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Verbal Fluency Tasks: Effects of Age, Gender, and Education

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Verbal fluency · Normative data · European Portuguese

Abstract
Objectives: This study presents data for semantic fluency, phonemic fluency, action fluency, and alternate fluency. The aim is to provide normative data by age, gender, and education for European Portuguese in each fluency category. ***Methods:*** Norms for the verbal fluency task were collected from a volunteer population of 444 healthy Portuguese participants. Multiple regression analysis with age, gender, and education as independent variables was performed for the semantic fluency global score, and these variables were considered separately for each phonemic category. ***Results:*** Age, education, and gender significantly affected the semantic global score, as well as scores of names, supermarket, kitchen objects, food, and clothes. No gender effect was observed in the categories "p-words," animals, transports, verbs, and alternating fluency. This last category was only influenced by years of education. ***Conclusions:*** Equivalent scores of verbal fluency tasks are useful in clinical practice, allowing the comparison between the normal and the abnormal performance of language disorders.

Introduction

Verbal fluency, as measured by the ability to generate words under time constraints, relies on the coordination of multiple brain areas, particularly the frontal and temporal lobes of the left hemisphere. There is evidence that different verbal fluency tasks involve different aspects of mental activity. Some literature points to the role of the frontal lobes in the retrieval of verbs, whereas the production of common and proper nouns is mediated primarily by posterior and anterior temporal regions, respectively [1–8]. Studies have shown that frontal lobe damage results in a disproportionate impairment of letter fluency, while temporal lobe damage impairs semantic fluency to a greater extent than letter fluency [9, 10]. Verbal fluency tasks are therefore submitted to people with executive function disorders due to brain injury and can also be found in psychiatric syndromes, semantic dementia, and Parkinson disease [11].

Normative data on semantic fluency are specific for each language and population and have been published for several languages. All studies followed the same methodology. Participants were asked to produce as many words as possible belonging to a given category over a period of 60 s for each category. All existing normative

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data for different languages have considered the effects of demographic variables such as age, education, and sex. For the Italian population, normative data have been collected by Novelli et al. [12], Spinnler and Tognoni [13], Capitani et al. [14], Costa et al. [15, 16], and Zarino et al. [17]. Apart from the Spanish and German studies [18, 19], it was found that education significantly affects fluency performance [20–22]. In the European Portuguese and English data, age also affected performance [20, 23, 24]. Findings are, however, somewhat inconsistent, most likely due to variance in both population sampling, the category of verbal fluency tasks, and analysis methods. A few studies suggest that age is of practically no relevance for the performance on phonemic and action fluency, whereas the level of education plays a significant role in all tests [21, 25, 26]. In most studies, gender is found to have little influence on verbal fluency production [21, 25, 26]. Other studies found that women perform better than men on phonemic and semantic tasks, depending on the categories are used [21, 25, 26]. Phonemic fluency is regarded as a measure of executive function because generating words on the basis of orthographic criteria is unusual, requiring the creation of strategies based on lexical representations. In addition, such a performance requires efficient organization of verbal retrieval and recall as well as self-monitoring aspects of cognition, self-initiation, and inhibition of responses when they are inappropriate. An emerging body of literature points to the prominent role of the frontal lobes in the retrieval of verbs. Findings from these studies suggest that action fluency is sensitive to the integrity of frontosubcortical neural circuitry and is a valid measure of executive and language functions [26]. Finally, alternating fluency tasks (switching between categories) have been introduced to put an additional load on executive functions and cognitive flexibility [11, 27].

Verbal fluency tests (phonological and semantic) are used in clinical assessment as measures of language performance in order to assess executive functions, lexical retrieval, and verbal production. Verbal fluency tasks are often included in neuropsychological and speech and language assessment, both in clinical practice and research. They have been used to support diagnoses of attention-deficit/hyperactivity disorder [28] and cognitive impairment in individuals with neurodegenerative diseases [29] and Parkinson disease [30]. Verbal fluency tasks have also been used in research to measure normal verbal ability including lexical knowledge and lexical retrieval [31, 32]. The use of the verbal fluency tasks stems in part from their validity as tests of both verbal ability and executive control as participants need to retrieve words of their mother language, requiring them to access their mental lexicon, to focus on the task, select words meeting certain constraints, and avoid repetition, which involves a complex executive control process. Thus, some deficits in either verbal ability or executive control should manifest themselves in poor performance in the fluency tasks. Therefore, the fluency tasks can be used as an efficient screening instrument of general verbal functioning [33] and as language training for patients with language and/or cognitive impairments in order to improve brain executive skills. The aim of this study was to provide data for 10 different verbal fluency tests of different kinds (phonemic, semantic, action, and alternating fluency) in a healthy sample of Portuguese citizens.

Table 1. Descriptive statistics and cutoff scores for the verbal fluency tests

	Mean	SD	Median	Mode	Cutoff
Semantic fluency category					
Total score	188.50	53.38	188.50	175.00	115.24
Names	26.55	8.46	26.00	26.00	15.96
Supermarket	25.61	9.52	26.00	25.00	11.11
Food	23.11	8.07	22.00	22.00	12.23
Animals	22.78	7.49	22.00	21.00	12.82
Kitchen	20.75	6.85	20.00	17.00	9.88
Clothes	19.69	6.30	20.00	20.00	11.27
Verbs	18.87	8.58	18.00	11.00	8.54
Cities, professions	16.99	7.04	17.00	18.00	6.88
P-words	14.35	6.47	14.00	18.00	5.27
Transports	14.15	5.09	14.00	12.00	6.85

Methods

This study was undertaken in a sample of 444 healthy Portuguese volunteers (202 were male). Participants were recruited from different sources, and they were living and educated in Portugal with European Portuguese as their mother language. Inclusion criteria were (1) a minimum age of 16 years; (2) absence of neurological or psychiatric diseases, no history of alcohol and/or drug abuse, and (3) absence of any diagnosed medical diseases that cause cognitive and or language disorder. Even without a known medical disease, the Portuguese version of the Mini-Mental State Examination [34] was used to screen for cognitive impairment in people aged 65 years and more. Participants' mean age was 49.14 years (range 16–97, SD = 23.14), and their mean education was 11.17 years (range 0–20, SD = 4.99). Participants were balanced for demographic variables (age, education, and sex) and divided into 8 groups according to age and 5 groups according to education. Participants did not receive any financial reimbursement or any other compensation.

Table 2. Correction grid for the verbal fluency semantic total score

Education, years/gender	Age, years							
	16–25	26–34	35–44	45–54	55–64	65–74	75–84	≥85
≤4								
M					51.74	61.33	69.11	84.10
F				29.78	35.26	42.75	53.23	61.94
Total				29.78	43.50	48.06	60.03	69.61
5–9								
M	–0.63	6.23	16.51	24.96	37.71	39.45	43.41	
F	–6.56	–10.58	1.42	7.46	21.02	21.73	31.32	32.52
Total	–1.62	–6.38	5.73	13.30	29.37	26.79	36.16	32.52
10–12								
M	–14.39	–8.80	–0.84	7.95	11.43	19.75	28.45	42.91
F	–30.87	–26.22	–3.64	–9.27	–3.05	5.66	10.33	
Total	–22.76	–18.18	–2.27	–0.66	2.74	16.62	20.21	42.91
13–16								
M	–29.48	–26.14	–21.75	–11.75	–4.57	0.82	10.51	
F	–45.98	–43.08	–34.92	–29.36	–18.15	–12.85	–10.35	
Total	–37.73	–32.49	–30.53	–22.75	–13.63	–6.02	7.04	
≥17								
M	–39.47	–39.74	–33.01	–27.54	–17.14		–2.93	
F	–54.87	–54.36	–52.56	–42.09	–45.64	–25.81	–18.90	
Total	–48.71	–46.32	–38.88	–39.18	–21.89	–25.81	–13.57	

Adjusted score = raw score – (–0.728 × [birth – 49.14]) – (4.82 × [years_of_education – 11.17]) – (16.33 × [gender – 0.55]).

Human data included in this paper was obtained in compliance with the Helsinki Declaration.

The method of administration of the tests was constant across participants both within the phonemic fluency test (letters by "p") and the semantic fluency test (names, supermarket objects, animals, kitchen objects, food, transports, and clothes), the action fluency test (verbs), and the alternating fluency test (cities/professions). A word repeated twice was counted only once. The total semantic score was represented by the total number of words produced for all categories except for the phonemic category that was separately analyzed.

Statistical Analyses

The associations between individual verbal fluency measures as well as the association between different background parameters and verbal fluency scores were examined using the Pearson linear correlation coefficients. Further statistical analysis and scoring followed the method developed by Capitani et al. [21, 25, 26] and later applied by Zarino et al. [21, 25, 26] to the Italian population. This method includes 5 steps: (1) multiple regression analyses were performed to evaluate the effect of age, education, and sex on verbal fluency tasks, separately and for the global score, different regression models were estimated using the raw scores of the independent variables but also their logarithmic, quadratic, and reciprocal transformations. The former showed the highest goodness of fit values; (2) independent variables with a significant effect were used to explain the variation in raw scores; (3) the fluency test scores were estimated according to the relative influence of those independent variables with a significant effect on the regressed model; (4) correction grid tables were then constructed to adjust, whenever necessary, the performance of each newly tested participant for the effect of age, education level, and gender; (5) finally, adjusted scores were also used to compute tolerance limits and were subsequently transformed into a 5-point scale. A first cutoff value was estimated. Scores equal to or lower than the cutoff score were considered pathological and were categorized as 0. Categories 1, 2, and 3 correspond to intermediate normal scores, and category 4 corresponds to a score better than the sample mean.

Results

The central tendency and dispersion measures for the 11 categories separately and semantic categories together, as well as the cutoff values are given in Table 1.

Linear multiple regression models with age, gender, and education as independent variables were estimated for the semantic fluency test global score (F [3, 444] =

Table 3. Correction grids for the category "p-words," "animals," "transports," and "verbs"

Education, years	Age, years							
	16–25	26–34	35–44	45–54	55–64	65–74	75–84	≥85
p-words								
≤4				3.91	4.28	4.88	5.60	6.53
5–9	0.09	0.22	1.19	1.63	2.74	2.61	3.09	3.18
10–12	–1.69	–1.37	–0.79	–0.21	0.12	0.60	1.15	2.51
13–16	–3.36	–3.23	–2.73	–2.32	–1.57	–1.34	–0.73	0.00
≥17	–4.45	–4.59	–4.31	–3.78	–3.34	–2.59	–2.13	0.00
Total	–2.26	–3.03	–2.00	–0.68	0.80	2.38	3.27	6.06
Adjusted score = raw score – (–0.049 × [birth – 49.14]) – (0.521 × [years_of_education – 11.17])								
Animals								
≤4				3.59	4.51	5.75	7.22	8.69
5–9	–2.45	–1.30	0.26	1.41	3.24	3.76	5.04	5.73
10–12	–3.69	–2.81	–1.36	–0.04	0.82	2.17	3.30	5.22
13–16	–5.01	–4.32	–3.29	–1.97	–0.51	0.47	1.57	0.00
≥17	–5.72	–5.47	–4.54	–3.23	–2.04	–0.61	0.52	0.00
Total	–4.14	–4.16	–2.54	–0.50	1.51	3.62	5.17	8.28
Adjusted score = raw score – (–0.121 × [birth – 49.14]) – (0.441 × [years_of_education – 11.17])								
Transports								
≤4				2.70	3.04	3.55	4.17	4.90
5–9	–0.31	–0.07	0.70	1.11	2.00	2.00	2.46	2.60
10–12	–1.48	–1.17	–0.64	–0.12	0.18	0.65	1.12	2.16
13–16	–2.60	–2.43	–2.00	–1.58	–0.95	–0.67	–0.18	
≥17	–3.31	–3.35	–3.06	–2.57	–2.15	–1.52	–1.10	
Total	–1.86	–2.29	–1.48	–0.45	0.67	1.85	2.57	4.58
Adjusted score = raw score – (–0.045 × [birth – 49.14]) – (0.354 × [years_of_education – 11.17])								
Verbs								
≤4				6.87	7.51	8.55	9.79	11.40
5–9	0.24	0.42	2.12	2.87	4.80	4.55	5.37	5.50
10–12	–2.92	–2.36	–1.37	–0.37	0.18	1.00	1.95	4.34
13–16	–5.85	–5.64	–4.78	–4.09	–2.79	–2.40	–1.35	
≥17	–7.77	–8.03	–7.57	–6.66	–5.89	–4.59	–3.81	
Total	–3.91	–5.28	–3.49	–1.20	1.39	4.14	5.68	10.57
Adjusted score = raw score – (–0.084 × [birth – 49.14]) – (0.917 × [years_of_education – 11.17])								

128, 721; $p < 0.0001$) and for each phonemic/semantic category: "p-words" ($F [3, 444] = 54.586$; $p < 0.0001$), "names" ($F [3, 444] = 108, 55$; $p < 0.0001$), "supermarket" ($F [3, 444] = 31, 852$; $p < 0.0001$), "animals" ($F [3, 444] = 78, 523$; $p < 0.0001$), "kitchen" ($F [3, 444] = 45, 360$; $p < 0.0001$), "food" ($F [3, 444] = 71.072$; $p < 0.0001$), "transports" ($F [3, 444] = 46, 462$; $p < 0.0001$), "clothes" ($F [3, 444] = 75, 242$; $p < 0.0001$), "verbs" ($F [3, 444] = 128, 969$; $p < 0.0001$) and "cities/professions" ($F [3, 444] = 46, 370$; $p < 0.0001$). Education showed a significant effect on all categories and also on the total score. Age had a significant and negative effect on all fluency tasks except on the alternate fluency test. Using a *t* test for independent samples, with gender as a grouping variable, significant gender effects on 5 tasks (names, supermarket, kitchen, food, and clothes) plus the semantic total score were found, with women performing better than men in all tasks. In the regression analysis, a slightly different result was found when the variables age and sex were entered as a co-effect: the effect of sex was not significant for the categories "p-words," "animals," "transports," and "verbs."

Tables 2–5 show the correction grids and equivalent scores for the total semantic fluency score (Table 2) and

Table 4. Correction grid for the category "clothes," "food," "kitchen," "names," and "supermarket"

Education, years	Age, years							
	16–25	26–34	35–44	45–54	55–64	65–74	75–84	≥85
Clothes								
≤4								
M					5.38	6.39	7.29	8.75
F				2.26	2.88	3.71	4.81	5.75
Total				2.26	4.13	4.47	5.87	6.79
5–9								
M	2.84	0.82	1.86	2.84	4.14	4.45	4.95	
F	0.19	−1.73	−0.49	0.19	1.61	1.80	2.86	3.09
Total	1.08	−1.09	0.18	1.08	2.87	2.56	3.70	3.09
10–12								
M	1.31	−0.58	0.29	1.31	1.74	2.67	3.62	5.06
F	−1.26	−3.15	−2.09	−1.26	−0.58	0.44	0.94	
Total	0.02	−1.96	−1.20	0.02	0.35	2.18	2.40	5.06
13–16								
M	−1.58	−2.11	−1.58	−0.48	0.38	0.96	1.97	
F	−3.80	−4.64	−3.80	−3.09	−1.94	−1.25	−0.92	
Total	−3.06	−3.06	−3.06	−2.11	−1.16	−0.15	1.49	
≥17								
M	−2.57	−3.33	−2.57	−1.93	−0.79	0.00	0.79	
F	−5.37	−5.65	−5.37	−4.23	−4.44	−2.43	−1.66	
Total	−3.41	−4.38	−3.41	−3.77	−1.40	−2.43	−0.84	
Adjusted score = raw score – (−0.082 × [birth – 49.14]) – (0.431 × [years_of_education – 11.17]) – (2.488 × [gender – 0.55])								
Food								
≤4								
M					6.83	8.07	9.18	11.01
F				2.79	3.55	4.58	5.94	7.11
Total				2.79	5.19	5.58	7.33	8.46
5–9								
M	0.11	1.14	2.44	3.64	5.26	5.62	0.87	
F	−2.00	−2.18	−0.64	0.20	1.95	2.18	0.82	3.76
Total	−0.24	−1.35	0.24	1.34	3.60	3.16	1.63	3.76
10–12								
M	−1.37	−0.62	0.45	1.71	2.23	3.39	0.34	6.35
F	−4.66	−3.98	−2.67	−1.65	−0.81	0.44	0.11	
Total	−3.04	−2.43	−1.50	0.03	0.41	2.73	1.84	6.35
13–16								
M	−3.06	−2.56	−1.90	−0.55	0.51	1.23	2.48	
F	−6.34	−5.86	−4.81	−3.95	−2.52	−1.69	−1.28	
Total	−4.70	−3.80	−3.84	−2.68	−1.51	−0.23	1.85	
≥17								
M	−4.14	−4.10	−3.15	−2.36	−0.96	0.00	0.99	
F	−7.29	−7.13	−6.80	−5.38	−5.68	−3.17	−2.21	
Total	−6.03	−5.46	−4.25	−4.78	−1.74	−3.17	−1.15	
Adjusted score = raw score – (−0.101 × [birth–49.14]) – (0.544 × [years_of_education – 11.17])– (3.253 × [gender – 0.55])								

Table 4 (continued)

Education, years	Age, years							
	16–25	26–34	35–44	45–54	55–64	65–74	75–84	≥85
Kitchen								
≤4								
M					4.267	5.091	5.750	7.05
F				0.885	1.352	1.991	2.891	3.64
Total				0.885	2.809	2.877	4.116	4.81
5–9								
M	–0.239	0.339	1.225	1.941	3.041	3.178	3.510	
F	–2.230	–2.604	–1.572	–1.057	0.108	0.158	0.976	1.07
Total	–0.571	–1.869	–0.773	–0.058	1.574	1.021	1.990	1.07
10–12								
M	–1.447	–0.970	–0.345	0.457	0.750	1.458	2.203	3.45
F	–4.360	–3.968	–3.147	–2.523	–1.991	–1.253	–0.853	
Total	–2.928	–2.584	–2.096	–1.033	–0.895	0.856	0.814	3.45
13–16								
M	–2.766	–2.486	–2.115	–1.261	–0.655	–0.193	0.640	
F	–5.683	–5.442	–4.740	–4.274	–3.310	–2.866	–2.658	
Total	–4.225	–3.594	–3.865	–3.144	–2.425	–1.530	0.090	
≥17								
M	–3.643	–3.673	–3.101	–2.638	–1.749		–0.536	
F	–6.464	–6.428	–6.281	–5.386	–5.706	–3.996	–3.407	
Total	–5.336	–4.913	–4.055	–4.837	–2.408	–3.996	–2.450	
Adjusted score = raw score – (–0.062 × [birth–49.14]) – (0.421 × [years_of_education – 11.17]) – (2.902 × [gender – 0.55])								
Names								
≤4								
M					5.35	7.04	8.81	10.94
F				2.37	3.53	5.04	6.91	8.57
Total				2.37	4.44	5.61	7.73	9.39
5–9								
M	–3.46	–1.70	–0.04	1.87	3.93	4.81	5.90	
F	–4.29	–3.59	–1.57	–0.29	2.06	2.73	4.67	5.35
Total	–3.60	–3.12	–1.13	0.43	2.99	3.32	5.16	5.35
10–12								
M	–4.61	–3.51	–1.78	0.02	0.94	2.70	4.37	6.57
F	–6.51	–5.36	–3.43	–1.86	–0.63	1.38	2.27	
Total	–5.57	–4.51	–2.81	–0.92	0.00	2.41	3.41	6.57
13–16								
M	–6.14	–5.26	–4.15	–2.16	–0.39	0.62	2.29	
F	–7.96	–7.04	–5.66	–4.12	–2.24	–0.73	0.06	
Total	–7.05	–5.93	–5.15	–3.38	–1.62	–0.05	1.92	
≥17								
M	–7.00	–6.70	–5.23	–3.96	–1.91	0.00	0.99	
F	–8.68	–8.23	–7.50	–5.44	–5.35	–2.18	–0.72	
Total	–8.00	–7.39	–5.91	–5.14	–2.49	–2.18	–0.15	
Adjusted score = raw score – (–0.154 × [birth – 49.14]) – (0.505 × [years_of_education – 11.17]) – ([3.253 × gender × 0.55])								

Table 4 (continued)

Education, years	Age, years							
	16–25	26–34	35–44	45–54	55–64	65–74	75–84	≥85
Supermarket								
≤4								
M					6.22	7.22	7.99	9.61
W				2.86	3.41	4.17	5.26	6.15
Total				2.86	4.82	5.04	6.43	7.35
5–9								
M	0.73	1.38	2.47	3.30	4.65	4.77	5.14	0.00
F	–0.89	–1.46	–0.20	0.40	1.82	1.83	2.81	2.88
Total	0.46	–0.75	0.56	1.37	3.23	2.67	3.74	2.88
10–12								
M	–0.84	–0.27	0.45	1.41	1.74	2.57	3.46	5.01
F	–3.64	–3.20	–2.22	–1.49	–0.85		0.48	
Total	–2.27	–1.85	–1.22	–0.04	0.18	2.00	2.11	5.01
13–16								
M	–2.54	–2.22	–1.80	–0.78	–0.09	0.46	1.48	
F	–5.35	–5.09	–4.24	–3.72	–2.54	–2.05	–1.83	
Total	–3.94	–3.30	–3.42	–2.62	–1.72	–0.79	0.93	
≥17								
M	–3.67	–3.74	–3.07	–2.53	–1.47		–0.04	
F	–6.37	–6.35	–6.21	–5.14	–5.59	–3.49	–2.80	
Total	–5.29	–4.91	–4.01	–4.62	–2.16	–3.49	–1.88	

Adjusted score = raw score – (–0.073 × [birth – 49.14]) – (0.539 × [years_of_education – 11.17]) – ([2,796 × gender × 0.55])

Table 5. Correction grid for the category "cities and professions"

Education, years	
≤4	5.31
5–9	2.08
10–12	–0.40
13–16	–2.78
≥17	–4.70
Total	0.00

Adjusted score = raw score – (0.671 × [years_of_education – 11.17]).

for each category (Tables 3–5) with the demographic variables that proved to be significant for each category.

Table 6 shows the classification grid of the adjusted score on a scale from 0 = pathological to 4 = better than average, for each category separately and for the total score.

To illustrate the use of the correction grids, we report a case of an 88-year-old female with 4 years of education living in a nursing home with no diagnosis of dementia. Nevertheless, some cognitive functions were decreasing and prevented her from carrying out some daily tasks without supervision (Table 7). Her total score was 69; a female with her age and education has a correction of +61.94, resulting in an adjusted total score of 130.94 and a final classification in category 1 (lowest normal). However, for categories "supermarket" and "names," this female is classified as abnormal.

Discussion

Normative data for semantic fluency were collected in order to complement and update the current European Portuguese normative data [20]. Furthermore, each category was analyzed separately in order to provide a tool to evaluate category-specific output. The standardization method proposed by Zarino et al. [17] was also used.

Table 6. Equivalent scores for each category

	Equivalent scores				
	0	1	2	3	4
Semantic fluency category					
p-words	≤5.27	5.28–8.29	8.30–11.32	11.33–14.34	≥14.35
Animals	≤12.82	12.83–16.13	16.14–19.44	19.45–22.76	≥22.77
Cities/professions	≤6.88	6.89–10.24	10.25–13.60	13.61–16.98	≥16.99
Clothes	≤11.27	11.28–14.07	14.08–16.88	16.89–19.69	≥19.70
Food	≤12.23	12.24–15.85	15.86–19.48	19.49–23.12	≥23.13
Kitchen	≤9.88	9.89–13.15	13.16–16.43	16.44–19.71	≥19.72
Names	≤15.96	15.97–19.47	19.48–22.98	22.99–26.51	≥26.52
Supermarket	≤11.11	11.12–15.92	15.93–20.75	20.76–25.57	≥25.58
Transports	≤6.85	6.86–9.27	9.28–11.71	11.72–14.14	≥14.15
Verbs	≤8.54	8.55–11.97	11.98–15.42	15.43–18.86	≥18.87
Total score	≤115.24	115.25–139.68	136.69–164.12	164.13–188.57	≥188.58

Table 7. How to classify a case report

	Test result (raw score)	Correction grid	Value (adjusted score)	Eq. score	N/A
Semantic fluency category					
p-words	4	653	1,053	2	N
Animals	6	869	1,469	1	N
Cities/professions	5	531	1,031	2	A
Clothes	10	575	1,575	2	N
Food	12	711	1,911	2	N
Kitchen	10	364	1,364	2	N
Names	7	857	1,557	0	N
Supermarket	4	615	1,015	0	A
Transports	6	490	1,090	2	N
Verbs	5	1,140	1,640	3	N
Total score	69	6,194	13,094	1	N

Eq., equivalent; N, normal; A, abnormal.

The present study revealed that, with the exception of alternating fluency, all categories were affected by age (a progressive age-related decrease in the number of generated words), as in previous studies [12, 13, 18–24, 35, 36]. Alternating fluency had a negative correlation with age as in other studies [11, 27]. In a healthy population such as the one in the present study, the effect of age probably disappears in the presence of years of education. Moreover, education affects all categories, a finding similar to what was found by other authors [12, 13, 18–23, 37–39]. Essentially, when an effect of education is found, the assumption is that education increases the individual's exposure to vocabulary. This reflects the fact that this performance is shared with cognitive abilities of auditory attention and articulation speed and is affected by the stored vocabulary. As in most previous studies, gender is found to have little influence on verbal fluency production. However, in the present study and in the studies by Capitani et al. [14] and Costa et al. [15, 16], women always performed better. However, when these 3 demographic variables are considered together, age and education have a much greater effect on fluency than gender. The study on Danish normative data with the same categories as the present study found a minor influence of the demographic background [40]. However, the former study was undertaken only for individuals aged 60 years or more. We found the average production of "supermarket" and "names" to be higher than the average production of the remaining categories. The lowest performance score was for "transports," probably due to a larger semantic representation of the first 2 categories. In our sample, the mean production of "animals" is 7 points higher than the one reported in Zarino et al. [17]. Normative data for lexical fluency are most often reported as scores on FAS and not for the single letters. It is therefore not possible to compare our data to those of previous studies. We found positive and significant correlations between all fluency tests. The majority of correlations were low to moderate. The category "animals" and "food" had the highest correlation, and "supermarket," "clothes," and "kitchen" the second highest. It has been hypothesized that alternating flu-

ency would draw on similar (executive) processes as action fluency and "p-words," but this assumption is not supported by the pattern of correlations in the present study. The results are in accordance with previous findings concerning age and education playing an important role on category-based performance. However, the existing fluency literature that has investigated age effects is inconsistent despite the number of researchers documenting that fluency performance is negatively related to ageing [8, 14, 24, 41, 42].

A significant effect of age and education was found in a previous standardization on the Portuguese population. It was observed that performance decreases with ageing, and education improves performance. In the present study, more fluency tasks were assessed with similar results. However, the results show that changes in the normal population profiles can affect performance (especially the number of years of education that have been increasing in Portugal in the last decades), and therefore it is necessary to update normative data.

Conclusions

The results from the present study provide norms for European Portuguese verbal fluency tests. By recruiting healthy individuals having a wide range of ages (16–95 years) and years of education (0–21), the present set of norms represents a substantial improvement over those previously available [20]. Evidence from a variety of sources shows that verbal fluency measures are sensitive to the effect of age, gender, and years of education. The present study confirms and extends these findings by showing that measures of phonemic and semantic verbal fluency are differentially sensitive to gender, age, and education. The major clinical utility of these norms is that they will increase the ability to determine more precisely the degree to which verbal fluency is impaired in patients of varying ages and educational levels. Moreover, the provision of norms for both phonemic and semantic fluency offers the additional advantage of determining if one type of verbal fluency is affected more than the other. Such a determination has been shown to be useful in making differential diagnoses.

The present study clearly underlines that the combination of different verbal fluency measures is a helpful tool when examining cognitive and language dysfunction. The pattern of impairment may be important to consider when language disorders are diagnosed. Taken together, the given norms are expected to assist professionals such as neuropsychologists and speech pathologists in the evaluation of language difficulties of adult European Portuguese speakers.

Limitations

One of the limitations of this study is the small number of observations per group. This implies that more data need to be collected in order to sustain the present results. Another limitation is that the levels of education are very low in the oldest groups, with no valid observations for those aged 85 years or more and with more than 12 years of education. This is a representative picture of the elders in current-day Portugal, but it will certainly change in the near future, meaning this study is a dynamic moving target.

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Disclosure Statement

The authors declare no conflicts of interest.

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