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Spanish Multicenter Normative Studies (NEURONORMA Project): Norms for Verbal Fluency Tests

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Abstract

Lexical fluency tests are frequently used in clinical practice to assess language and executive function. As part of the Spanish multicenter normative studies (NEURONORMA project), we provide age- and education-adjusted norms for three semantic fluency tasks (animals, fruit and vegetables, and kitchen tools), three formal lexical tasks (words beginning with P, M, and R), and three excluded letter fluency tasks (excluded A, E, and S). The sample consists of 346 participants who are cognitively normal, community dwelling, and ranging in age from 50 to 94 years. Tables are provided to convert raw scores to age-adjusted scaled scores. These were further converted into education-adjusted scaled scores by applying regression-based adjustments. The current norms should provide clinically useful data for evaluating elderly Spanish people. These data may also be of considerable use for comparisons with other international normative studies. Finally, these norms should help improve the interpretation of verbal fluency tasks and allow for greater diagnostic accuracy.

Keywords: Language tests; Vocabulary; Age factors; Demography; Educational status; Reference values

Introduction

The acquisition of normative data from the most widely used neuropsychological tests is one of the major objectives of the Spanish multicenter normative studies (NEURONORMA project). The characteristics of this study have been recently

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reported elsewhere (Peña-Casanova et al., 2009). This study represents the first multicenter Spanish project for the normalization and validation of neuropsychological instruments. In this paper, we provide normative data of nine verbal fluency (VF) tests: Three semantic (SVF) and six lexical (LVF) ones (three initial-letter [ILF] and three excluded-letter [ELF]).

Verbal fluency tasks supply data on verbal productivity, semantic memory, language, and executive function and are considered to be a sensitive measure of brain dysfunction (Ramier & Hécaen, 1970; Lezak, Howieson, & Loring, 2004). A large number of fluency tests have been proposed (*see* Lezak et al., 2004; Strauss, Sherman, & Spreen, 2006; Mitrushina, Boone, Razani, & D'Elia, 2005, for a review), and a series of neuropsychological batteries have included these kinds of tasks. The most common tests require the subject to name as many examples of a category as possible in a minute. In fact, the most frequently used tasks are semantic fluency (animals) and letter fluency (ILF) verbal tests.

Concerning ILF, Benton developed the first oral version of the controlled verbal fluency task (Borkowski, Benton, & Spreen, 1967), the later modification of which represents the controlled oral word association test (COWAT; Benton & Hamsher, 1989). Nowadays, a great number of different initial-letter tasks have been presented with no general agreement as to which is the most suitable. The most recent proposed VF version has been the ELF which requires patients to generate as many words as they can that do not contain certain letters. Shores, Carstairs, & Crawford (2006) provided the first normative data of this test in a group of young, healthy people.

The set test was one of the first instruments of SVF published (Isaacs & Kennie, 1973) and involved the generation items from four specific categories: Colors, animals, towns, and fruits. Later, other categories were proposed, such as fruits and vegetables, items found in a supermarket, foods, and first names (*see* Mitrushina et al., 2005, for a review).

The association of demographic factors and the performance in VF tasks have been reported in a large number of normative data studies. The significant effect of age and education in the scores is a general and consistent conclusion (Acevedo et al., 2000; Boone, Victor, Wen, Razani, & Ponton, 2007; Cauthen, 1978; Gladsjo et al., 1999; Ivnik, Malec, Smith, Tangalos, & Petersen, 1996; Kavé, 2005; Knight, McMahon, Green, & Skeaff, 2006; Loonstra, Tarlow, & Sellers, 2001; Lucas et al., 1998; Lucas et al., 2005). Specifically, Tombaugh, Kozak, and Rees (1999) reported that education was more significantly related than age in lexical fluency tasks, and age was associated more significantly with semantic fluency tasks. In contrast, Steinberg, Bieliauskas, Smith, Ivnik, and Malec (2005) found that the COWAT performance was more strongly related to WAIS-R IQ than to the years of education. In fact, the IQ effect on VF tests has been previously well-documented by other studies (Cauthen, 1978; Bolla, Lindgren, Bonaccorsy, & Bleecker, 1990). There is controversial evidence about the effect of sex. Tombaugh and colleagues (1999) reported no significant effect of sex in VF tasks and animal naming. However, other studies have found significant correlations between sex and VF performance (Acevedo et al., 2000; Capitani, Laiacona, & Basso, 1998; Capitani, Laiacona, & Barbarotto, 1999; Knight et al., 2006; Loonstra et al., 2001). In a metanorms published by Loonstra and colleagues (2001), the influence of sex in the COWAT test was clearly concluded. Capitani and colleagues (1998, 1999), however, reported sex differences only in specific categories of SVF (women performed better at naming fruits and men at naming tools) and a global female advantage in LVF tasks.

With regard to the effects of ethnicity in the scores of VF tests, some studies found a significant influence in performance (Boone et al., 2007; Gladsjo et al., 1999; La Rue, Romero, Ortiz, Liang, & Lindeman, 1999). Lucas and colleagues (2005) presented normative data from a group of Afro-Americans on a large number of neuropsychological tests. The Mayo Older African American normative studies (MOAANS project) were based on the hypothesis that specific norms from that particular ethnic group were necessary. However, other studies as, for example, Kempler, Teng, Dick, Taussig, and Davids (1998) found no differences in the impact of ethnicity on the general performance in VF tests, although other factors, such as language, must be considered.

Spanish neuropsychological batteries include VF tasks (Ardila, Rosselli, & Puente, 1994; Artiola, Hermosillo, Heaton, & Pardee, 1999; Peña-Casanova, 1990), and several studies of Spanish normative data have been proposed (Benito-Cuadrado, Esteba-Castillo, Bohm, Cejudo-Bolivar, & Peña-Casanova, 2002; Buriel, Gramunt, Bohm, Rodes, & Peña-Casanova, 2004; Carnero, Lendinez, Maestre, & Zunzunegui, 1999; Del Ser et al., 2004; Ramirez, Ostrosky-Solis, Fernandez, & Ardila-Ardila, 2005; Villodre et al., 2006). Some transcultural adaptations have been made to minimize language effects: For example, Artiola and colleagues (1999) proposed PMR as an ILF task instead of FAS. In addition, some studies compared VF performance between Hispanics and non-Hispanics or between bilingual Spanish–English samples (Acevedo et al., 2000; González et al., 2005; La Rue et al., 1999). More recently, Ostrosky-Solis, Gutierrez, Flores, and Ardila (2007) reviewed the most important Spanish normative data studies and proposed a standardized method of application of VF tasks to minimize the possible variability administration effect. In this last review, Ostrosky-Solis and colleagues (2007) compared the instructions of some normative data studies of VF in Spanish and found that administration and scoring criteria differences could explain the different normative data results more than a specific country effect.

Results of multiple studies underscore the need for appropriate normative data in the assessment of VF in older patients. The objective of this paper is to provide normative data for older adults on a series of VF measures allowing comparisons between these and other tests with NEURONORMA norms.

Table 1. Sample size by demographics

	Count	Percent of Total	MMSE Mean (*SD*)	MMSE-adj Mean (*SD*)
Age group				
50–56	75	21.68	29.31 (1.10)	29.13 (1.26)
57–59	50	14.45	28.92 (1.36)	29.16 (1.43)
60–62	34	9.83	28.65 (1.72)	28.82 (1.42)
63–65	18	5.20	28.78 (1.59)	29.22 (1.59)
66–68	26	7.51	28.96 (1.39)	29.46 (1.33)
69–71	49	14.16	29.22 (1.10)	29.43 (1.19)
72–74	31	8.96	28.52 (1.56)	28.94 (1.52)
75–77	30	8.67	28.07 (19.2)	29.27 (1.92)
78–80	21	6.07	27.90 (1.75)	29.43 (1.66)
>80	12	3.47	27.75 (2.22)	29.05 (2.06)
Education (years)				
≤5	73	21.10	27.97 (1.90)	29.16 (1.90)
6–7	23	6.65	27.17 (2.08)	28.52 (2.02)
8–9	66	19.08	29.08 (1.25)	30.05 (1.22)
10–11	40	11.56	28.82 (1.41)	28.98 (1.42)
12–13	35	10.12	29.23 (0.91)	29.20 (0.93)
14–15	33	9.54	29.36 (0.82)	29.45 (0.79)
≥16	76	21.97	29.41 (0.88)	28.66 (0.98)
Sex				
Men	139	40.17		
Women	207	59.83		
Total sample	346			

Notes: SD = standard deviation; MMSE = mini-mental state examination; MMSE-adj = mini-mental state examination adjusted (age and education) range 0–32 (Blesa et al., 2001).

Materials and Methods

Research Participants

Recruitment methods, sample characteristics, and other details of the NEURONORMA research project have been reported previously (Peña-Casanova et al., 2009). Briefly, NEURONORMA is an observational cross-sectional study performed in nine services of neurology in different Spanish regions. The study was conducted in accordance with the Declaration of Helsinki (World Medical Association, 1977) and its subsequent amendments, and the European Union regulations concerning medical research, and was approved by the Research Ethics Committee of the Municipal Institute of Medical Care of Barcelona, Spain. All participants were Caucasian and fluent in Spanish. An informant who knew the participant well and could answer questions about their cognition, function, and health was required. A total of 346 participants were studied. Basic demographic information is presented in Table 1.

Neuropsychological Measures

Semantic fluency tasks. Participants were asked to generate as many words as possible for three semantic categories: Animals, fruits and vegetables, and kitchen tools. Sixty seconds were allowed for each category. Instructions were given following the administration procedures provided in the manual of the Barcelona neuropsychological test (Peña-Casanova, 1991). The specific instruction was the following: “I am going to ask you to tell me all the names of animals you remember”, and the same for the other two categories. The examiner provided prompts if the participant gave no response over a 10-s period during each trial. The general scoring criteria were the following: Only correct answers were scored; intrusions or repeated attempts were not taken into account; and variations within the same specie or supra-ordinations were not counted if there was more than one representative of the class (e.g., if someone told “bird” and “canary”, only “canary” was counted as correct response). Concerning to the category kitchen tools, it is important to mention some specific instructions and scoring criteria. This category was translated to Spanish as “utensilios de cocina” and the command was the following: “I am going to ask you to tell as many tools that can be utilized specifically in the kitchen”. There were not taken into account the electrical appliances and tools which could be used in elsewhere.

Formal lexical tasks. Participants were asked to generate as many words as possible beginning with P, M, and R (fluency PMR). PMR was chosen instead of FAS because these letters are more appropriate for Spanish vocabulary (Artiola et al., 1999). In these tasks, it was indicated that personal names and variations in the same word should be avoided. The examiner provided prompts if the participant gave no response over a 10-s period during each trial. Sixty seconds were allowed for each task.

ELF tasks. Participants were asked to generate as many words as possible not containing a specific letter (Crawford, Wright, & Bate, 1995). Excluded letters were "A", "E", and "S". Sixty seconds were allowed for each excluded letter. Variations in the same word, intrusions, and repeated attempts were not taken into account. The examiner provided prompts if the participant gave no response over a 10-s period during each trial. Sixty seconds were allowed for each task.

Statistical Analysis

Considering that the ability to compare all co-normed test scores directly with each other facilitates clinical interpretation of neuropsychological test profiles, an uniform normative procedure was applied to all measures as in the MOANS studies (Ivnik et al., 1990, 1992; Lucas et al., 2005) and previous NEURONORMA studies (Peña-Casanova et al., 2009). Briefly, the procedure was the following: (a) The overlapping interval strategy (Pauker, 1988) was adopted to maximize the number of subjects contributing to the normative distribution at each midpoint age interval. Each midpoint age group provided norms for individuals of that age, plus or minus 1 year; (b) Coefficients of correlation (r) and determination (r^2) of raw scores with age, years of education, and sex were determined for each VF task; (c) To ensure a normal distribution, the frequency distribution of the raw score was converted into age-adjusted scaled scores, NSS_A (NEURONORMA scaled score age adjusted), as in the previous NEURONORMA studies. For each age rank, a cumulative frequency distribution of the raw scores was generated. Raw scores were assigned percentile ranks in function of their place within a distribution. Subsequently, raw scores were converted to scaled scores (from 2 to 18) based on percentile ranks. This transformation of raw scores to NSS_A produced a normalized distribution (mean = 10; $SD = 3$) on which linear regressions could be applied; (d) Years of education were modeled using the following equation: $NSS_A = k + (\beta \times \text{Educ})$. The resulting equations were used to calculate age- and education-adjusted NEURONORMA scaled scores ($NSS_{A\&E}$) for each test. The regression coefficient (β) from this analysis was used as the basis for education adjustments. The following formula outlined by Mungas, Marshall, Weldon, Haan, and Reed (1996) was employed: $NSS_{A\&E} = NSS_A - (\beta * [\text{Educ} - 12])$. The obtained value was truncated to the next lower integer; (e) To minimize the sex effect, the following equation was applied: $NSS_{A\&S} = NSS_A - (\gamma \times \text{sex})$. The resulting equation was used to calculate age- and sex-adjusted NEURONORMA scaled scores ($NSS_{A\&S}$). In this case, the regression coefficient (γ) from this analysis was used as the basis for sex adjustments.

Results

Age distribution of the sample made it possible to calculate norms for 10 midpoint age groups (Table 1). Sample sizes resulting from midpoint age intervals and socio-demographic characteristics of each group are presented in Table 1.

Correlations (Pearson's, r) and shared variance (determination coefficient, r^2) of VF tests scores with age (years), education (years), and sex are presented in Table 2. Age and education accounted significantly for the raw score variance for all measures,

Table 2. Correlations (r) and shared variances (r^2) of raw scores with age, years of education, and sex

Fluency Tests	Age (years)		Education (years)		Sex	
	r	r^2	r	r^2	r	r^2
Animals	−0.30760	0.09462	0.45709	0.20893	−0.10841	0.01175
Fruit and vegetables	−0.39490	0.15595	0.29073	0.08452	0.24278	0.05894
Kitchen tools	−0.33629	0.11309	0.17950	0.03222	0.34655	0.12010
Initial letter "P"	−0.37210	0.13846	0.52440	0.27500	−0.01915	0.00037
Initial letter "M"	−0.27782	0.07718	0.53615	0.28746	−0.06071	0.00369
Initial letter "R"	−0.27953	0.07814	0.53851	0.28999	−0.09007	0.00811
Excluded letter "A"	−0.33344	0.11118	0.56894	0.32369	−0.02225	0.00050
Excluded letter "E"	−0.33880	0.11479	0.55642	0.30960	0.02819	0.00079
Excluded letter "S"	−0.35185	0.12380	0.56622	0.32061	0.06102	0.00372

Table 3. Age-adjusted NEURONORMA scores (NSS_A) for age 50–56 (age range for norms = 50–60) corresponding to lexical fluency tests

Scaled Score	Percentile Range	Semantic			Phonological					
					Initial Letter			Excluded Letter		
		Animals	Fruits and Vegetables	Kitchen Tools	P	M	R	A	E	S
2	<1	0–10	0–9	0–7	0–4	0–1	0–1	0	0–1	0–1
3	1	—	—	—	5–6	—	—	—	—	2
4	2	11–12	10–11	—	7	2–4	—	—	2	3–4
5	3–5	13	—	8	8	5	2–4	1–2	3–4	5–6
6	6–10	14	12–13	—	—	6	5	3	—	7
7	11–18	15	14	9–10	9–10	7–8	6–7	4	5–6	8–9
8	19–28	16–17	15–16	11	11–12	9	8	5–6	8	10–11
9	29–40	18–19	17	12–13	13	10–11	9–10	7	9	12
10	41–59	20–21	18–19	14	14–17	12–13	11–13	8–9	10–11	13–15
11	60–71	22–23	20	15–16	18	14	14–15	10	12–13	16–18
12	72–81	24–26	21–22	—	19–20	15–16	16–17	11–12	14	19–20
13	82–89	27–29	23–24	17–18	21–22	17	18	13–14	15–16	21–23
14	90–94	30–31	25–26	19	23	18–20	19–22	15–16	17	24
15	95–97	32	27–28	20–21	24–27	21–22	23	17	18–20	25–26
16	98	—	29	22–24	28–29	23–24	24–25	18–19	21	27
17	99	33	—	—	30	—	26–28	20	22	28–29
18	>99	≥34	≥30	≥25	≥31	≥25	≥29	≥21	≥23	≥30
Sample size		135	135	135	135	135	135	135	135	135

Table 4. Age-adjusted NEURONORMA scores (NSS_A) for age 57–59 (age range for norms = 53–63) corresponding to lexical fluency tests

Scaled Score	Percentile Range	Semantic			Phonological					
					Initial Letter			Excluded Letter		
		Animals	Fruits and Vegetables	Kitchen Tools	P	M	R	A	E	S
2	<1	0–7	0–9	0–6	0–3	0–1	0–1	0	0–1	0
3	1	—	—	—	4	—	—	—	—	1
4	2	8–10	10–11	—	—	2–3	—	—	—	—
5	3–5	11–12	—	7–8	5–7	4	2–4	—	2–3	2–4
6	6–10	13–14	12–13	9	8	5	5	1–2	4–5	5–6
7	11–18	15	14–15	10	9–10	6–7	6	3–4	6	7–8
8	19–28	16–17	16	11	11–12	8–9	7–8	5	7	9–10
9	29–40	18	17	12	13	10	9–10	6	8	11–12
10	41–59	19–21	18–19	13–14	14–16	11–12	11–13	7–8	9–11	13–14
11	60–71	22–23	20	15	17–19	13–14	14–15	9–10	12	15–17
12	72–81	24–26	21	16	20	15	16–17	11–12	13–15	18–20
13	82–89	27–29	22–23	17–18	21	16–17	18	13–14	16–17	21
14	90–94	30–32	24–26	19	22–23	18–20	19–21	15–16	18–20	22–23
15	95–97	—	27–28	20–21	24–25	21–22	22–23	17–19	21	24–25
16	98	33	29	22	26	23	—	—	22	26–27
17	99	34	30	23–24	27–28	24	24	20	—	28–29
18	>99	≥35	≥31	≥25	≥29	≥25	≥25	≥21	≥23	≥30
Sample size		132	132	132	132	132	132	128	132	132

except kitchen tools (in which education does not have a significant effect). Sex differences were only observed in the naming of fruit and vegetables (5%) and kitchen tools (12%), indicating the need to control the sex effect in these two VF tests.

Age-adjusted NEURONORMA scaled scores (NSS_A) for each midpoint group are presented in Tables 3–12. To use the table correctly, select for each test the patient's raw score, and then refer to the corresponding NSS_A and percentile range (left part of the table).

As expected, the normative adjustments (NSS_A) eliminated the shared variance of age (Table 13). Education, in most of the VF tests (except for fruit and vegetables, and kitchen tools where shared variance <5%), continued to account for significant values of shared variance with age-adjusted test scores. In fact, education represented more than 15% variance in PMR tasks, in

Table 5. Age-adjusted NEURONORMA scores (NSS_A) for age 60–62 (age range for norms = 56–66) corresponding to lexical fluency tests

Scaled Score	Percentile Range	Semantic			Phonological					
					Initial Letter			Excluded Letter		
		Animals	Fruits and Vegetables	Kitchen Tools	P	M	R	A	E	S
2	<1	0–7	0–7	0–6	0–3	0–1	0–1	0	0–1	0
3	1	—	8	7	4	2–3	—	—	—	1
4	2	8–10	—	—	5	—	2–4	—	—	—
5	3–5	11	9–11	8	6	4	—	—	2–3	2–4
6	6–10	12–13	12	9	7–8	5	5	1–2	4	5
7	11–18	14	13–14	10	9	6	6	3	5	6–7
8	19–28	15–16	15–16	11	10	7–8	7	4	6	8–9
9	29–40	17–18	17	12	11–12	9	8–9	5–6	7–8	10–11
10	41–59	19–20	18–19	13–14	13–14	10–11	10–13	7–8	9–10	12–14
11	60–71	21–23	20	15	15–17	12–14	14	9	11–12	15–16
12	72–81	24–26	21	16	18–19	15	15–17	10	13–15	17–19
13	82–89	27–29	22–23	17	20–21	16	18	11–13	—	20
14	90–94	30–32	24–25	18	22	17–18	19–20	14–15	16–17	21–23
15	95–97	—	26–28	19	23	19–20	21–22	16–18	18	24–25
16	98	33	29	20	—	21–22	23	19	—	26–27
17	99	34	30	21–22	24	23–24	24	20	19–21	28
18	>99	≥35	≥31	≥23	≥25	≥25	≥25	≥21	≥22	≥29
Sample size		123	123	123	123	123	123	119	123	123

Table 6. Age-adjusted NEURONORMA scores (NSS_A) for age 63–65 (age range for norms = 59–69) corresponding to lexical fluency tests

Scaled Score	Percentile Range	Semantic			Phonological					
					Initial Letter			Excluded Letter		
		Animals	Fruits and Vegetables	Kitchen Tools	P	M	R	A	E	S
2	<1	0–7	0–7	0–6	0–4	0–3	0–2	0	0–1	0–1
3	1	8–10	8	—	5	—	—	—	—	—
4	2	—	—	7	—	4	3	—	—	2–4
5	3–5	11	9–11	8	6	5	—	—	2–3	—
6	6–10	12	12	—	7	—	4	1	—	5
7	11–18	13–14	13	9–10	8–9	6	5–6	2–3	4–5	6–7
8	19–28	15–16	14–15	11	10	7–8	7	4	6	8
9	29–40	17	16–17	12	11–12	9	8	5	7–8	9–10
10	41–59	18–20	18–19	13–14	13–15	10–12	9–11	6–8	9–10	11–14
11	60–71	21–22	20	15	16–17	13–14	12–14	9	11–12	15–16
12	72–81	23–24	21	—	18–19	15	15–16	10	13–15	17–19
13	82–89	25–26	22–23	16–17	20–21	16–17	17–18	11–13	16	20
14	90–94	27–30	24–25	18	—	18–19	19–21	14	17	21–23
15	95–97	—	26–27	19	22	20	22	15–16	18	24–26
16	98	31–33	28	20	23	—	23	17	—	27
17	99	34	30	21	24	21–22	24	18–19	19–21	28
18	>99	≥35	≥31	≥22	≥25	≥23	≥25	≥20	≥22	≥29
Sample size		107	107	107	107	107	107	103	107	107

all ELF tasks, and animals. With regard to sex, two categories account for significant values of shared variance with age-adjusted test scores (close to 5% in fruit and vegetables and 9% in kitchen tools).

The transformation of RS to NSS_A produces a normalized distribution on which linear regressions can be applied. Regression coefficients from this analysis were used as the basis for education corrections (Table 14). The resulting computational formulae were used to calculate $NSS_{A\&E}$. From these data, we have constructed adjustment tables (Tables 15–21) to help the clinician make the necessary adjustment. To use the tables, select the appropriate column corresponding to the patient's years of education, find the patient's NSS_A, and subsequently refer to the corresponding $NSS_{A\&E}$.

Table 7. Age-adjusted NEURONORMA scores (NSS_A) for age 66–68 (age range for norms = 62–72) corresponding to lexical fluency tests

Scaled Score	Percentile Range	Semantic			Phonological					
					Initial Letter			Excluded Letter		
		Animals	Fruits and Vegetables	Kitchen Tools	P	M	R	A	E	S
2	<1	0–7	0–6	0–6	0–3	0–3	0	0	0	0–1
3	1	8	7	—	—	—	—	—	—	2–4
4	2	—	—	—	4	—	—	—	—	—
5	3–5	9–11	8–9	7	5	4	1–3	1	1–3	5
6	6–10	12	10–11	8	6	5	4	2	4	6
7	11–18	13	12–13	9	7	6	5	3	—	7
8	19–28	14–15	14	10	8–9	7–8	6–7	4	5–6	8
9	29–40	16	15	11	10–11	9	8	5	7	9–10
10	41–59	17–19	16–18	12–13	12–14	10–12	9–11	6–7	8–9	11–12
11	60–71	20–21	19	14	15–16	13–14	12–14	8–9	10–11	13–14
12	72–81	22–23	20–21	15	17	15	15	10	12–13	15–17
13	82–89	24	22	16	18–19	16–17	16	11–12	14–15	18–20
14	90–94	25–27	23	17–18	20	18–19	17–18	13	16–17	—
15	95–97	28–29	24–25	19–20	21–22	20–21	19–21	14	18	21–24
16	98	—	26	—	23	—	—	15	19–20	25
17	99	30–33	27	21	24–25	22	22	16	21	26
18	>99	≥34	≥28	≥22	≥26	≥23	≥23	≥17	≥22	≥27
Sample size		121	121	121	121	121	121	118	121	121

Table 8. Age-adjusted NEURONORMA scores (NSS_A) for age 69–71 (age range for norms = 65–75) corresponding to lexical fluency tests

Scaled Score	Percentile Range	Semantic			Phonological					
					Initial Letter			Excluded Letter		
		Animals	Fruits and Vegetables	Kitchen Tools	P	M	R	A	E	S
2	<1	0–7	0–6	0–6	0–3	0–2	0	0	0	0
3	1	8	—	—	4	—	—	—	1	1–4
4	2	—	7–8	—	—	3	—	—	—	—
5	3–5	9–10	9	7	5	—	—	—	—	5
6	6–10	11	10	8	6	4	1–3	1	2–3	6
7	11–18	12–13	11–12	9	7	5–6	4–5	2	4	7
8	19–28	14	13	10	8–9	7	6	3	5–6	8
9	29–40	15–16	14–15	11	10	8–9	7–8	4	7	9
10	41–59	17–18	16	12	11–13	10–11	9–11	5–6	8–9	10–12
11	60–71	19–21	17–18	13–14	14–16	12–14	12–13	7–8	10	13–14
12	72–81	22–23	19–20	15	17	15	14–15	9–10	11–13	15–17
13	82–89	24	21	16	18–19	16–17	16	11	14–15	18–20
14	90–94	25–26	22–23	17–18	20–21	18	17–18	12–13	16	21
15	95–97	27–29	24–25	19–20	22–23	19–20	19–21	14	17–18	22–24
16	98	30	26	—	24	21	—	15	19	25
17	99	31–33	27	21	25	22	22	16	—	26
18	>99	≥34	≥28	≥22	≥26	≥23	≥23	≥17	≥20	≥27
Sample size		125	125	125	125	125	125	125	125	125

When that formula is applied to the NEURONORMA normative sample, the shared variances between demographically adjusted NEURONORMA scaled scores and years of education fall to $<1\%$.

Finally, sex adjustments ($NSS_{A\&S}$) were made to minimize the female advantage effect in two semantic categories: Fruit and vegetables, and kitchen tools. In a similar manner to the education adjustments, after transformations of raw scores in NSS_A, sex corrections could be applied ($\gamma = 1.24574$ for the fruit and vegetables' category, and $\gamma = 1.74961$ for the kitchen tools' task). To correctly apply the formula, 0 represents man and 1 represents woman to minimize the female advantage in these two semantic categories. Tables 22 and 23 are presented to help the clinician make the necessary sex adjustment.

Table 9. Age-adjusted NEURONORMA scores (NSS_A) for age 72–74 (age range for norms = 68–78) corresponding to lexical fluency tests

Scaled Score	Percentile Range	Semantic			Phonological					
					Initial Letter			Excluded Letter		
		Animals	Fruits and Vegetables	Kitchen Tools	P	M	R	A	E	S
2	<1	0–6	0–5	0–5	0–3	0–2	0	0	0	0
3	1	7	6	—	4	—	—	—	1	1–4
4	2	8	7	6	—	3	—	—	—	—
5	3–5	9–10	8	—	5	—	—	—	—	5
6	6–10	11	9	7–8	6	4	1–3	1	2–3	6
7	11–18	12–13	10–12	9	7	5	4–5	2	4	7
8	19–28	14	13	10	8–9	6–7	6	3	5–6	—
9	29–40	15–16	14	—	10	8	7–8	4	—	8
10	41–59	17–18	15–16	11–12	11–13	9–10	9–10	5–6	7–8	9–11
11	60–71	19–20	17	13	14–16	11–12	11–12	7	9–10	12
12	72–81	21–23	18	14	17	13–15	13–15	8–9	11–12	13–15
13	82–89	24	19–20	15–16	18–19	16–17	—	10	13–14	16–18
14	90–94	25–26	21	17–18	20–21	—	16	11–12	15	19–20
15	95–97	27–28	22–25	19–20	22–23	18–20	17–19	13–14	16–18	21–23
16	98	29	—	—	24	—	—	15	19	24
17	99	30	26	21	25	21	22	16	—	25
18	>99	≥31	≥27	≥22	≥26	≥22	≥23	≥17	≥20	≥26
Sample size		125	125	125	125	125	125	123	125	125

Table 10. Age-adjusted NEURONORMA scores (NSS_A) for age 75–77 (age range for norms = 71–81) corresponding to lexical fluency test

Scaled Score	Percentile Range	Semantic			Phonological					
					Initial Letter			Excluded Letter		
		Animals	Fruits and Vegetables	Kitchen Tools	P	M	R	A	E	S
2	<1	0–6	0–5	0–5	0–2	0–2	0	0	0	0
3	1	—	—	—	3	—	—	—	—	—
4	2	7	6	—	—	3	—	—	1	1–2
5	3–5	8–9	7	6	4	—	1–2	—	—	3–4
6	6–10	10	8–9	7	5–6	4	3	1	2	5
7	11–18	11–12	10	8	7	—	4	2	3	6
8	19–28	13	11–12	9	—	5–6	5	—	4	7
9	29–40	14–15	13	10	8–9	7	6–7	3–4	5–6	8
10	41–59	16–18	14–15	11	10–12	8–9	8–10	5	7	9–10
11	60–71	19	16–17	12	13	10–11	11–12	6	8	11
12	72–81	20–21	18	13	14–16	12–13	13–14	7–8	9–11	12–13
13	82–89	22–24	19	14–15	17–18	14–16	15	9–10	12–13	14–16
14	90–94	25–26	20–21	16–17	19	17	—	—	14–15	17–20
15	95–97	27	22–23	18–19	20	18–19	16	11–12	16–17	21–22
16	98	28	—	20	21	20	17	13–15	18	23
17	99	29	24–25	21	22–23	—	18–19	16	19	24
18	>99	≥30	≥26	≥22	≥24	≥21	≥20	≥17	≥20	≥25
Sample size		100	100	100	100	100	100	99	100	100

To use the tables correctly, select the appropriate column to the patient's sex, find the patient's NSS_A, and then refer to the corresponding $NSS_{A\&S}$.

Discussion

The purpose of this report is to provide normative and comprehensive data for older Spaniards for several VF tests. Age-adjusted normative data and regression-based adjustments for education and sex are presented. Some previous normative

Table 11. Age-adjusted NEURONORMA scores (NSS_A) for age 78–80 (age range for norms = 74–84) corresponding to lexical fluency tests

Scaled Score	Percentile Range	Semantic			Phonological					
					Initial Letter			Excluded Letter		
		Animals	Fruits and Vegetables	Kitchen Tools	P	M	R	A	E	S
2	<1	0–6	0–5	0–5	0–3	0–2	0	0	0	0
3	1	—	6	—	4	3	—	—	—	1–2
4	2	—	—	—	—	—	—	—	—	—
5	3–5	7–8	7	6	—	—	2	—	—	3–4
6	6–10	9–11	8–9	7	5–6	4	3	1	1–2	5
7	11–18	—	10	8	—	5	4	2	3–4	—
8	19–28	12–13	11–12	9	7	—	5–6	3	—	6–7
9	29–40	14	—	—	8	6	7	—	5–6	8
10	41–59	15–17	13–14	10	9–10	7–8	8–9	4	7	9
11	60–71	18	15	11	11–13	9–10	10–11	5	8	10–11
12	72–81	19–20	16–17	12	14	11	12	6–7	9	12
13	82–89	21	—	13	15–18	12–14	13	8	10–11	13–14
14	90–94	22–25	18	14–15	19	—	14–15	9–10	12–13	15–17
15	95–97	26–27	—	16	20	15–17	16	11–12	14–16	18–21
16	98	—	19	17–18	—	18	17	13	17	22
17	99	—	—	—	—	—	—	—	—	—
18	>99	≥28	≥20	≥19	≥21	≥19	≥18	≥14	≥18	≥23
Sample size		65	65	65	65	65	65	63	65	65

Table 12. Age-adjusted NEURONORMA scores (NSS_A) for age 81–90 (age range for norms = 77–90) corresponding to lexical fluency tests

Scaled Score	Percentile Range	Semantic			Phonological					
					Initial Letter			Excluded Letter		
		Animals	Fruits and Vegetables	Kitchen Tools	P	M	R	A	E	S
2	<1	0–7	0–6	0–4	0–3	0–2	0	0	0	0
3	1	—	—	—	—	—	—	—	—	—
4	2	8	—	5	4	3	—	—	—	1–2
5	3–5	9	7	6	5	4	2	—	—	3–4
6	6–10	10–12	8	7	6	—	3	1	2	—
7	11–18	—	9	—	—	—	—	2	3	5
8	19–28	12–13	10–11	8	7	5	4–6	—	4	6
9	29–40	14	12	9	8	6	7	3–4	5	7
10	41–59	15–16	13	10	9	7–8	8–9	5	6	8–9
11	60–71	17–18	14–15	11	10–12	9–10	10	6	7	10
12	72–81	—	16	—	13–14	11	11	7–8	8	11–12
13	82–89	19	17	12	15	12	12–13	9–10	9	13
14	90–94	20	18	—	17–18	13	—	—	10	14
15	95–97	—	—	13	—	14	—	11–12	11–12	—
16	98	21–22	19	14	—	15–16	14	13–15	—	15–16
17	99	—	—	—	—	—	—	16	—	—
18	>99	≥23	≥20	≥15	≥19	≥17	≥15	≥17	≥13	≥17
Sample size		42	42	42	42	42	42	40	42	42

data studies have discussed the problems associated with using normative data from different sources, especially in verbal cognitive tests (Kempler et al., 1998). Therefore, using data from the same population sample reduces the risk of misinterpretation of neuropsychological performances and increases the reliability of the cognitive diagnosis. This study differs from a previous MOANS study (Lucas et al., 1998) in which the number of correct responses for two fluency semantic categories (animals, fruit and vegetables) was summed up to obtain a final total score.

This study has three important points to be commented on. On the one hand, this is the first normative data study that presents data from the same sample on a wide set of VF tasks (three SVF, three ILF, and three ELF). On the other hand, no norms have previously been reported for ELF test in Spanish. Finally, our normative sample includes a wide range of educational levels and provides age- and education-based adjustments.

Table 13. Correlations (r) and shared variance (r^2) of NEURONORMA subtest scores with age, years of education, and sex after age adjustment (NSS_A)

Fluency Tests	Age (years)		Education (years)		Sex	
	r	r^2	r	r^2	r	r^2
Animals	−0.01662	0.000276	0.40110	0.160881	−0.17263	0.029801
Fruit and vegetables	−0.05144	0.002646	0.18943	0.035884	0.21217	0.045016
Kitchen tools	−0.03784	0.001432	0.08505	0.007234	0.30594	0.093599
Initial letter “P”	−0.02539	0.000645	0.43289	0.187394	−0.08025	0.006440
Initial letter “M”	−0.01374	0.000189	0.47980	0.230208	−0.12015	0.014436
Initial letter “R”	−0.02803	0.000786	0.47385	0.224534	−0.18177	0.033040
Excluded letter “A”	−0.00732	0.000053	0.51395	0.264145	−0.12327	0.015195
Excluded letter “E”	−0.02216	0.000491	0.50411	0.254127	−0.02348	0.000551
Excluded letter “S”	−0.02838	0.000805	0.50046	0.250460	−0.00750	0.000056

Table 14. Computational formulae for age and education corrected NEURONORMA scaled scores: β values

Fluency Tests	β
Animals	0.20588
Initial letter “P”	0.22078
Initial letter “M”	0.24352
Initial letter “R”	0.24088
Excluded letter “A”	0.25483
Excluded letter “E”	0.25448
Excluded letter “S”	0.25277

Table 15. Animals. Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times (Education_{(years)} - 12))$, where $\beta = 0.20588$

NSS_A	Education (years)																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	4	4	4	3	3	3	3	3	2	2	2	2	2	1	1	1	1	0	0	0	0
3	5	5	5	4	4	4	4	4	3	3	3	3	3	2	2	2	2	1	1	1	1
4	6	6	6	5	5	5	5	5	4	4	4	4	4	3	3	3	3	2	2	2	2
5	7	7	7	6	6	6	6	6	5	5	5	5	5	4	4	4	4	3	3	3	3
6	8	8	8	7	7	7	7	7	6	6	6	6	6	5	5	5	5	4	4	4	4
7	9	9	9	8	8	8	8	8	7	7	7	7	7	6	6	6	6	5	5	5	5
8	10	10	10	9	9	9	9	9	8	8	8	8	8	7	7	7	7	6	6	6	6
9	11	11	11	10	10	10	10	10	9	9	9	9	9	8	8	8	8	7	7	7	7
10	12	12	12	11	11	11	11	11	10	10	10	10	10	9	9	9	9	8	8	8	8
11	13	13	13	12	12	12	12	12	11	11	11	11	11	10	10	10	10	9	9	9	9
12	14	14	14	13	13	13	13	13	12	12	12	12	12	11	11	11	11	10	10	10	10
13	15	15	15	14	14	14	14	14	13	13	13	13	13	12	12	12	12	11	11	11	11
14	16	16	16	15	15	15	15	15	14	14	14	14	14	13	13	13	13	12	12	12	12
15	17	17	17	16	16	16	16	16	15	15	15	15	15	14	14	14	14	13	13	13	13
16	18	18	18	17	17	17	17	17	16	16	16	16	16	15	15	15	15	14	14	14	14
17	19	19	19	18	18	18	18	18	17	17	17	17	17	16	16	16	16	15	15	15	15
18	20	20	20	19	19	19	19	19	18	18	18	18	18	17	17	17	17	16	16	16	16

In a similar manner to other NEURONORMA reports, to help clinicians NSS_A were adjusted to $NSS_{A\&E}$ using a table resulting from the application of a computational formula. In this table, scores were rounded to an integer. In the case of very extreme scores (e.g., a person with one year of education and a NSS_A of 18, or a person of 20 years of education and a NSS_A of 2), the resulting adjustment may be placed beyond the defined scaled score ranges (e.g., 21 or −1). In these extreme cases, the final score should be 18 or 2, respectively.

As in all normative studies, the validity of these norms is clearly dependent upon the similarity between the characteristics of the studied subject and the demographic features of the NEURONORMA normative samples. Therefore, as other similar studies have concluded, it would not be accurate to use this computational formula with younger individuals due to the different impact of the demographic variables on the cognitive performance across the life span (Lucas et al., 2005). Regarding to the use

Table 16. Initial letter P. Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times (Education_{(years)} - 12))$, where $\beta = 0.22078$

NSS_A	Education (years)																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	4	4	4	3	3	3	3	3	2	2	2	2	2	1	1	1	1	0	0	0	0
3	5	5	5	4	4	4	4	4	3	3	3	3	3	2	2	2	2	1	1	1	1
4	6	6	6	5	5	5	5	5	4	4	4	4	4	3	3	3	3	2	2	2	2
5	7	7	7	6	6	6	6	6	5	5	5	5	5	4	4	4	4	3	3	3	3
6	8	8	8	7	7	7	7	7	6	6	6	6	6	5	5	5	5	4	4	4	4
7	9	9	9	8	8	8	8	8	7	7	7	7	7	6	6	6	6	5	5	5	5
8	10	10	10	9	9	9	9	9	8	8	8	8	8	7	7	7	7	6	6	6	6
9	11	11	11	10	10	10	10	10	9	9	9	9	9	8	8	8	8	7	7	7	7
10	12	12	12	11	11	11	11	11	10	10	10	10	10	9	9	9	9	8	8	8	8
11	13	13	13	12	12	12	12	12	11	11	11	11	11	10	10	10	10	9	9	9	9
12	14	14	14	13	13	13	13	13	12	12	12	12	12	11	11	11	11	10	10	10	10
13	15	15	15	14	14	14	14	14	13	13	13	13	13	12	12	12	12	11	11	11	11
14	16	16	16	15	15	15	15	15	14	14	14	14	14	13	13	13	13	12	12	12	12
15	17	17	17	16	16	16	16	16	15	15	15	15	15	14	14	14	14	13	13	13	13
16	18	18	18	17	17	17	17	17	16	16	16	16	16	15	15	15	15	14	14	14	14
17	19	19	19	18	18	18	18	18	17	17	17	17	17	16	16	16	16	15	15	15	15
18	20	20	20	19	19	19	19	19	18	18	18	18	18	17	17	17	17	16	16	16	16

Table 17. Initial letter M. Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times (Education_{(years)} - 12))$, where $\beta = 0.24352$

NSS_A	Education (years)																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	4	4	4	4	3	3	3	3	2	2	2	2	2	1	1	1	1	0	0	0	0
3	5	5	5	5	4	4	4	4	3	3	3	3	3	2	2	2	2	1	1	1	1
4	6	6	6	6	5	5	5	5	4	4	4	4	4	3	3	3	3	2	2	2	2
5	7	7	7	7	6	6	6	6	5	5	5	5	5	4	4	4	4	3	3	3	3
6	8	8	8	8	7	7	7	7	6	6	6	6	6	5	5	5	5	4	4	4	4
7	9	9	9	9	8	8	8	8	7	7	7	7	7	6	6	6	6	5	5	5	5
8	10	10	10	10	9	9	9	9	8	8	8	8	8	7	7	7	7	6	6	6	6
9	11	11	11	11	10	10	10	10	9	9	9	9	9	8	8	8	8	7	7	7	7
10	12	12	12	12	11	11	11	11	10	10	10	10	10	9	9	9	9	8	8	8	8
11	13	13	13	13	12	12	12	12	11	11	11	11	11	10	10	10	10	9	9	9	9
12	14	14	14	14	13	13	13	13	12	12	12	12	12	11	11	11	11	10	10	10	10
13	15	15	15	15	14	14	14	14	13	13	13	13	13	12	12	12	12	11	11	11	11
14	16	16	16	16	15	15	15	15	14	14	14	14	14	13	13	13	13	12	12	12	12
15	17	17	17	17	16	16	16	16	15	15	15	15	15	14	14	14	14	13	13	13	13
16	18	18	18	18	17	17	17	17	16	16	16	16	16	15	15	15	15	14	14	14	14
17	19	19	19	19	18	18	18	18	17	17	17	17	17	16	16	16	16	15	15	15	15
18	20	20	20	20	19	19	19	19	18	18	18	18	18	17	17	17	17	16	16	16	16

of these norms in other Spanish populations, we consider that the data of this study could be used to assess Spanish-speaking subjects from different countries. In this field, a meta-analysis concluded that educational level and age influenced in SVF tests more than the country of origin (Ramirez et al., 2005; Ostrosky-Solis et al., 2007). In other words: The SVF test yields similar data from one Spanish-speaking country to another provided that the subjects' age and education are taken into account (Ramirez et al., 2005).

The age effect on the VF tests scores is clearly found in the nine VF tests studied. Our results confirm that the performance of elderly people was significantly lower than younger healthy controls and, therefore, agree with previous studies conclusions about the influence of aging on VF ability (Acevedo et al., 2000; Boone et al., 2007; Cauthen, 1978; Gladsjo et al., 1999; Ivnik et al., 1996; Kavé, 2005; Knight et al., 2006; Loonstra et al., 2001; Lucas et al., 1998; Lucas et al., 2005). A major age effect in semantic fluency tasks than in lexical ones was not clearly found. Our findings are in line with the reported by others (Kosmidis, Vlahou, Panagiotaki, & Kiosseoglou, 2004) but not comparable with those who find the differential effect of age on semantic and lexical tasks (Gladsjo et al., 1999; Kavé, 2005; Tombaugh et al., 1999).

Table 18. Initial letter R. Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times (Education_{(years)} - 12))$, where $\beta = 0.24088$

NSS_A	Education (years)																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	4	4	4	4	3	3	3	3	2	2	2	2	2	1	1	1	1	0	0	0	0
3	5	5	5	5	4	4	4	4	3	3	3	3	3	2	2	2	2	1	1	1	1
4	6	6	6	6	5	5	5	5	4	4	4	4	4	3	3	3	3	2	2	2	2
5	7	7	7	7	6	6	6	6	5	5	5	5	5	4	4	4	4	3	3	3	3
6	8	8	8	8	7	7	7	7	6	6	6	6	6	5	5	5	5	4	4	4	4
7	9	9	9	9	8	8	8	8	7	7	7	7	7	6	6	6	6	5	5	5	5
8	10	10	10	10	9	9	9	9	8	8	8	8	8	7	7	7	7	6	6	6	6
9	11	11	11	11	10	10	10	10	9	9	9	9	9	8	8	8	8	7	7	7	7
10	12	12	12	12	11	11	11	11	10	10	10	10	10	9	9	9	9	8	8	8	8
11	13	13	13	13	12	12	12	12	11	11	11	11	11	10	10	10	10	9	9	9	9
12	14	14	14	14	13	13	13	13	12	12	12	12	12	11	11	11	11	10	10	10	10
13	15	15	15	15	14	14	14	14	13	13	13	13	13	12	12	12	12	11	11	11	11
14	16	16	16	16	15	15	15	15	14	14	14	14	14	13	13	13	13	12	12	12	12
15	17	17	17	17	16	16	16	16	15	15	15	15	15	14	14	14	14	13	13	13	13
16	18	18	18	18	17	17	17	17	16	16	16	16	16	15	15	15	15	14	14	14	14
17	19	19	19	19	18	18	18	18	17	17	17	17	17	16	16	16	16	15	15	15	15
18	20	20	20	20	19	19	19	19	18	18	18	18	18	17	17	17	17	16	16	16	16

Table 19. Excluded letter A. Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times (Education_{(years)} - 12))$, where $\beta = 0.25483$

NSS_A	Education (years)																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	5	4	4	4	4	3	3	3	3	2	2	2	2	1	1	1	0	0	0	0	−1
3	6	5	5	5	5	4	4	4	4	3	3	3	3	2	2	2	1	1	1	1	0
4	7	6	6	6	6	5	5	5	5	4	4	4	4	3	3	3	2	2	2	2	1
5	8	7	7	7	7	6	6	6	6	5	5	5	5	4	4	4	3	3	3	3	2
6	9	8	8	8	8	7	7	7	7	6	6	6	6	5	5	5	4	4	4	4	3
7	10	9	9	9	9	8	8	8	8	7	7	7	7	6	6	6	5	5	5	5	4
8	11	10	10	10	10	9	9	9	9	8	8	8	8	7	7	7	6	6	6	6	5
9	12	11	11	11	11	10	10	10	10	9	9	9	9	8	8	8	7	7	7	7	6
10	13	12	12	12	12	11	11	11	11	10	10	10	10	9	9	9	8	8	8	8	7
11	14	13	13	13	13	12	12	12	12	11	11	11	11	10	10	10	9	9	9	9	8
12	15	14	14	14	14	13	13	13	13	12	12	12	12	11	11	11	10	10	10	10	9
13	16	15	15	15	15	14	14	14	14	13	13	13	13	12	12	12	11	11	11	11	10
14	17	16	16	16	16	15	15	15	15	14	14	14	14	13	13	13	12	12	12	12	11
15	18	17	17	17	17	16	16	16	16	15	15	15	15	14	14	14	13	13	13	13	12
16	19	18	18	18	18	17	17	17	17	16	16	16	16	15	15	15	14	14	14	14	13
17	20	19	19	19	19	18	18	18	18	17	17	17	17	16	16	16	15	15	15	15	14
18	21	20	20	20	20	19	19	19	19	18	18	18	18	17	17	17	16	16	16	16	15

Concerning the education effect on performance, our results confirm that there is an important influence of the educational level in the generation of animals but not in the generation of fruit and vegetables, and kitchen tools. In contrast, an important educational effect was found in the six LVF tests, and especially in the ability of generation words without a specific letter. With regard to the lower impact of education on the ability to generate fruit and vegetables, and kitchen tools, some reports argue that everyday word retrieval is more related to semantic processes, which is easier than lexical fluency and, therefore, less influenced by cultural level (Tombaugh et al., 1999; Shores et al., 2006; Lezak, Howieson, & Loring, 2004). Our results support the hypothesis that the more evident education effect in LVF tasks could be related to the fact that they are more demanding and more sensitive to executive dysfunction than semantics (Tombaugh et al., 1999; Shores et al., 2006). In contrast, some authors suggest that the high educational effect could be partly explained by the different characteristics of the studied populations in which ranges of years of education were certainly different (Kavé, 2005).

No significant sex effect on VF tests was found, with the exception of a minor, but significant female advantage in two semantic categories: Fruit and vegetables, and kitchen tools. In those variables, age-and-sex adjustments are provided. Controversial data about sex influence on the VF tests have been published (*see* Mitrushina et al., 2005, for a review).

Table 20. Excluded letter E. Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times (Education_{(years)} - 12))$, where $\beta = 0.25448$

NSS_A	Education (years)																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	5	4	4	4	4	3	3	3	3	2	2	2	2	1	1	1	0	0	0	0	−1
3	6	5	5	5	5	4	4	4	4	3	3	3	3	2	2	2	1	1	1	1	0
4	7	6	6	6	6	5	5	5	5	4	4	4	4	3	3	3	2	2	2	2	1
5	8	7	7	7	7	6	6	6	6	5	5	5	5	4	4	4	3	3	3	3	2
6	9	8	8	8	8	7	7	7	7	6	6	6	6	5	5	5	4	4	4	4	3
7	10	9	9	9	9	8	8	8	8	7	7	7	7	6	6	6	5	5	5	5	4
8	11	10	10	10	10	9	9	9	9	8	8	8	8	7	7	7	6	6	6	6	5
9	12	11	11	11	11	10	10	10	10	9	9	9	9	8	8	8	7	7	7	7	6
10	13	12	12	12	12	11	11	11	11	10	10	10	10	9	9	9	8	8	8	8	7
11	14	13	13	13	13	12	12	12	12	11	11	11	11	10	10	10	9	9	9	9	8
12	15	14	14	14	14	13	13	13	13	12	12	12	12	11	11	11	10	10	10	10	9
13	16	15	15	15	15	14	14	14	14	13	13	13	13	12	12	12	11	11	11	11	10
14	17	16	16	16	16	15	15	15	15	14	14	14	14	13	13	13	12	12	12	12	11
15	18	17	17	17	17	16	16	16	16	15	15	15	15	14	14	14	13	13	13	13	12
16	19	18	18	18	18	17	17	17	17	16	16	16	16	15	15	15	14	14	14	14	13
17	20	19	19	19	19	18	18	18	18	17	17	17	17	16	16	16	15	15	15	15	14
18	21	20	20	20	20	19	19	19	19	18	18	18	18	17	17	17	16	16	16	16	15

Table 21. Excluded letter S. Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times (Education_{(years)} - 12))$, where $\beta = 0.25277$

NSS_A	Education (years)																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	5	4	4	4	4	3	3	3	3	2	2	2	2	1	1	1	0	0	0	0	-1
3	6	5	5	5	5	4	4	4	4	3	3	3	3	2	2	2	1	1	1	1	0
4	7	6	6	6	6	5	5	5	5	4	4	4	4	3	3	3	2	2	2	2	1
5	8	7	7	7	7	6	6	6	6	5	5	5	5	4	4	4	3	3	3	3	2
6	9	8	8	8	8	7	7	7	7	6	6	6	6	5	5	5	4	4	4	4	3
7	10	9	9	9	9	8	8	8	8	7	7	7	7	6	6	6	5	5	5	5	4
8	11	10	10	10	10	9	9	9	9	8	8	8	8	7	7	7	6	6	6	6	5
9	12	11	11	11	11	10	10	10	10	9	9	9	9	8	8	8	7	7	7	7	6
10	13	12	12	12	12	11	11	11	11	10	10	10	10	9	9	9	8	8	8	8	7
11	14	13	13	13	13	12	12	12	12	11	11	11	11	10	10	10	9	9	9	9	8
12	15	14	14	14	14	13	13	13	13	12	12	12	12	11	11	11	10	10	10	10	9
13	16	15	15	15	15	14	14	14	14	13	13	13	13	12	12	12	11	11	11	11	10
14	17	16	16	16	16	15	15	15	15	14	14	14	14	13	13	13	12	12	12	12	11
15	18	17	17	17	17	16	16	16	16	15	15	15	15	14	14	14	13	13	13	13	12
16	19	18	18	18	18	17	17	17	17	16	16	16	16	15	15	15	14	14	14	14	13
17	20	19	19	19	19	18	18	18	18	17	17	17	17	16	16	16	15	15	15	15	14
18	21	20	20	20	20	19	19	19	19	18	18	18	18	17	17	17	16	16	16	16	15

In fact, our results are globally in agreement with those in which a lack of sex influence has been reported (Cauthen, 1978; Pontón et al., 1996; Tombaugh et al., 1999). The minor female advantage in the generation of fruit and vegetables and kitchen tools found could be comparable with that found by other studies (Acevedo et al., 2000; Capitani et al., 1998). More research could be done to confirm whether those findings are really related to gender differences in the cognitive processing of semantic information or simply represent a bias of the sample characteristics. In our study, socio-cultural features related to the major implication of women in housework could partly explain the better performance achieved by this group in those tasks.

There are several limitations in the present study that we would like to comment. First, some limitations are related to the selection of the participants (limited representation of extremely elderly participants and a convenience sample of community volunteers). Second, the statistical analysis procedure carried out in this project made difficult to compare our results to other VF normative studies because they present their data by means of means, standard deviations, and percentile tables for each test (Benito-Cuadrado et al., 2002; Buriel et al., 2004; González et al., 2005; Kavé, 2005; Kosmidis et al., 2004; Ostrosky-Solis

Table 22. Fruit and vegetables: sex adjustment formula: $NSS_{A\&S} = NSS_A - (\gamma \times sex)$, where $\gamma = 1.24574$, man = 0, and woman = 1

NSS_A	$NSS_{A\&S}$	
	Men	Women
2	2	0
3	3	1
4	4	2
5	5	3
6	6	4
7	7	5
8	8	6
9	9	7
10	10	8
11	11	9
12	12	10
13	13	11
14	14	12
15	15	13
16	16	14
17	17	15
18	18	16

Table 23. Kitchen tools: sex adjustment formula: $NSS_{A\&S} = NSS_A - (\gamma \times sex)$, where $\gamma = 1.74961$, man = 0, and woman = 1

NSS_A	$NSS_{A\&S}$	
	Men	Women
2	2	0
3	3	1
4	4	2
5	5	3
6	6	4
7	7	5
8	8	6
9	9	7
10	10	8
11	11	9
12	12	10
13	13	11
14	14	12
15	15	13
16	16	14
17	17	15
18	18	16

et al., 2007; Tombaugh et al., 1999). Despite these difficulties our project provides several methodological advantages which contribute to perform reliable comparisons across a broad range of neuropsychological instruments used in clinical practice.

The normative data presented here were obtained from the same study sample as all the other NEURONORMA norms. In addition, the same statistical procedures for data analyses were applied. These data should provide a useful resource for clinical and research studies and may reduce the risk of misdiagnosis of cognitive impairment in normal individuals in a Spanish-speaker population. These co-normed data will allow clinicians to compare scores from one test with all tests.

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Conflict of Interest

None declared.

Appendix

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