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The Effects of Aging on the Word Fluency Subtest of the Western Aphasia Battery

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Abstract

This study was intended to determine if age effects were present on a semantic category word fluency task. This investigation compared the performance of 141 normal adults in four age groups, 40-49, 60-69, 70-79, and 80+, on the Word Fluency subtest of the Western Aphasia Battery (Kertesz & Poole, 1982). Results indicated that older subjects (70-79, 80+) produced fewer animal names in a one-minute time period than did younger subjects (40-49, 60-69). Older subjects (70-79, 80+) also improved significantly on the test-retest condition. Based on these findings, it is hypothesized that a critical period for a decrease in word fluency skills occurs after the 60-69 year age range.

Introduction

Word fluency measurements are controlled verbal association tasks in which an individual produces as many words as possible beginning with a specified letter or belonging to a semantic category (Davis, 1983). These measurements are sensitive indicators of mild aphasia (Kertesz, 1979). Word-fluency tasks also have been used to evaluate recovery of aphasia (Sarno, 1980), to distinguish normals from aphasics (Chapey, Rigrodsky, & Morrison, 1976), to differentiate normals from patients with bilateral, right, or left hemisphere lesions (Wertz, Shubitowski, Dronkers, Lemme, & Deal, 1985), and to differentiate normals from patients with mild or moderate Alzheimer's Disease (Bayles, 1984; Ober, Dronkers, Koss, Delis, & Friedland, 1986).

Word fluency measurements have been included as subtests in the *Boston Diagnostic Aphasia Examination* (BDAE) (Goodglass & Kaplan, 1983), the *Western Aphasia Battery* (WAB) (Kertesz & Poole, 1982), and the *Neurosensory Center Comprehensive Examination for Aphasia* (NCCEA) (Spreen & Benton, 1969). The Word Fluency subtest of the WAB allows each patient a 60-second time period to produce animal names. Scoring is based on one point per animal named to a maximum of 20 (Kertesz & Poole, 1982).

A range of ability on the word fluency task was noted by Borod, Goodglass, and Kaplan (1980) when they were establishing norms for the BDAE. Kertesz (1979) attributed this high variability to intellectual ability, anxiety, educational level, distractibility, or age factors. Davis (1983) observed that since relatively few studies have adequately analyzed the variability noted on normal word fluency performance, there is a need for more research to explore this measure.

Experience in the treatment of geriatric patients with varying etiologies and degrees of language impairment suggested to the current investigator that normal performance for older individuals may differ from that of younger ones. A word fluency score of 20 on the WAB may be an artificially high expectation of performance for geriatric individuals on this task. A review of the literature confirmed that normative data for the WAB lacked sufficient representation from the geriatric age groups. In particular, the 80+ age group has not been carefully considered in most studies of adult word fluency.

Word fluency is reported to be relatively stable in early and mid-adulthood (Borod, Goodglass, & Kaplan, 1980); therefore, one ten-year age group (40-49) was selected for comparison with the senescent age groups on this task. It was hypothesized that differences in word fluency exist between the age groups 40-49, 60-69, 70-79, and 80+. A study was undertaken in which additional normative data for the Word Fluency subtest of the WAB could be collected and analyzed for differences related to aging.

Method

Subjects

One hundred forty-one non-brain-damaged men and women participated in this study. Thirty-six men and 105 women in the age groups 40-49, 60-69, 70-79, and 80+ were randomly selected from hospital patients and visitors, seniors' organizations, and university academic and non-academic staff. The 80+ group had a mean age of 84.25 years, with a range from 80-98 years. Subjects included 80 Canadians and 61 Americans. All were native speakers of English and had sufficient hearing with or without aids to participate well in conversation. They had no self-reported or observable behaviors or symptoms of senility, confusion, or neurological disorder.

Procedure

An explanation of the procedure and a consent form was presented to each subject. Each subject was tested individually and verbally instructed by the examiner according to standardized instructions on the Word Fluency subtest of the WAB. Subjects' responses were timed, audiotape-recorded, and tallied on the response sheet by the examiner.

Table 1. Word fluency mean scores by age group.

Age group	N	Mean years education	Range	Mean Score	*SD*
80+	32	10.6	8-20	12.65	3.75
70-79	51	9.7	9-26	14.49	3.58
60-69	27	13.0	13-27	18.96	3.94
40-49	31	14.5	11-28	20.00	5.17

Reliability

Test-retest reliability was established by repeating the administration of the task to 10 randomly-chosen subjects within each age group within a 7-10 day period. Subjects were unaware of the nature of the retest prior to its administration.

Table 2. Analysis of variance summary table for age effects.

Source of Variation	*SS*	*df*	*Ms*	*F*	*P*
Age groups	1158.61	3	386.20	23.51	<0.0001
Within treatments	2200.92	134	16.424		

Analysis of Data

Data from this investigation consisted of individual raw scores from the WAB Word Fluency subtest. The data were then divided by age group and analyzed using a one-way analysis of variance for independent samples with an unequal N. Post-hoc analysis consisted of Duncan's New Multiple Range test.

Table 3. Word fluency mean scores by education group.

Education	N	Range	Mean Score	*SD*
>12 years	46	9-27	15.77	5.51
≤12 years	63	8-26	14.81	4.16

A one-tailed *t*-test for independent samples was used to determine the existence of a statistical difference between subjects with fewer than 12 years of education. Subjects in the 60-69, 70-79, and 80+ groups were pooled together for this analysis.

Test-retest reliability was determined using a Pearson Product Moment Correlation Coefficient. Further analysis to determine whether differences existed between and among age groups was completed using a two-way repeated measures design for the analysis of variance. Post-hoc analysis consisted of the Test of Simple Main Effects.

Results

Table 1 shows the mean scores by age group for subjects on the Word Fluency subtest of the WAB. Results of the analysis of variance and Duncan's New Multiple Range Test, shown in Table 2, indicated that a statistically significant difference was found between all groups with the exception that no difference was found between the 40-49 and 60-69 year olds and between the 70-79 and 80+ year olds. Therefore, it may be stated that older subjects produce fewer animal names in a one-minute time period than younger subjects.

Table 4. Analysis of variance summary table for test-retest differences.

Source of Variation	*SS*	*df*	*Ms*	*F*	*P*
(A) Age groups	368.44	3	122.81	2.52	0.0721
error (A)	1753.44	36	48.71		
(B) Test-retest	86.11	1	86.11	12.85	0.0013
A x B	112.21	3	37.38	5.58	0.0033
error (B)	241.25	36	6.70		

Table 5. Test of Simple Main Effects for test-retest.

Source of Variation	*SS*	*df*	*Ms*	*F*	*P*
B at A1 (80+)	80.00	1	80.00	11.940	0.01
B at A2 (70-79)	101.25	1	101.25	15.112	0.01
B at A3 (60-69)	9.80	1	9.80	1.463	NS
B at A4 (40-49)	7.20	1	7.20	1.075	NS
Residual	241.25	36	6.70		

Because years of education were not equal among the groups (see Table 1), education effects were analyzed using a *t*-test. Results showed education effects to be non-significant at the 0.05 level of confidence. Table 3 shows these data.

The test-retest reliability correlation coefficients were high and positive ranging from 0.742 to 0.808 for all groups with the exception of the 80+ year old group in which no correlation was found. There was extreme variability in the 80+ group with individual test-retest score differences ranging from -2 to +13. Correlations, however, only show relationships and do not demonstrate differences or changes in performance.

These differences were examined using a two-way repeated measures design for the analysis of variance and the post-hoc Test of Simple Main Effects. Table 4 shows the results of this analysis and indicates that there were statistically significant differences in test-retest scores and an age by test-retest interaction in the 70-79 and 80+ age groups.

Further analysis of the age and test-retest interaction was done using the Test of Simple Main Effects, which determined that a significant difference existed between test-retest scores for 70-79 and 80+ year old groups, but not for the 40-49 and 60-69 year old groups. Table 5 shows these data.

Discussion

The findings of this study support the hypothesis that differences exist among Word Fluency scores of the WAB in normal adults aged 40-49, 60-69, 70-79, and 80+. When comparing the mean scores of the 40-49 year olds to the 70-79 and 80+ year olds, and when comparing the mean scores of the 60-69 year olds to the 70-79 or 80+ year olds, a statistically significant difference was found. It appears that a critical period for a decrease in word fluency skills occurs after the 60-69 year age range.

These findings support those of Borod, Goodglass and Kaplan (1980) and MacDonald (1985), who found a decrease in semantic word fluency associated with increasing age. Borod, Goodglass, and Kaplan reported that 60 years was a critical period for a decrease in animal naming, whereas results from this investigation support a critical period after 60-69 years of age.

Older subjects may be more readily influenced by factors external to the task, such as physical status, fatigue, distractibility, or anxiety. Also, older age groups, 70-79 and 80+, may be adversely affected by the pressure of the time constraint imposed in this task. However, it is more likely that strategies for calling to mind subcategories of animals are not as easily accessed by the older age groups. Older subjects may have lower scores on the Word Fluency subtest of the WAB due to the nature of the changes in neural processing in senescence.

Welford (1965) presents four changes in the function of the central nervous system that influence psychomotor function in the elderly. The first change is a reduction in the total number of functional neuron cells that decreases signal strength and overall processing capacity. The second change is an increase in random neural activity that creates "noise" buildup during processing which may affect processing efficiency and speed. The third change is an increase in the after-effects of neural activity, which may cause a blurring of new signals and difficulty processing more recent messages. The fourth change is a diminished arousal and optimum activity level, which also may reduce signal strength and functional capacity.

These four changes appear to cause the elderly individual to process more slowly, have less overall capacity, and to have more difficulty "changing gears." It is likely that processing speed and the ability to shift from one subcategory of animals to another is what is responsible for lower scores in the 70-79 and 80+ age groups. Overall capacity is probably not a key issue in animal naming.

Education effects in the 60-69, 70-79, and 80+ age groups were found to be non-significant. This finding supports the results of Borod, Goodglass, and Kaplan (1980) that in normal adults animal naming in a one-minute time period is a semantic word fluency task uninfluenced by the amount of education.

The test-retest correlations for the 40-49, 60-69, and 70-79 year age groups were high and positive. For the 80+ year olds, however, there was no correlation and, indeed, the greatest amount of variability occurred on this group's test-retest scores.

The analysis of variance and the Test of Simple Main Effects demonstrate more clearly than do correlations what actually happened to the different age groups under the test-retest condition. It is notable that the 70-79 and 80+ groups improved on retest (both nine out of ten subjects) to the extent that it was statistically significant. These results support the earlier findings of a critical period following the 60-69 year age range on the age-effect analysis (see Table 6).

Table 6. Test-retest results.

Age Group	N	Mean Scores Test	Mean Scores Retest	Range of Test-Retest Differences	Number of Subjects Improved
80+	10	13.5	17.5	-2 to 13	9
70-79	10	14.8	19.3	-2 to 8	9
60-69	10	19.8	18.4	-7 to 4	3
40-49	10	20.6	21.8	-4 to 8	6

These results cannot be directly compared to those of Wertz, Shubitowski, Dronkers, Lemme, and Deal (1985), who found that normals improved on a test-retest reliability measure using four letters from Spreen and Benton's *Word Fluency Measure* (1969). However, this analysis does support Wertz et al. (1985) in that differences in performance on a test-retest task could not be shown by correlation coefficients alone.

The variability of performance on test-retest suggests a lack of stability of test-retest reliability for older subjects on a word fluency task. It may be that, for older subjects, retest may provide the individual with an opportunity to employ strategies not used on the initial test and thereby to benefit from repetition of the same task.

Clinical Implications

The results of this study suggest that the score of 20 set by Kertesz and Poole (1982) on the Word Fluency subtest of the WAB is appropriate for 40 and 60 year olds but may be an artificially high expectation of performance in 70 and 80+ year olds. If normal performance is considered to be within one standard deviation of the mean, then based on the current results the range of appropriate scores would be 9-16 for the 80+ age group and 11-18 for the 70-79 age group.

The improvement evidenced on the test-retest scores of the 70-79 and 80+ age groups would suggest that clinicians be cautious in interpreting an increase in scores over time as a result of the effect of therapy or spontaneous recovery. Since there is no reported data on which to base a suitable amount of lapse time after which practice effects are non-existent, a clinician must use discretion in interpreting the results of retests of word fluency.

Further research should be conducted using a larger sample and varied time interval on the test-retest condition. This would provide information with respect to the extent and limitations of the practice effect on word fluency. Once established, test-retest may then be used to aid in differential diagnosis of mild Alzheimer's, mild anomic aphasia, and normal aging. The current literature (Ober et al., 1986; Wertz et al., 1985) suggests that normals improve on letter and semantic category word fluency tasks in ways which brain-diseased or brain-damaged individuals do not.

Finally, further analysis of individual test forms should be made to determine the strategies that are most commonly used in animal naming by individuals in each age group. A comparison of strategies on the test-retest conditions of the 70-79 and 80+ age groups also may provide useful information to compare with aphasic or Alzheimer's patients' strategies on retest. The strategies found in these analyses should be valuable to the speech-language pathologist when choosing commonly used compensatory techniques for word finding.

The results of this study support the growing awareness of speech-language pathologists that normative data needs to be collected from the geriatric population in order that they be fairly assessed on adult tests of speech and language function. Particular concern needs to be paid to timed tasks in which geriatric performance may exhibit a natural decline.

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