	.11 (.32)
<b>Perseveration</b>										
Animal; <i>M (SD)</i>	.07 (.33)	.53 (.70)	.35 (.75)	.53 (.96)	.18 (.60)	.53 (1.43)	.05 (.22)	.25 (.70)	.10 (.67)	.00 (.00)
Transportation; <i>M (SD)</i>	.11 (.32)	.32 (.58)	.08 (.27)	.21 (.54)	.09 (.30)	.05 (.23)	.15 (.37)	.09 (.28)	.02 (.13)	.39 (1.65)
Animal and transportation; <i>M (SD)</i>	.18 (.44)	.84 (.83)	.42 (.76)	.74 (1.05)	.27 (.65)	.58 (1.64)	.20 (.41)	.33 (.84)	.12 (.68)	.39 (1.65)

countries, it seems to be appropriate to apply the category fluency test that was originally developed in western countries to Asian societies for clinical use.

The present findings indicated that participants across all ages performed significantly better in the animal than the transportation fluency tasks. According to the category association norms by Battig and Montague (1969), it is easier for individuals to generate more examples of the animal than of the transportation category. Baldo and Shimamura (1998) also found that more items were generated for animals than for other semantic categories in normal respondents. Thus, it may be that there are more items in the category of animals, or animal is a more familiar category than most other concepts. It is unlikely that this difference represents some specific cognitive processing strategy in normal individuals.

The present findings demonstrated that normal individuals, regardless of their ages, committed relatively few intrusion and perseveration errors. These results were consistent with those reported by Kozora and Cullum (1995) and Tröster et al. (1989), that the number of intrusion and perseveration errors in normals was relatively low. It should be noted that some studies have shown that the number of intrusion and perseveration errors committed by individuals may be sensitive in differentiating patients with various types of brain-damage. For instance, previous studies have reported that patients with Alzheimer's disease tend to commit more intrusion errors than normal elderly on some language tasks (Cahn et al., 1997; Ober et al., 1986), and patients with frontal lobe lesions have more perseveration errors than normal controls (Baldo & Shimamura, 1998; Canavan et al., 1985; Jones-Gotman, 1991). Thus, the present results probably will be clinically useful for diagnosing patients with frontal-lobe and/or language deficits.

Several studies reported a gender difference on the verbal fluency test, with female participants generally generating more items than male participants (Bolla et al., 1990; Monsch et al., 1992; Wiederholt et al., 1993). In contrast, the present study demonstrated that in general men and women did not perform significantly different on the category fluency test. It was only in the elderly group that men generated significantly more items than women, but such discrepancy is probably due to the significantly higher educational level of male than female participants. In particular, while 20% of female elderly participants were illiterate, only 3% of the men had no formal education. The predominantly illiterate female elderly participants in this sample reflect a Chinese traditional custom that women were given fewer opportunities to attend school.

Another set of normative data on the older adults in Hong Kong was provided by Chiu et al. (1997). They studied a group of 59- to 97-year-old adults with a mean education level of 4.8 years. They reported that the mean score on the animal fluency test was 12.4 (*SD* = 4.4), which is comparable with the present result. Similarly, Chiu et al. also failed to find female superiority in the task. Thus, the present finding seems to be reliable, at least in terms of representing the performance of the older population in Hong Kong.

It should be noted that the educational level of the present samples, when compared with the samples in most western studies, is relatively low. For example, in the study by Kozora and Cullum (1995), the mean years of education of their participants (50–89 years old) was about 14, but that of the present study was 5.4. This difference is mostly related to the distribution of education level in Hong Kong, where most of the older adults did not receive much education because of the wars that took place during their childhood and early adulthood. Given that education was found to be a significant factor in the fluency scores (Crossley et al., 1997; Marcopulos et al., 1997; Ratcliff et al., 1998), the effect of education should be taken into consideration when using the present set of normative data for clinical use.

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