# Category fluency test: effects of age, gender and education on total scores, clustering and switching in Brazilian Portuguese-speaking subjects

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#### **Abstract**

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Verbal fluency tests are used as a measure of executive functions and language, and can also be used to evaluate semantic memory. We analyzed the influence of education, gender and age on scores in a verbal fluency test using the animal category, and on number of categories, clustering and switching. We examined 257 healthy participants (152 females and 105 males) with a mean age of 49.42 years (SD = 15.75) and having a mean educational level of 5.58 (SD = 4.25)years. We asked them to name as many animals as they could. Analysis of variance was performed to determine the effect of demographic variables. No significant effect of gender was observed for any of the measures. However, age seemed to influence the number of category changes, as expected for a sensitive frontal measure, after being controlled for the effect of education. Educational level had a statistically significant effect on all measures, except for clustering. Subject performance (mean number of animals named) according to schooling was: illiterates, 12.1; 1 to 4 years, 12.3; 5 to 8 years, 14.0; 9 to 11 years, 16.7, and more than 11 years, 17.8. We observed a decrease in performance in these five educational groups over time (more items recalled during the first 15 s, followed by a progressive reduction until the fourth interval). We conclude that education had the greatest effect on the category fluency test in this Brazilian sample. Therefore, we must take care in evaluating performance in lower educational subjects.

#### **Key words**

- Verbal fluency
- Educational level
- Neuropsychological tests
- Category fluency

#### Introduction

Verbal fluency is a very useful test, which can be used to evaluate executive functions and language. The category test can be used to evaluate semantic memory. A number of versions of the category test based on letter and semantic categories have been used. The most extensive experience has been obtained with

FAS (oral fluency by letters F, A and S) and the animal category. Deficits in this task have been observed in patients with focal cortical brain lesions, mainly frontal injury (1-3), as well as temporal injury (3), Parkinson's disease (4), schizophrenia (5,6), and subcortical and Alzheimer dementia (7-12). Finally, the category fluency test seems to be more sensitive than the phonological test, even during the initial course

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of Alzheimer's disease, discriminating between early Alzheimer's disease and normal controls (13-16).

The population of Brazil is aging and current low literacy and educational levels continue to be problems hampering the correct evaluation of subjects with suspected cognitive impairment. However, normative data are needed for use in comparison with other studies, and descriptive analysis can help to understand cognitive processes in poorly educated individuals.

Many studies have revealed the influence of education on total scores (17-23). In a previous survey of a Brazilian sample based on educational level, we determined cut-off scores of 9 for illiterates and subjects aged <8 years, and of 13 for persons with more than 8 years of schooling (24). A differentiated cut-off must be used for each country. A subsequent analysis of preliminary data showed that other qualitative measures in the word fluency test are also influenced by education (25). Nitrini et al. (26) found a cut-off of 13 named animals for subjects with 4 to 16 years of education in a Brazilian sample, but only elderly individuals were included.

Our main hypothesis was that education may have an important influence on the quantitative and qualitative analysis of animal naming, which extends beyond the total scores observed in previous surveys. The specific goals are to investigate the effects of age (young to elder subjects), education and gender on animal naming, and to determine peculiarities in qualitative analysis specific for use in our environment.

# **Subjects and Methods**

We examined 257 healthy subjects with no memory complaints and Mini-Mental State Examination (MMSE) scores above the cut-off levels for education (27). The population, recruited at Santa Marcelina Hospital, included spouses, relatives, and subjects either waiting for appointments or from other clinics, along with hospital workers. We excluded subjects with motor limitations or uncorrected visual or hearing deficits that might influence their performance in tests, by means of both observation and a simple semi-structured questionnaire. The demographic characteristics of the sample used in the analysis are shown in Table 1. Distribution by gender was 152 females (59.14%) and 105 males. To assess the influence of education on the scores, we divided subjects into five groups on the basis of education as follows: illiterate (N = 34,13.2%); group 1: 1 to 4 years of schooling (N = 106, 41.2%); group 2: 5 to 8 years (N = 62, 24.1%); group 3: 9 to 11 years (N = 37,14.4%), and group 4: subjects with more than 11 years of education (N = 18, 7.0%). To determine the influence of age we divided the sample into three groups: young  $(\leq 50 \text{ years}, N = 135; 52.5\%)$ , adult (51 to 64) years, N = 68; 26.5%) and elderly subjects ( $\geq$ 65 years, N = 54; 21%). The groups did not differ in terms of age or education by gender, but educational level was different across age groups, with means of 6.5, 5.1, and 4.0 years of schooling, respectively, for young, adult and elderly individuals (F(2,254) =7,786; P = 0.0005).

Following the MMSE, we asked subjects to name animals over a period of 1 min, separating answers in four periods of 15 s. Analysis was based on the following definitions: a) total scores (number of animals named in 60 s); b) sub-scores (number of animals named in each 15-s interval); c) number of categories (naming animals representing a defined semantic subcategory of animals); d) category switching, and e) clustering. The categories utilized were: domestic/farm animals, wild animals, insects, fish, birds (other than domestic fowl, such as ducks or chickens), and reptiles. Repetitions within a subcategory were considered as one single answer. Category switching was scored when subjects named at least three elements of correlated semantic subcategories or members of well-defined category (4 farm animals, 1 wild animal, 3 insects, and 3 wild animals were considered to be three category changes); clustering was scored when subjects generated at least three consecutive animals of the same subcategory, with the possibility of repeating categories (3 farm animals, 3 wild animals, and 3 farm animals were considered to be three clusters). This classification was applied by the same examiner (SMDB) to all data following collection, and using the same procedure.

The animals named were analyzed to determine the role of education in the type of animals named, and to determine whether the prototype example would be the same across the educational groups.

### Statistical analysis

Analysis of variance (ANOVA) was performed to ascertain whether age, gender and education had a significant main effect on total category fluency scores, intervals, clustering, and switching. Main univariate effects and interaction terms were examined, with the adoption of a significant F at P < 0.05, and mean values were submitted to *post hoc* comparison by the Tukey test. Friedman analysis of variance was performed to compare the number of animals produced per 15-s interval for each educational level. The comparison between male and female subjects in the verbal fluency measures was analyzed by the Student *t*-test.

#### Results

Scores for all subjects are shown in Table 1.

#### Effect of age

The total number of animals generated, the number of categories, and the clustering and switching of categories were analyzed by ANOVA, with *post hoc* comparisons of the means by the Tukey test, when required.

We observed no significant difference between total 60-s scores or 15-s intervals. Qualitative analysis showed no difference in clustering, but there was a clear effect of age on number of categories (F(2,254) = 5.43; P = 0.0049) and switching (F(2,254)= 10.72; P = 0.00003). Post hoc comparisons showed that these differences occurred between young and elderly individuals in number of categories (P = 0.0195) and switching (P =0.0010), and again between young and adult subjects in switching (P = 0.0237). When we introduced educational level as a covariable, the difference only persisted in switching (F(2,252) = 5.61; P = 0.0041). In post hoc comparison these results were attributable to the young group, with P = 0.0004 when comparing young and elderly groups and P = 0.0135 when comparing adult and young groups. There was no difference between adult and elderly individuals, i.e., subjects more than 50 years of age presented the same behavior in the test.

#### Effect of gender

There was no difference in age or education according to gender, nor for total scores, number of categories, clustering, or switching. Male subjects mentioned slightly more items than females regarding total scores,

Table 1. Demographic characteristics of the 257 subjects of the study sample and verbal fluency test scores.

	Mean (SD)	Median	Minimum	Maximum	
Age (years)	49.42 (15.75)	50	16	88	
Education (years)	5.58 (4.25)	4	0	20	
MMSE scores	25.15 (3.30)	26	15	30	
Total scores	13.71 (4.18)	13	5	29	
Interval 1	5.79 (1.85)	6	1	13	
Interval 2	3.33 (1.59)	3	0	7	
Interval 3	2.54 (1.62)	2	0	9	
Interval 4	2.03 (1.45)	2	0	6	
Number of cluster	1.82 (0.94)	2	0	5	
Number of categories	3.16 (1.03)	3	1	6	

MMSE = Mini-Mental State Examination. Intervals 1, 2, 3, and 4 refer to the successive 15-s intervals of the test carried out in 1 min (total score). Cluster (group of same categories), category (group of similar subspecies or of similar environment animals).

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intervals 2, 3, 4 and number of clusters. However, this difference was significant only for interval 2 (t = -2.398, P < 0.017). These results are presented in Table 2.

#### Effect of education

Educational level significantly affected the total number of animals generated in the fluency tasks, and in the various intervals, as well as number of clusters, changes between categories and number of categories. All measures exhibited significant differences.

This influence persisted after group division by educational level, except for clustering. There were significant differences among the five educational level groups, whose values are presented in Table 3. *Post hoc* com-

Table 2. Comparison between male and female subjects in the verbal fluency measures.

	Femal	es	Males	Males		
	Mean (SD)	Median	Mean (SD)	Median		
Verbal fluency (total)	13.5 (3.73)	13	14.0 (4.76)	14		
Interval 1	5.87 (1.79)	6	5.69 (1.94)	6		
Interval 2	3.14 (1.42)	3	3.62 (1.79)*	4		
Interval 3	2.51 (1.51)	2	2.57 (1.76)	2		
Interval 4	1.97 (1.34)	2	2.10 (1.60)	2		
Cluster	1.81 (0.92)	2	1.84 (0.96)	2		
Category	3.18 (0.98)	3	3.13 (1.11)	3		
Switching	4.70 (2.42)	5	4.56 (2.69)	4		

<sup>\*</sup>P < 0.05 compared to females for interval 2 (Student t-test).

parison revealed significant differences between illiterates and groups 3 and 4 (>8 years of schooling), with P value of 0.0003 and 0.00007, respectively. Similarly, there was a difference between groups 1 and 2 (1 to 8 years of education) and groups 3 and 4 (>8 years). No difference was observed between groups 3 (9 to 11 years) and 4 (>11 years of education), or between illiterate subjects and group 1 (1 to 4 years) and group 2 (5 to 8 years). Similar results were encountered in post hoc analysis of number of categories, and switching between categories. A statistically significant difference in verbal fluency was observed between groups with less and more than 8 years of education.

# Interval analysis

The number of animals mentioned during each 15-s interval decreased with time (Table 3). This effect occurred in all education groups. The scores differed significantly between intervals in individual educational groups:  $\chi^2 = 54.290$ , P < 0.00001, for illiterates;  $\chi^2 = 179.341$ , P < 0.00001, for group 1;  $\chi^2 = 97.86$ , P < 0.00001, for group 2;  $\chi^2 = 58.178$ , P < 0.00001, for group 3;  $\chi^2 = 29.407$ , P < 0.00001, for group 4.

#### **Prototype examples**

The animals most frequently mentioned

	Illiterates	Group 1 (1-4 years of schooling)	Group 2 (5-8 years of schooling)	Group 3 (9-11 years of schooling)	Group 4 (more than 11 years of schooling)	F(4,249)	P value
Total	12.1 (3.0)	12.3 (3.1)	14.0 (3.8)	16.7 (4.2)	17.8 (6.6)	15.98	<0.00001
Interval 1	5.4 (1.5)	5.3 (1.6)	6.0 (2.1)	6.8 (1.9)	6.5 (1.9)	6.46	0.00006
Interval 2	2.8 (1.4)	3.1 (1.4)	3.4 (1.6)	3.7 (1.8)	4.3 (2.1)	3.58	0.0074
Interval 3	2.3 (1.3)	2.2 (1.4)	2.4 (1.5)	3.5 (1.7)	3.8 (2.0)	8.30	< 0.00001
Interval 4	1.7 (1.2)	1.7 (1.3)	2.1 (1.4)	2.6 (1.5)	3.1 (1.9)	6.33	0.00007
Number of clusters	1.7 (0.7)	1.7 (0.8)	1.8 (1.1)	1.8 (0.9)	2.2 (1.4)	1.13	0.3411
Number of categories	2.8 (0.8)	2.9 (0.9)	3.2 (0.8)	3.9 (1.1)	3.9 (1.2)	11.68	< 0.00001
Number of switching	3.6 (2.1)	4.0 (2.3)	4.7 (2.2)	6.1 (2.2)	7.0 (3.4)	11.77	< 0.00001

Data are reported as means (SD) for 257 subjects and were analyzed statistically by ANOVA.

were: dog (33%), cat (15.2%) and horse (13.2%). However, the frequencies of animals mentioned were different between educational groups: for illiterates, horse (35.5%) and dog (32.2%); for group 1, dog (31.1%) and cat (14.1%); for group 2, dog (37.1%) and cat (21%); for group 3: dog (37.8%) and lion (13.5%); for group 4: dog (27.8%) and cat (22.2%). Therefore, illiterates did not mention the same prototypical animal as the other groups. However, the dog was the animal most often mentioned as the first specimen when data were analyzed according to age group and gender.

#### **Discussion**

In the present study, animal fluency was associated with education, but not with age and gender. Male subjects generated slightly more items than females in terms of total scores and intervals 2, 3, 4, and in terms of number of clusters, with significance only in generation between 15 and 30 s. Similar findings were reported by Kempler et al. (21), in whose study men performed better than women. However, other studies have presented better performance by women in verbal fluency (14,20,23,28). Nevertheless, we failed to find a gender effect, as did our previous survey (24). Other studies have not found a gender effect, especially when results by gender were corrected for educational level (29).

The present survey is the first publication of qualitative data obtained with Portuguese-speaking Brazilian subjects. Reis and Castro-Caldas (30) reported similar findings regarding educational level in a study on the performance of illiterate women from a seaside community in Portugal. In the study by Reis and Castro-Caldas, given the same cultural, social, and economic environments, women without education performed worse in both phonemic and category fluency, thus showing that the achievement of illiterates, even at the semantic level, is worse than that of

literate individuals, in agreement with the results of the present study, which included males in the analysis.

Clustering and switching had never been described before in Brazil, except in a presentation by Caramelli et al. (31), which reported similar results, with subjects with more than 8 years of education performing better than illiterates, producing more items and clusters. Also noteworthy is the fact that our literate subjects did not outperform illiterates in clustering. We observed a global poverty of cluster production, with greater changing and numbers of categories among more educated people. We could not prove that these individuals generated more items in each subcategory until exhausting it before changing to another. Our results indicate that even though more educated individuals retrieve words systematically by searching for subcategories, they do not produce clusters.

Ratcliff et al. (19) observed a greater effect of education on initial sound fluency than on category fluency, although scores for animal and fruit fluency were also influenced by education. They emphasized the need for care when devising test batteries for use in different settings, and when interpreting results obtained from different subject groups.

The results of the present study indicate that age is not a predictor of fluency scores. Increasing age was not associated with lower scores, except for category changing, in agreement with the frontal hypothesis regarding aging, since it is well known that set shifting is a fine measure of frontal function. Since our age groups included different educational levels and the results clearly showed these interactions, we inserted education as a covariable to eliminate their confounding effect. Education is a strong factor, with educational achievement being associated with higher total category fluency scores and interval production, changing between categories, and number of categories. Less edu1776 S.M.D. Brucki and M.S.G. Rocha

cated subjects showed a more limited production in all measures, except for clustering, meaning that mental screening is poorer among individuals with less schooling. Kempler et al. (21) and Acevedo et al. (23) detected the influence of age and education in their studies.

Category fluency requires the systematic retrieval of hierarchically organized information from semantic memory, and content analysis of the verbal fluency performance of normal subjects has provided valuable insights into the structural organization of semantic categories. Apparently educational level facilitates this semantic access, seemingly enlarging the possibilities of repertoire of categories. This effect is more pronounced when comparing greatly differing educational levels, such as illiterates and subjects with lower educational levels, in contrast to those with more than 8 years of education, as demonstrated our results. Other studies have found similar performance, albeit in different languages: English, Spanish, Chinese, and Vietnamese (21,22,32). When performing any category fluency task, it is essential to access semantic stores: activation of an initial, and highly prototypical specimen leads to automatic activation of closely related semantic neighbors. If automatic activation fails, subjects can also use more active search strategies (33). Analogous findings were presented by other investigators related to interval production, with a decline over time. Maximal word retrieval occurred during the first 15 s for all subjects in both studies (34).

In a previous study, we observed the absence of a prototype specimen when analyzing subjects according to schooling and environment (35). The study in question revealed that illiterates mentioned the horse (41%) as a prototype animal in an urban environment while non-illiterates more often mentioned the dog (38%). It is worth noting that illiterates and non-illiterates in rural communities mentioned the jaguar (24.4%) and monkey (26%), respectively. The environment, besides education, appears to influence the animals named in that, as a rule, city samples mentioned a dog while rainforest communities mentioned a jaguar. In the present study, dog was the prototype specimen, except among illiterates. Moreover, we subscribe to the view that higher education leads to the retrieval of more animal types, whereas in illiterates the distribution of animals was poor, with the dog being generated as the first specimen by 32.2% of subjects and the horse by 35.5 and 60% of subjects. We believe that education influences semantic access to information, and this hypothesis has been corroborated by these two studies (Ref. 35 and present study).

These findings are important to gain a better understanding of cognitive functions in lower performance as a result of insufficient education in our population. More studies are needed to compare different Portuguese-speaking populations with respect to knowledge concerning patterns of semantic memory and executive functions in our environment.

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