Verbal fluency in older adults with low educational level: what is the role of executive functions and processing speed?

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Neuropsychological tests related to verbal fluency paradigms are among those most frequently used to assess executive functions in older adults. These tasks are quick and easy to administer and widely used for clinical assessment. However, despite their apparent simplicity, these tests involve different cognitive demands and are influenced by sociodemographic factors.[1] Two cognitive domains are particularly related to verbal fluency performance: executive functions and processing speed. Performance on these two cognitive domains declines with age and mediates the effect of other cognitive and demographic factors on verbal fluency scores.[2] The objective of the present report is to investigate the contribution of executive functions and processing speed on category fluency performance. We hypothesize that these two cognitive domains will be related to test performance, suggesting that verbal fluency may not be used as a unidimensional measure of executive functions.

Table 1 Regression models of verbal fluency test performance

Model	R^2	R^2 (change)	F	p-value	Variables	SE	SB	t	p-value
1	0.26	0.26	20.92	< 0.001	Formal education	0.061	0.515	4.574	< 0.001
2	0.37	0.11	16.58	< 0.001	Formal education	0.058	0.455	4.243	< 0.001
					Executive functions*	0.035	-0.326	-3.043	0.004
3	0.43	0.06	13.84	< 0.001	Formal education	0.063	0.323	2.765	0.008
					Executive functions*	0.034	-0.282	-2.689	0.009
					Processing speed†	0.091	-0.282	-2.378	0.021
4	0.48	0.05	12.93	< 0.001	Formal education	0.06	0.332	2.97	0.004
					Executive functions*	0.032	-0.291	-2.903	0.005
					Processing speed†	0.088	-0.321	-2.804	0.007
					Sex (female)	0.024	0.247	2.507	0.015

SB = standard beta; SE = standard error.
* Measured by the Five Digit Test reading time.
† Measured by the Five Digit Test shifting errors.

Sixty older adults (37 women), with a mean age (standard deviation) of 74.08 (6.51) years and a mean duration of formal schooling of 4.42 (2.60) years took part in this study. Inclusion criteria included a Mini-Mental State Examination (MMSE) score above the cutoff for cognitive impairment based on education,[3] a Geriatric Depression Scale score below the cutoff for depression, a Clinical Dementia Rating below 1, no history of psychiatric disorders according to a clinical interview, and no severe perceptual or motor impairments. The participants provided informed consent for participation, and the study was approved by the university's ethics committee (COEP-334/06).

The subjects completed a Category Fluency Test ("Fruits", duration = 1 minute) and the Five Digit Test,[4] a Stroop-like paradigm designed to avoid the effect of educational background. From this test, number-reading time (first test component) was used as a measure of processing speed, while errors on an inhibition/shifting task (fourth test component) were used as a measure of executive functions. Previous studies suggest this test is adequate for assessment of older adults.[5,6]

For statistical analyses, nonparametric data were normalized by logarithmic transformation. Partial correlations (controlling for age, gender, and education) were used to assess the relationship between cognitive measures. A stepwise multiple linear regression analysis assessed contributions of sociodemographic (age, education, and sex) and cognitive (executive functions and processing speed) factors on category fluency performance.

The mean five-digit reading time was 37.38 (14.18) seconds, and the mean number of five-digit shifting errors was 7.36 (7.19). Significant partial correlations were found between processing speed and category fluency ($r = -0.427$, $p < 0.001$) and executive functions and category fluency ($r = -0.368$, $p = 0.005$), but not between processing speed and executive functions ($r = 0.166$, $p = 0.217$). The MMSE total score was correlated with category fluency ($r = 0.402$, $p = 0.002$), executive functions ($r = -0.330$, $p < 0.012$), and processing speed ($r = -0.313$, $p = 0.018$). Geriatric Depression Scale scores were not associated with any cognitive measure (all $p > 0.05$). The stepwise regression model (Table 1) suggested four steps, with the best model involving formal education, executive functions, processing speed, and sex (female), explaining 48% of total test variance. Age was not a significant predictor ($p = 0.674$). Figure 1 shows the standardized predictors of verbal fluency performance. A competing model designed to compare the step 2 (education + executive functions) was built with education and processing speed. This competing model was significant ($F = 11.84$, $p < 0.001$, $R^2 = 27\%$), with education ($\beta = 0.278$, $p = 0.028$) and processing speed ($\beta = -0.360$, $p = 0.005$) as significant and independent predictors.

The results indicate that specific cognitive processes may contribute to verbal fluency test performance. In this sense, the test may be best suited as a general screening or global cognitive measure, and its adoption as a measure for executive functions must be approached cautiously, while estimating the effects of processing speed on test performance. Interestingly, age was not a significant predictor of performance in the model,

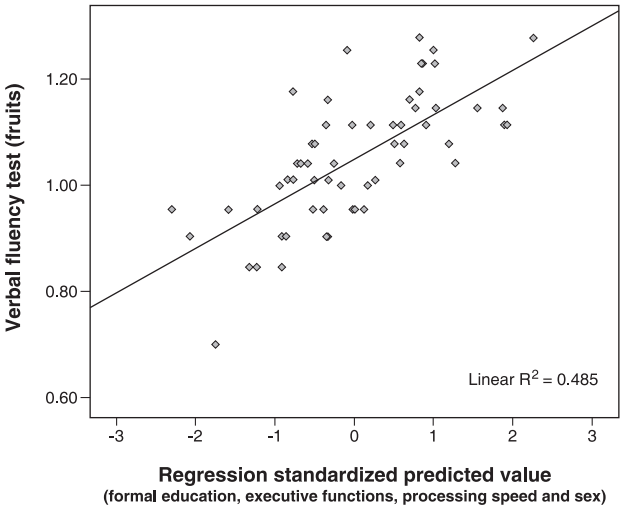

Figure 1 Scatterplot of predictors of verbal fluency test performance

contradicting previous studies[1]. We hypothesize that this may reflect the cognitive aging theory,[7] where age-related cognitive changes might be mediated by executive functions and processing speed, a pattern corroborated by our results. However, this hypothesis must be better investigated in larger and heterogeneous samples. Although the inclusion criteria minimize the risk of cognitively impaired participants, the present study did not use refined clinical or cognitive assessment to exclude other mild cognitive conditions, which may have influenced the results.

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Disclosure

The authors report no conflicts of interest.

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