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Spanish Multicenter Normative Studies (NEURONORMA Project): Norms for the Rey–Osterrieth Complex Figure (Copy and Memory), and Free and Cued Selective Reminding Test

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Abstract

The Rey–Osterrieth complex figure (ROCF) and the free and cued selective reminding test (FCSRT) are frequently used in clinical practice. The ROCF assesses visual perception, constructional praxis, and visuospatial memory, and the FCSRT assesses verbal learning and memory. As part of the Spanish Normative Studies (NEURONORMA), we provide age- and education-adjusted norms for the ROCF (copy and memory) and for the FCSRT. The sample consists of 332 and 340 participants, respectively, 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. Although age and education affected the score of the ROCF and FCSRT, sex was found to be unrelated in this normal sample. The normative data presented here were obtained from the same study sample as all other NEURONORMA norms and the same statistical procedures were applied. These co-normed data will allow clinicians to compare scores from one test with all the tests included in the project.

Keywords: Neuropsychological tests/standards; Age factors; Educational status; Reference values; Memory; Psychomotor/performance physiology

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Introduction

The Spanish Multicenter Normative Studies (NEURONORMA project; Peña-Casanova et al., 2009) attempts to provide useful norms for people aged over 49 years for commonly used neuropsychological tests. In this paper we provide normative data for the Rey–Osterrieth complex figure (ROCF; Osterrieth, 1944; Rey, 1941) and the free and cued selective reminding test (FCSRT; Buschke, 1984).

Rey–Osterrieth Complex Figure

The purpose of the ROCF is to assess visual perception, visual–spatial constructional ability, and visual memory. It also measures a series of cognitive capacities including planning and problem-solving strategies (Lezak, Howieson, & Loring, 2004; Meyers & Meyers, 1995a; Mitrushina, Boone, Razani, & D'Elia, 2005). The ROCF has been used to study a variety of neurological disorders (Machulda et al., 2007).

The ROCF is a popular test with a long history in the field of neuropsychological assessment; it has been the object of multiple versions and modifications. The test developed by Rey (1941) consisted of a copy trial followed by a recall trial 3 min later. Current administration procedures vary considerably (Strauss, Sherman, & Spreen, 2006). Some investigators give both immediate- and delayed-recall trials. Furthermore, the amount of delay varies from 3 to 45 min (Taylor, 1969). After a long (e.g., 30 min) recall, a recognition subtest can be given (Meyers & Lange, 1994; Meyers & Meyers, 1995a). The recognition subtest includes 24 figures that are placed at random on four pages. The subject is required to indicate the 12 figures that were part of the original design.

There is little difference in performance in scores between immediate and 3 min delayed-recall performance (Meyers & Meyers, 1995a). In cases of a long delay, most forgetting tends to occur very quickly, within the first few minutes after copying (Berry & Carpenter, 1992; Chiulli, Haaland, LaRue, & Garry, 1995; Delaney et al., 1992). Because very little difference is observed between immediate- and delayed-recall trials in normal, healthy controls (Chiulli et al., 1995; Loring, Martin, Meador, & Lee, 1990), a decline between the immediate- and delayed-recall trials is considered to be of clinical significance.

Mitrushina and colleagues (2005) provide a review of a series of normative studies published on the ROCF, including norms from the samples of Spanish-speaking populations (*see* also Ardila & Rosselli, 2003; Ardila, Rosselli, & Puente, 1994; Ostrosky-Solis, Jaime, & Ardila, 1998; Ponton et al., 1996). A wide variability exists with regard to the type of administration (specifically number and timing of recall trials). A series of works provide data on cognitively normal, elderly subjects (Machulda et al., 2007).

Demographic effects such as age and education have been frequently associated with ROCF scores (Rosselli & Ardila, 1991). Age contributes significantly to performance in the ROCF. Copy scores increase with age, with adult levels being reached at about the age of 17 years (Meyers & Meyers, 1996). There is a decrement in scores with advancing age, particularly after the age of 70 years (Chervinsky, Mitrushina, & Satz, 1992). Rates of forgetting are calculated as copy score minus delay score. The effect of sex on the ROCF scores is controversial. Some studies have shown that men outperform women, but in general the differences are minor or nonexistent (Berry, Allen, & Schmitt, 1991; Boone, Lesser, Hill-Gurierrez, Berman, & D'Elia, 1993). As the ROCF is a complex constructional task, an effect of education on scores is expected (Ardila, Rosselli, & Rosas, 1989; Berry et al., 1991; Caffarra, Vezzadini, Dieci, Zonato, & Venneri, 2002).

Free and Cued Selective Reminding Test

The FCSRT measures verbal learning and memory. The test was originally introduced by Buschke and colleagues (Buschke, 1973; Buschke & Fuld, 1974) as the selective reminding test (SRT). Various forms were subsequently introduced (Mitrushina et al., 2005; Strauss et al., 2006). Buschke (1984) added a cued-recall component to the test. This version is known as FCSRT. The FCSRT emphasizes encoding specificity (Tulving & Osler, 1968) during learning and recall. Encoding specificity implies that information is processed in a precise manner (i.e., semantically) during the process of learning. Encoding specificity is a technique that in normal subjects produces efficient learning and memory (Ivnik et al., 1997). This task is particularly sensitive to pathological states; especially in early stages of Alzheimer's disease (Petersen, Smith, Ivnik, Kokmen, & Tangalos, 1994; Petersen et al., 1995; Tuokko et al., 1991). The FCSRT has been used with nondemented elderly, demented, and amnesic subjects (Degenszajn, Caramelli, Caixeta, & Nitrini, 2001; Grober, Lipton, Hall, & Crystal, 2000; Grober, Lipton, Katz, & Sliwinski, 1998; Grober, Merling, Heimlich, & Lipton, 1997; Ivnik et al., 1997; Petersen et al., 1999).

There are a number of studies that provide normative data for the different languages that SRT and FCSRT were adapted to (Lezak et al., 2004; Mitrushina et al., 2005; Strauss et al., 2006). Normative data for the elderly have been reported from the MOANS project (Ivnik et al., 1997) and from the Aging Project of the Einstein College of Medicine (Grober et al., 1998).

A Spanish version of the SRT, using two letters as a cue, has been published recently (Campo & Morales, 2004; Campo, Morales, & Juan-Malpartida, 2000; Campo, Morales, & Martínez-Castillo, 2003).

Demographic effects such as age, education, and sex have been frequently associated with the FCSRT scores (Grober et al., 1998). There is, in general, a decline in most SRT measures with advancing age (Campo & Morales, 2004; Larrabee, Trahan, Curtiss, & Levin, 1988; Sliwinski, Buschke, Stewart, Masur, & Lipton, 1997; Stricks, Pittman, Jacobs, Sano, & Stern, 1998; Wiederholt et al., 1993). It is of interest that elderly subjects recall twice as many words in FCSRT than in SR (Grober et al., 1997). Free recall impairment on the FCSRT predicted the development of dementia by as much as 5 years in advance of the diagnosis (Grober et al., 2000).

Sex also affects the scores, women perform better than men on SRT and FCSRT (Bishop, Dickson, & Allen, 1990; Campo & Morales, 2004; Larrabee et al., 1988; Wiederholt et al., 1993).

The effect of education is inconsistent, some studies find it to be modest and relatively unimportant (Petersen, Smith, Kokmen, Ivnik, & Tangalos, 1992), whereas others (Campo & Morales, 2004) observed significantly better performance for those subjects with more education on all scores except the short-term memory index. See Strauss and colleagues (2006) for more information on the SR.

Materials and Methods

Research Participants

Socio-demographic and participant characteristics of the entire NEURONORMA sample have been reported in a previous paper (Peña-Casanova et al., 2009). In summary, the sample is composed of cognitively normal people aged over 49 years, including independently functioning, community dwelling people who have no active medical, neurologic, or psychiatric disorders which may potentially affect behavior or cognition. Following the MOANS model, volunteers did not need to be completely medically healthy to participate (Lucas et al., 2005). Demographic information concerning ROCF and FCSRT is presented in Table 1.

Ethical approval for the study, including the study protocol, written informed consents, and information, was granted by the Research Ethics Committee of the Municipal Institute of Medical Care of Barcelona, Spain, and from the different participating

Table 1. Sample size and basic demographic information by test

	ROCF		FCSRT	
	Count	Percentage of Total	Count	Percentage of Total
Age group				
50–56	73	21.99	76	22.35
57–59	49	14.76	50	14.70
60–62	33	9.94	32	9.41
63–65	15	4.52	16	4.71
66–68	24	7.23	26	7.65
69–71	48	14.46	48	14.12
72–74	29	8.73	32	9.41
75–77	30	9.04	29	8.53
78–80	20	6.02	20	5.88
>80	11	3.31	11	3.24
Education (years)				
≤5	68	20.48	67	19.71
6–7	19	5.72	24	7.06
8–9	64	19.28	66	19.41
10–11	38	11.45	39	11.47
12–13	35	10.54	36	10.59
14–15	33	9.94	34	10.00
≥16	75	22.59	74	21.76
Sex				
Men	137	41.27	137	40.29
Women	195	58.73	203	59.71
Total sample	332		340	

Notes: FCSRT = free and cued selective reminding test; ROCF = Rey–Osterrieth complex figure.

centers. 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.

Neuropsychological Measures

The neuropsychological measures were administered as part of a larger test battery, the NEURONORMA battery (Peña-Casanova et al., 2009). Tests were administered and scored by neuropsychologists specifically trained for this project.

Rey–Osterrieth complex figure

For the ROCF, participants were supplied with a sheet of paper (DIN-A4) placed horizontally on the table. Instructions were given following the administration procedures provided in the manual. The participants were not allowed to erase the paper or change its orientation.

The ROCF was scored according to the criteria developed by Rey (1941) and presented by Meyers & Meyers (1995b). The measures include a copy score (which reflects the accuracy of the original copy and is a measure of visual–spatial constructional ability), the time required to copy the figure, and 3-min and 30-min delayed-recall scores. The figure is divided into 18 scored elements. Between 0.5 and 2 points are awarded for each element depending on the accuracy, distortion, and location of its reproduction. The maximum score is 36.

Free and cued selective reminding test (Buschke, 1984)

The version included in the NEURONORMA project uses category cues at both acquisition and retrieval in an attempt to ensure semantic encoding and enhance recall. Materials and instruction of the FCSRT were provided to researchers by the author (Buschke's FCSRT. Copyright, 1996–2000. Albert Einstein College of Medicine of Yeshiva University, New York; due to copyright limitations items are not shown). Administration procedures were translated into Spanish as described in previous studies (Erzigkeit et al., 2001). The selection of stimulus words followed the same principles as the English version. To prevent a correct response due to chance, words were selected from the intermediate frequency of prototypicality within a semantic category (frequencies in Soto, Sebastian, García, & del Amo, 1994). The NEURONORMA version of the FCSRT presents its 16 items as words on stimulus cards (four cards with four items on each card). Participants were tested individually and told before presentation of test items that they should remember the items so that they could recall them later.

Each participant was presented with a DIN-A4 sheet with four items to be recalled. Each item belonged to a different category. The individual was asked to read items aloud and then asked to identify the name of each item (e.g., "owl") when the tester said its category cue (e.g., "bird"). This procedure continued until all 16 items had been correctly read and identified. After a nonsemantic interference task (counting from 1 to 20 and back) lasting 20 s, the test taker attempted to freely recall as many items as possible, in any order. The time allowed for this task was 90 s. The task was stopped if there was no response in 15 s. Items that were not spontaneously remembered were then cued by the examiner (e.g., "Which one was a bird?"). In other words, the category cues were presented to elicit cued recall of only those items that were not retrieved by free recall. This procedure was repeated three times. A 30-min delayed-recall trial was included. Each trial was scored for the number of freely recalled items, the number of items recalled after cuing, and the sum of these two scores.

In the NEURONORMA version of the FCSRT, six derived scores were considered: (a) Trial 1 free recall (maximum score, 16); (b) total free recall (Trial 1 free recall + Trial 2 free recall + Trial 3 free recall; maximum score, 48); (c) total recall (free recall + cued recall; maximum score, 48); (d) delayed free recall (maximum score, 16); (e) delayed total recall (maximum score, 16); (f) retention index: total delayed recall/Trial 3 total recall (maximum score, 1).

Statistical Analysis

Considering that the ability to compare all co-normed test scores directly with each other facilitates clinical interpretation of neuropsychological test profiles, a uniform normative procedure was applied to all measures as in the MOANS studies (Ivnik et al., 1992; Lucas et al., 2005). The procedure is described in a previous paper (Peña-Casanova et al., 2009). In summary, the principal characteristics of this process were the following: (a) the overlapping interval strategy (Pauker, 1988) was adopted to maximize the number of subjects contributing to the normative distribution at each mid-point age interval; (b) effects of age, sex, and education on raw subtest scores were studied using coefficients of correlation (r) and determination (r^2) (Lucas et al., 2005); (c) to ensure a normal distribution, the frequency distribution of the raw scores (RS) was converted into age-adjusted scaled scores, NSS_A (NEURONORMA scaled score-age adjusted) following the methodology described by Ivnik and colleagues (1992). Raw scores were assigned percentile ranks in function of their place within a distribution. Subsequently, percentile ranks were converted to scaled scores (from 2 to 18) based on percentile ranges. This transformation of RS to NSS_A

produced a normalized distribution on which linear regressions could be applied; (d) Years of education were modeled with the following equation: $NSS_A = k + (\beta \times Educ)$. The resulting equations were used to calculate age- and education-adjusted NEURONORMA scaled scores ($NSS_{A\&E}$) for each variable. The regression coefficients (β) from this analysis were used as the basis for education adjustments. A linear regression was employed to derive age- and education-adjusted scaled scores. The following formula outlined by Mungas, Marshall, Weldon, Haan, and Reed (1996) was employed: $NSS_{A\&E} \geq NSS_A - (\beta \times [Educ - 12])$.

Results

The age distribution of the sample made it possible to calculate norms for 10 mid-point age groups. Sample sizes resulting from mid-point age intervals are presented in each normative table.

Correlations and shared variance of ROCF scores and FCSRT-derived scores, with age, education, and sex, are presented in Table 2. Concerning ROCF, age and education accounted both significantly and differentially for the RS variance for all measures (age: between 4% and 10%; education: between 10% and 17%). Sex differences were minimally observed (only 1% in the case of execution time), indicating no need to control this demographic variable. Concerning FCSRT, Table 2 data show that age and education account significantly for the RS variance for all measures (age: between 12% and 25%; education: between 12% and 16%). Sex differences were only observed in two measures (total recall and delayed free recall), the effect was, however, $\leq$3%, indicating minimal influence and suggesting that adjustments for sex are not needed.

Age-adjusted NEURONORMA scaled scores (NSS_A) for the ROCF and FCSRT are presented in Tables 3–12. The tables include percentile ranks, ranges of ages contributing to each normative sub-sample, and the number of participants contributing to each normative estimate. To use the tables, select the appropriate table corresponding to the patient's age, find the patient's RS, and subsequently refer to the corresponding NSS_A and percentile rank (left part of the table).

As expected, the normative adjustments eliminated variance with age. Education, however, continued to account for a significant amount of shared variance (Table 13). In the case of the ROCF, the effect of education affects slightly more copy (8%–14%) than the memory reproduction (6%). Concerning the FCSRT education continues to account significantly for age-adjusted test score variance up to 11%, although the effect is minor for the index of retention.

The transformation of RS to NSS_A (Tables 3–12) produced a normalized distribution on which linear regressions could be applied. Regression coefficients from this analysis were used as the basis for education (years) corrections. The following formula was used: $NSS_{A\&E} = NSS_A - (\beta \times [Educ - 12])$. The values of β are presented in Tables 14–17.

From these data, adjustment tables for ROCF (Tables 14–17) and FCSRT (Tables 18–23) were drawn up 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 $NSS_{A\&E}$. When these formulae were applied to the NEURONORMA normative sample, the shared variances between demographically adjusted NEURONORMA scaled scores and years of education fell to <1%.

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

Measures	Age (years)		Education (years)		Sex	
	r	r^2	r	r^2	r	r^2
ROCF copy						
Time (s)	0.32380	0.10485	−0.42299	0.17892	0.11409	0.01302
Accuracy	−0.21685	0.04702	0.35736	0.12771	−0.07768	0.00603
ROCF memory						
Immediate recall (accuracy)	−0.31050	0.09641	0.32068	0.10284	−0.07146	0.00511
Delayed recall (accuracy)	−0.31971	0.10221	0.33111	0.10963	−0.08528	0.00727
FCSRT						
Trial 1 free recall	−0.34998	0.12249	0.34827	0.12129	0.15369	0.02362
Total free recall	−0.50232	0.25233	0.40394	0.16317	0.20009	0.04004
Total recall (free recall + cued recall)	−0.44646	0.19933	0.39884	0.15907	0.13634	0.01859
Delayed free recall	−0.50442	0.25444	0.37660	0.14183	0.18241	0.03327
Delayed total recall	−0.41145	0.16929	0.37315	0.13924	0.09302	0.00865
Total delayed recall/Trial 3 total recall	−0.16601	0.02756	0.17910	0.03208	0.00532	0.00003

Notes: FCSRT = free and cued selective reminding test; ROCF = Rey–Osterrieth complex figure.

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

Scaled score	Percentile range	ROCF				FCSRT					
		Copy		Memory		Trial 1 free recall	Total free recall	Total recall	Delayed free recall	Delayed total recall	TDR/T3TR
		Raw Score	Time (s)	Immediate recall RS	Delayed recall RS						
2	<1	≤13	≥420	≤2.5	≤3	0–1	≤11	≤28	0–3	0–7	≤0.62
3	1	13.5–14	—	3	3.5	—	12–13	29–30	—	8	0.63–0.67
4	2	14.5–17	410–419	3.5	—	2	—	31–32	4	9–10	0.68–0.73
5	3–5	17.5–19	365–409	4–6.5	4–6	3	14–17	33–34	—	—	0.74–0.79
6	6–10	19.5–23	310–364	7–8.5	6.5–7.5	—	18	35	6	11	0.8–0.86
7	11–18	23.5–27	263–309	9–10.5	8–10	4	19–20	36–38	7	12–13	0.87–0.92
8	19–28	27.5–29	229–262	11–12.5	10.5–12.5	5	21–22	39–40	8	—	0.93
9	29–40	29.5–31	190–228	13–15.5	13–15.5	—	23–25	41–42	9	14	0.94
10	41–59	31.5–33	155–189	16–19	16–18.5	6	26–28	43–44	10	15	—
11	60–71	33.5–34	138–154	19.5–21	19–21	7	29–30	45	11	—	—
12	72–81	34.5–35	120–137	21.5–24.5	21.5–23.5	8	31–32	46	12	—	—
13	82–89	—	101–119	25–27	24–27	9	33	—	13	—	—
14	90–94	—	90–100	27.5–28	27.5–29	—	34–36	47	—	—	0.95–1
15	95–97	—	72–89	28.5–32	29.5–31	10	—	—	14–15	—	1.01–1.08
16	98	—	62–71	32.5–34	31.5–33	—	37–38	—	—	—	—
17	99	—	61	34.5–35	33.5–34	—	—	—	—	—	1.09–1.14
18	>99	35.5–36	≤60	35.5–36	34.5–36	11–16	39–48	48	16	16	≥1.15
Sample size		131		131		135			133		

Notes: FCSRT = free and cued selective reminding test; ROCF = Rey–Osterrieth complex figure; RS = raw score; TDR/T3TR = total delayed recall/Trial 3 total recall.

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

Scaled score	Percentile range	ROCF				FCSRT					
		Copy		Memory		Trial 1 free recall	Total Free recall	Total recall	Delayed free recall	Delayed total recall	TDR/T3TR
		Raw score	Time (s)	Immediate Recall RS	Delayed recall RS						
2	<1	≤13	≥423	≤2.5	≤3	0–1	≤11	≤28	0–3	0–7	≤0.62
3	1	13.5–14	420–422	3	3.5	—	12	—	4	8	0.63–0.67
4	2	14.5–17	—	3.5	—	—	—	29–30	5	—	0.68–0.73
5	3–5	17.5–19	383–419	4–4.5	4–5.5	2	13–16	31–32	—	10	0.74–0.79
6	6–10	19.5–23	316–382	5–7	6–6.5	3	17–19	33–35	6	11	0.8–0.86
7	11–18	23.5–25	285–315	7.5–9.5	7–9	4	20	36–37	7	12	0.87–0.88
8	19–28	25.5–28	237–284	10–11.5	9.5–11	—	21–22	38–39	—	13	0.92–0.93
9	29–40	28.5–30	203–236	12–14	11.5–14	5	23	40–41	8	14	—
10	41–59	30.5–33	175–202	14.5–17.5	14.5–17.5	6	24–27	42–43	9–10	—	0.94
11	60–71	33.5–34	152–174	18–20	18–19.5	7	28–29	44	11	15	—
12	72–81	34.5–35	133–151	20.5–22	20–21.5	8	30–31	45	12	—	—
13	82–89	—	104–132	22.5–25.5	22–24	9	32–33	46	—	—	—
14	90–94	—	92–103	26–27	24.5–28	—	34–36	47	13	—	0.95–1
15	95–97	—	82–91	27.5–32	28.5–30	10	37	—	14	—	1.01–1.07
16	98	—	72–81	32.534	31.5–33	—	38	—	15	—	1.08
17	99	—	61–71	34.5–35	33.5–34	11	39	—	—	—	—
18	>99	35.5–36	≤60	35.5–36	34.5–36	12–16	40–48	48	16	16	≥1.09
Sample size		128		128		128			126		

Notes: FCSRT = free and cued selective reminding test; ROCF = Rey–Osterrieth complex figure; RS = raw score; TDR/T3TR = total delayed recall/Trial 3 total recall.

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

Scaled score	Percentile range	ROCF				FCSRT					
		Copy		Memory		Trial 1 free recall	Total free recall	Total recall	Delayed free recall	Delayed total recall	TDR/T3TR
		Raw Score	Time (s)	Immediate recall RS	Delayed recall RS						
2	<1	≤13	≥456	≤2.5	≤3	0–1	≤11	≤26	0–3	0–7	0.62
3	1	13.5–14	423–455	3	3.5	—	12	27–30	—	8	0.63–0.64
4	2	14.5–17	420–422	3.5	—	—	13	31	—	9	0.65–0.67
5	3–5	17.5–19.5	385–419	4–4.5	4–5	2	14–15	32	4–5	10	0.68–0.77
6	6–10	20–22	360–384	5–7	5.5–6.5	3	16–18	33–35	—	—	0.78–0.79
7	11–18	22.5–25	295–359	7.5–9.5	7–8	4	19–20	36–37	6	11–12	0.8–0.87
8	19–28	25.5–27	240–294	10–11	8.5–11.5	—	21	38–39	7	13	0.88–0.92
9	29–40	27.5–29	192–239	11.5–13.5	12–13.5	5	22–23	40	8	—	0.93
10	41–59	29.5–32	165–191	14–17.5	14–17.5	6	24–27	41–43	9	14	0.94
11	60–71	32.5–33	142–164	18–19.5	18–18.5	7	28–29	44	10–11	15	—
12	72–81	33.5–34	129–141	20–21	19–20.5	8	30–31	45	—	—	—
13	82–89	34.5–35	108–128	21.5–25	21–23	9	32–33	46	12	—	—
14	90–94	—	93–107	25.5–26.5	23.5–26	—	34–36	47	13	—	0.95–1
15	95–97	—	90–92	27–28	26.5–28.5	10	37	—	14	—	1.01–1.07
16	98	—	83–89	28.5–32	29	—	38	—	15	—	—
17	99	—	82	32.5–34	29.5–34	11	39	—	—	—	1.08
18	>99	35.5–36	≤81	34.5–36	34.5–36	12–16	40–48	48	16	16	1.09–1.14
Sample size		118		118		119			118		

Notes: FCSRT = free and cued selective reminding test; ROCF = Rey–Osterrieth complex figure; RS = raw score; TDR/T3TR = total delayed recall/Trial 3 total recall.

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

Scaled score	Percentile range	ROCF				FCSRT					
		Copy		Memory		Trial 1 free recall	Total free recall	Total recall	Delayed free recall	Delayed total recall	TDR/T3TR
		Raw Score	Time (s)	Immediate recall RS	Delayed recall RS						
2	<1	≤13	≥456	≤2.5	≤2.5	0–1	≤12	≤25	0–3	0–7	≤0.62
3	1	13.5–17	423–455	—	3	—	—	26	—	8	0.63–0.64
4	2	17.5	420–422	3	—	—	—	—	4	9	0.65–0.67
5	3–5	18–20.5	372–419	3.5–4.5	3.5–5	—	13–14	27–31	5	—	0.68–0.77
6	6–10	21–22.5	333–371	5–6.5	5.5–6.5	2	15–16	32–33	—	10	0.78–0.8
7	11–18	23–25.5	290–332	7–8.5	7–9	3	17–19	34–35	6	11–12	0.81–0.88
8	19–28	26–28	240–289	9–11.5	9.5–11	4	20	36–38	7	—	0.89–0.92
9	29–40	28.5–30	197–239	12–14	11.5–14.5	5	21–22	39–40	—	13	0.93
10	41–59	30.5–33	173–196	14.5–18	15–17.5	—	23–25	41–42	8–9	14	0.94
11	60–71	—	148–172	18.5–20.5	18–19	6	26–27	43	10	15	—
12	72–81	33.5–34	134–147	21–22.5	19.5–21.5	7	28–30	44	11	—	—
13	82–89	34.5–35	120–133	23–24	22	8	31–32	45	12	—	—
14	90–94	—	108–119	24.5–26	22.5–24	9	33–34	46–47	13	—	0.95–1
15	95–97	—	93–107	26.5	24.5–28	10	35–36	—	14	—	1.01–1.07
16	98	—	92	—	28.5	—	37	—	—	—	—
17	99	—	90–91	27–28	—	11	38	—	15	—	—
18	>99	35.5–36	≤89	28.5–36	29–36	12	39–48	48	16	16	≥1.08
Sample size		101		101		103					

Notes: FCSRT = free and cued selective reminding test; ROCF = Rey–Osterrieth complex figure; RS = raw score; TDR/T3TR = total delayed recall/Trial 3 total recall.

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

Scaled score	Percentile range	ROCF				FCSRT					
		Copy		Memory		Trial 1 free recall	Total free recall	Total recall	Delayed free recall	Delayed total recall	TDR/T3TR
		Raw Score	Time (s)	Immediate recall RS	Delayed recall RS						
2	<1	≤12	≥545	≤2	≤2	0–1	0–2	≤13	0	0–6	0–0.63
3	1	12.5–14	535–544	—	2.5–3	—	3–7	14–19	—	7	—
4	2	14.5–15	469–534	2.5	—	—	8	20–25	1	—	0.64
5	3–5	15.5–21	420–468	3–4	3.5–5	—	9	26–27	2–3	8–9	0.65–0.77
6	6–10	21.5–22.5	372–419	4.5–6	5.5–6	2	10–14	28–29	4–5	10	0.78–0.79
7	11–18	23–25.5	300–371	6.5–8.5	6.5–8	3	15–16	30–33	—	11	0.8–0.87
8	19–28	26–28.5	247–299	9–11	8.5–10	4	17–19	34–35	6	12	0.88–0.92
9	29–40	29–30	215–246	11.5–13	10.5–13.5	—	20–21	36–38	7	13	0.93
10	41–59	30.5–32	174–214	13.5–17	14–16.5	5	22–23	39–41	8	14	0.94
11	60–71	32.5–33	150–173	17.5–20	17–18.5	6	24–25	42	9	—	—
12	72–81	33.5–34	136–149	20.5–22	19–21	7	26–27	43–44	10	15	—
13	82–89	34.5–35	119–135	22.5–23.5	21.5–23	8	28–30	45	11	—	0.95–1
14	90–94	—	105–118	24–26.5	23.5–27.5	—	31	46	12	—	1.01–1.07
15	95–97	—	92–104	27–28	28–28.5	9	32–33	47	13	—	1.08
16	98	—	90–91	28.5	29	—	34	—	14	—	1.09–1.10
17	99	—	76–89	—	29.5–31	10	—	—	—	—	1.11–1.17
18	>99	35.5–36	≤75	29–36	31.5–36	11–16	35–48	48	15–16	16	≥1.18
Sample size		116		116		118			115		

Notes: FCSRT = free and cued selective reminding test; ROCF = Rey–Osterrieth complex figure; RS = raw score; TDR/T3TR = total delayed recall/Trial 3 total recall.

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

Scaled score	Percentile range	ROCF				FCSRT					
		Copy		Memory		Trial 1 free recall	Total free recall	Total recall	Delayed free recall	Delayed total recall	TDR/T3TR
		Raw Score	Time (s)	Immediate recall RS	Delayed recall RS						
2	<1	≤12	≥564	≤2	≤1.5	0	0–2	≤13	0	0–6	≤0.57
3	1	12.5–14	545–543	—	2	1	3–4	14–19	—	—	—
4	2	14.5–15	535–544	2.5	2.5–3	—	5–7	20–22	—	7	—
5	3–5	15.5–21	413–534	3–4	3.5–4	—	8–9	23–26	1	8	0.58–0.7
6	6–10	21.5–22	369–412	4.5–6	4.5–6	—	10–12	27–28	2–3	9	0.71–0.79
7	11–18	22.5–25	320–368	6.5–8	6.5–7.5	2	13–14	29–32	4–5	10	0.8–0.85
8	19–28	25.5–28	254–319	8.5–10.5	8–9.5	3	15–17	33–34	6	11	0.86–0.91
9	29–40	28.5–30	222–253	11–12.5	10–12	4	18–19	35–36	—	12	0.92
10	41–59	30.5–32	181–221	13–17	12.5–16.5	5	20–22	37–40	7–8	13–14	0.93–0.94
11	60–71	32.5–34	152–180	17.5–20.5	17–19	—	23–25	41–42	9	—	—
12	72–81	—	136–151	21–22.5	19.5–22	6	26	43–44	10	15	—
13	82–89	34.5–35	119–135	23–23.5	22.5–23	7	27–29	45	11	—	0.95–1
14	90–94	—	105–118	24–26.5	24–27.5	8	30–31	46	—	—	1.01–1.07
15	95–97	—	90–104	27–29	28–29	9	32	47	12–13	—	1.08–1.10
16	98	—	76–89	29.5–30	29.5–30	—	33	—	—	—	1.11–1.17
17	99	—	64–75	—	30.5–31	10	—	—	14	—	1.18
18	>99	35.5–36	≤63	30.5–36	31.5–36	11–16	34–48	48	15–16	16	≥1.19
Sample size		120		120		125			122		123

Notes: FCSRT = free and cued selective reminding test; ROCF = Rey–Osterrieth complex figure; RS = raw score; TDR/T3TR = total delayed recall/Trial 3 total recall.

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

Scaled score	Percentile range	ROCF				FCSRT					
		Copy		Memory		Trial 1 free recall	Total free recall	Total recall	Delayed free recall	Delayed total recall	TDR/T3TR
		Raw Score	Time (s)	Immediate recall RS	Delayed recall RS						
2	<1	≤12	≥636	≤2	≤1.5	0	0–2	≤13	0	0–6	≤0.54
3	1	12.5–13	564–635	—	2	1	3–4	14–19	—	—	0.55–0.57
4	2	13.5–14	545–563	2.5	2.5–3	—	—	20–22	—	—	0.58–0.6
5	3–5	14.5–18.5	420–544	3–4	3.5–4	—	5–8	23–26	1	7	0.61–0.71
6	6–10	19–22	383–419	4.5–5.5	4.5–6	2	9–12	27–28	2–3	8	0.72–0.73
7	11–18	22.5–24.5	340–382	6–7.5	6.5–7.5	—	13	29–31	4	9–10	0.74–0.8
8	19–28	25–27.5	290–339	8–9.5	8–9	3	14–15	32–33	5	11	0.81–0.87
9	29–40	28–30	247–289	10–12	9.5–11.5	4	16–18	34–35	6	12	0.88–0.92
10	41–59	30.5–32	196–246	12.5–15.5	12–14.5	5	19–21	36–39	7–8	13	0.93–0.94
11	60–71	32.5–34	169–195	16–18.5	15–18	—	22–23	40–42	9	14	—
12	72–81	34.5–35	148–168	19–22	18.5–21	6	24–25	43	10	15	—
13	82–89	—	133–147	22.5–23.5	21.5–23	7	26–28	44	11	—	0.95–1
14	90–94	—	110–132	24–26.5	23.5–27.5	8	29–30	45	—	—	1.01–1.08
15	95–97	—	77–109	27–29	28–29	9	31–32	46–47	12	—	1.09–1.15
16	98	—	—	29.5–30	29.5–30	10	33	—	13	—	1.16–1.17
17	99	—	63–76	—	30.5–31	—	—	—	—	—	1.18–1.23
18	>99	35.5–36	≤62	30.5–36	31.5–36	11–16	34–48	48	14–16	16	≥1.24
Sample size		120		120		123			120		121

Notes: FCSRT = free and cued selective reminding test; ROCF = Rey–Osterrieth complex figure; RS = raw score; TDR/T3TR = total delayed recall/Trial 3 total recall.

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

Scaled score	Percentile range	ROCF				FCSRT					
		Copy		Memory		Trial 1 free recall	Total free recall	Total recall	Delayed free recall	Delayed total recall	TDR/T3TR
		Raw Score	Time (s)	Immediate recall RS	Delayed recall RS						
2	<1	≤10.5	≥637	≤0.5	≤1.5	0	0–1	≤12	0	0	≤0.53
3	1	11	636	—	—	—	2	13	—	1–6	0.54
4	2	11.5–12	564–635	—	2	—	3–4	14–19	—	—	0.55–0.57
5	3–5	12.5–15	469–563	1–2.5	2.5–3.5	1	5	20–22	—	—	0.56–0.6
6	6–10	15.5–21	406–468	3–4.5	4–5	—	6–9	23–25	1	7	0.61–0.73
7	11–18	21.5–22	342–405	5–7	5.5–7	2	10–12	26–28	2–3	8–9	0.74–0.79
8	19–28	22.5–25.5	300–341	7.5–8.5	7.5–8.5	—	13–14	29–31	4	10	0.8–0.86
9	29–40	26–29	276–299	9–11	9–11.5	3	15–16	32–34	5	11	0.87–0.92
10	41–59	29.5–32	215–275	11.5–14	12–13.5	4	17–20	35–38	6–7	12–13	0.93–0.94
11	60–71	32.5–33	181–214	14.5–17.5	14–16.5	5	21–22	39–41	8	—	—
12	72–81	33.5–34	152–180	18–19	17–18.5	6	23–25	42	9	14	—
13	82–89	34.5–35	120–151	19.5–22.5	19–22	7–8	26–28	43–44	10	15	0.95–1.07
14	90–94	—	110–119	23	22.5–25	—	29–30	45–46	11	—	1.08–1.10
15	95–97	—	90–109	23.5–28	25.5–28	9	31	47	12	—	1.11–1.17
16	98	—	76–89	28.5–29	28.5–30	10	32	—	13	—	1.18–1.22
17	99	35.5	62–75	29.5–30	30.5–32	—	—	—	—	—	1.23
18	>99	36	≤61	30.5–36	32.5–36	11–16	33–48	48	14–16	16	≥1.24
Sample size		96		96		99			97		98

Notes: FCSRT = free and cued selective reminding test; ROCF = Rey–Osterrieth complex figure; RS = raw score; TDR/T3TR = total delayed recall/Trial 3 total recall.

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

Scaled score	Percentile range	ROCF				FCSRT					
		Copy		Memory		Trial 1 free recall	Total free recall	Total recall	Delayed free recall	Delayed total recall	TDR/T3TR
		Raw Score	Time (s)	Immediate recall RS	Delayed recall RS						
2	<1	≤10.5	≥636	≤0.5	≤1.5	0	0–4	≤20	0	0–5	≤0.53
3	1	11	—	—	—	—	—	21	—	6	0.54
4	2	—	564–635	—	—	—	—	—	—	—	—
5	3–5	11.5–16	420–563	1–2	2–2.5	1	5–7	22	—	—	0.55–0.6
6	6–10	16.5–21	358–419	2.5–4.5	3–4	—	8–9	23–25	—	7	0.61–0.71
7	11–18	21.5–22	330–357	5–6.5	4.5–7	2	10–12	26–28	1–2	8	0.72–0.73
8	19–28	22.5–25.5	312–329	7–8	7.5–8.5	—	13	29–31	3	9	0.74–0.82
9	29–40	26–29	280–311	8.5–10.5	9–11	3	14	32–33	4	10–11	0.83–0.9
10	41–59	29.5–31	221–279	11–12	11.5–12.5	4	15–17	34–36	5–6	12	0.91–0.94
11	60–71	31.5–33	194–220	12.5–14	13–14	5	18–20	37–38	7–8	13	—
12	72–81	33.5–34	169–193	14.5–18	14.5–16.5	6	21	39–41	—	—	—
13	82–89	34.5–35	134–168	18.5–19	17–18.5	7	22–25	42	9–10	14	0.95–1.07
14	90–94	—	115–133	19.5–21	19–20	—	26–30	43	—	15	1.08–1.10
15	95–97	—	100–114	21.5–23	20.5–23	8	—	44–45	11	—	1.11–1.17
16	98	—	—	23.5–24	23.5–25	9	31	46	12	—	1.18–1.22
17	99	—	90–99	—	—	—	—	—	—	—	—
18	>99	36	≤89	24.5–36	25.5–27	11–16	32–48	47–48	13–16	16	≥1.23
Sample size		63		63		63					64

Notes: FCSRT = free and cued selective reminding test; ROCF = Rey–Osterrieth complex figure; RS = raw score; TDR/T3TR = total delayed recall/Trial 3 total recall.

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

Scaled score	Percentile range	ROCF				FCSRT					
		Copy		Memory		Trial 1 free recall	Total free recall	Total recall	Delayed free recall	Delayed total recall	TDR/T3TR
		Raw Score	Time (s)	Immediate recall RS	Delayed recall RS						
2	<1	≤9.5	≥636	0	0	0	0–4	≤20	0	0–5	≤0.53
3	1	—	—	—	—	—	—	—	—	—	—
4	2	10	565–635	—	0.5	—	—	21	—	6	0.54
5	3–5	10.5–11	481–564	0.5	1–2	1	—	22	—	—	0.55–0.58
6	6–10	11.5–13	420–480	1–2	2.5–3.5	—	5–8	23–25	—	—	0.59–0.62
7	11–18	13.5–21	350–419	2.5–4.5	4–6.5	2	9–11	26	1–2	7–8	0.63–0.75
8	19–28	21.5	323–349	5–7.5	7–8.5	—	12–13	27–28	3	9	0.76–0.82
9	29–40	22–29	300–322	8–10	9–10	3	—	29–34	4	10–11	0.83–0.92
10	41–59	29.5–30	256–299	10.5–11.5	10.5–12	4	14–16	35	5	12	0.93–0.94
11	60–71	30.5–33	205–255	12–13	12.5–13.5	5	17–19	36–38	6	13	—
12	72–81	—	180–204	13.5–15	14–15.5	—	20–21	39	7–8	—	—
13	82–89	33.5–35	144–179	15.5–18	16–18	6	22	40	—	14	0.95–1.08
14	90–94	—	120–143	18.5–19.5	18.5	7	23	—	9	—	1.09–1.10
15	95–97	—	113–119	20–22	—	8	24–25	41–42	10–11	15	1.11–1.17
16	98	—	90–112	—	—	—	—	—	—	—	—
17	99	—	—	—	—	—	—	—	—	—	—
18	>99	35.5–36	≤89	22.5–36	19–36	9–16	31–48	43–48	12–16	16	≥1.18
Sample size		40		40		40			40		

Notes: FCSRT = free and cued selective reminding test; ROCF = Rey–Osterrieth complex figure; RS = raw score; TDR/T3TR = total delayed recall/Trial 3 total recall.

Table 13. Correlations (r) and shared variances (r^2) of age-adjusted NEURONORMA scores (NSS_A) with age and education (years)

Variables	Age (years)		Education (years)	
	r	r^2	r	r^2
ROCF				
Copy				
Time (s)	−0.03589	0.00129	0.38195	0.14995
Accuracy	−0.05154	0.00266	0.29866	0.08920
Memory				
Immediate recall (accuracy)	−0.01915	0.00037	0.24934	0.06217
Delayed recall (accuracy)	−0.03106	0.00096	0.25951	0.06735
FCSRT				
Trial 1 free recall	−0.03634	0.00132	0.29129	0.08485
Total free recall	−0.05400	0.00292	0.32462	0.10538
Total recall (free recall + cued recall)	−0.07973	0.00636	0.33688	0.11349
Delayed free recall	−0.07637	0.00583	0.30934	0.09569
Delayed total recall	−0.15937	0.02540	0.34300	0.11765
Total delayed recall/Trial 3 total recall	−0.13261	0.01759	0.21283	0.04530

Notes: FCSRT = free and cued selective reminding test; ROCF = Rey–Osterrieth complex figure.

Table 14. ROCF: copy (time). Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times [Education_{(years)} - 12])$, where $\beta = 0.19735$

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

Note: ROCF = Rey–Osterrieth complex figure.

Discussion

The purpose of this report was to provide normative comprehensive data for older Spaniards for the ROCF and the FCSRT. Age-adjusted normative data and regression-based adjustments for education are presented.

Rey–Osterrieth Complex Figure

Although age and education affected the score of the ROCF, sex was found to be unrelated in this normal sample. The results observed concerning sex confirm that the differences are minor or nonexistent (Berry et al., 1991; Boone et al., 1993).

Education has a more important role than age on scores (10%–17% vs. 4%–10% of shared variances). Time to complete the task increases with age and is more affected by education (10% vs. 17% of shared variance). This study confirms previous ones (Ardila & Roselli, 1989; Ardila et al., 1989, 1994; Berry et al., 1991; Caffarra et al., 2002; Rosselli & Ardila, 1991) in which

Table 15. ROCF: copy (accuracy). Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times [Education_{(years)} - 12])$, where $\beta = 0.21285$

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

Note: ROCF = Rey–Osterrieth complex figure.

Table 16. ROCF: immediate recall (accuracy). Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times [Education_{(years)} - 12])$, where $\beta = 0.12856$

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	3	3	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	0
3	4	4	4	4	4	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	1
4	5	5	5	5	5	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	2
5	6	6	6	6	6	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	3
6	7	7	7	7	7	6	6	6	6	6	6	6	6	5	5	5	5	5	5	5	4
7	8	8	8	8	8	7	7	7	7	7	7	7	7	6	6	6	6	6	6	6	5
8	9	9	9	9	9	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	6
9	10	10	10	10	10	9	9	9	9	9	9	9	9	8	8	8	8	8	8	8	7
10	11	11	11	11	11	10	10	10	10	10	10	10	10	9	9	9	9	9	9	9	8
11	12	12	12	12	12	11	11	11	11	11	11	11	11	10	10	10	10	10	10	10	9
12	13	13	13	13	13	12	12	12	12	12	12	12	12	11	11	11	11	11	11	11	10
13	14	14	14	14	14	13	13	13	13	13	13	13	13	12	12	12	12	12	12	12	11
14	15	15	15	15	15	14	14	14	14	14	14	14	14	13	13	13	13	13	13	13	12
15	16	16	16	16	16	15	15	15	15	15	15	15	15	14	14	14	14	14	14	14	13
16	17	17	17	17	17	16	16	16	16	16	16	16	16	15	15	15	15	15	15	15	14
17	18	18	18	18	18	17	17	17	17	17	17	17	17	16	16	16	16	16	16	16	15
18	19	19	19	19	19	18	18	18	18	18	18	18	18	17	17	17	17	17	17	17	16

Note: ROCF = Rey–Osterrieth complex figure.

scores were affected by education. The differences observed with the study of Machulda and colleagues (2007) were probably due to sample variations. It is important to point out that the study of Machulda and colleagues included subjects with a minimal education of 9 years.

In agreement with previous studies (e.g., Chiulli et al., 1995; Loring et al., 1990), very little difference (0.5–1 point) was observed between immediate- and delayed-recall trials. This fact also confirms that a decline between immediate- and delayed-recall trials should be considered to be of clinical significance.

Table 17. ROCF: delayed recall (accuracy). Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times [Education_{(years)} - 12])$, where $\beta = 0.13346$

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	3	3	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	0
3	4	4	4	4	4	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	1
4	5	5	5	5	5	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	2
5	6	6	6	6	6	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	3
6	7	7	7	7	7	6	6	6	6	6	6	6	6	5	5	5	5	5	5	5	4
7	8	8	8	8	8	7	7	7	7	7	7	7	7	6	6	6	6	6	6	6	5
8	9	9	9	9	9	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	6
9	10	10	10	10	10	9	9	9	9	9	9	9	9	8	8	8	8	8	8	8	7
10	11	11	11	11	11	10	10	10	10	10	10	10	10	9	9	9	9	9	9	9	8
11	12	12	12	12	12	11	11	11	11	11	11	11	11	10	10	10	10	10	10	10	9
12	13	13	13	13	13	12	12	12	12	12	12	12	12	11	11	11	11	11	11	11	10
13	14	14	14	14	14	13	13	13	13	13	13	13	13	12	12	12	12	12	12	12	11
14	15	15	15	15	15	14	14	14	14	14	14	14	14	13	13	13	13	13	13	13	12
15	16	16	16	16	16	15	15	15	15	15	15	15	15	14	14	14	14	14	14	14	13
16	17	17	17	17	17	16	16	16	16	16	16	16	16	15	15	15	15	15	15	15	14
17	18	18	18	18	18	17	17	17	17	17	17	17	17	16	16	16	16	16	16	16	15
18	19	19	19	19	19	18	18	18	18	18	18	18	18	17	17	17	17	17	17	17	16

Note: ROCF = Rey–Osterrieth complex figure.

Table 18. FCSRT: Trial 1 free recall. Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times [Education_{(years)} - 12])$, where $\beta = 0.15266$

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	3	3	3	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	0	0
3	4	4	4	4	4	4	3	3	3	3	3	3	3	2	2	2	2	2	2	1	1
4	5	5	5	5	5	5	4	4	4	4	4	4	4	3	3	3	3	3	3	2	2
5	6	6	6	6	6	6	5	5	5	5	5	5	5	4	4	4	4	4	4	3	3
6	7	7	7	7	7	7	6	6	6	6	6	6	6	5	5	5	5	5	5	4	4
7	8	8	8	8	8	8	7	7	7	7	7	7	7	6	6	6	6	6	6	5	5
8	9	9	9	9	9	9	8	8	8	8	8	8	8	7	7	7	7	7	7	6	6
9	10	10	10	10	10	10	9	9	9	9	9	9	9	8	8	8	8	8	8	7	7
10	11	11	11	11	11	11	10	10	10	10	10	10	10	9	9	9	9	9	9	8	8
11	12	12	12	12	12	12	11	11	11	11	11	11	11	10	10	10	10	10	10	9	9
12	13	13	13	13	13	13	12	12	12	12	12	12	12	11	11	11	11	11	11	10	10
13	14	14	14	14	14	14	13	13	13	13	13	13	13	12	12	12	12	12	12	11	11
14	15	15	15	15	15	15	14	14	14	14	14	14	14	13	13	13	13	13	13	12	12
15	16	16	16	16	16	16	15	15	15	15	15	15	15	14	14	14	14	14	14	13	13
16	17	17	17	17	17	17	16	16	16	16	16	16	16	15	15	15	15	15	15	14	14
17	18	18	18	18	18	18	17	17	17	17	17	17	17	16	16	16	16	16	16	15	15
18	19	19	19	19	19	19	18	18	18	18	18	18	18	17	17	17	17	17	17	16	16

Note: FCSRT = free and cued selective reminding test.

Free and Cued Selective Reminding Test

As observed by Ivnik and colleagues (1997), the frequency distribution of some FCSRT derived scores was skewed. This fact is psychometrically very important and underscores the need to use cumulative percentile frequencies to assign age-adjusted NEURONORMA scaled score to each FCSRT derived score.

This study confirms that age and education affect the scores of the FCSRT, whereas sex is found to be minor or irrelevant. We also confirm that there is a decline in all measures with advancing age (Campo & Morales, 2004; Larrabee et al., 1988; Sliwinski et al., 1997; Stricks et al., 1998; Wiederholt et al., 1993). Concerning education, there is an obvious discrete effect (up to 11% in total recall). This effect was probably not observed by Ivnik and colleagues (1997), due to the higher education

Table 19. FCSRT: total free recall. Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times [Education_{(years)} - 12])$, where $\beta = 0.17127$

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

Note: FCSRT = free and cued selective reminding test.

Table 20. FCSRT: total recall (free recall + cued recall). Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times [Education_{(years)} - 12])$, where $\beta = 0.19386$

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

Note: FCSRT = free and cued selective reminding test.

level of the MOANS cohort compared with the NEURONORMA. In fact, Ivnik and colleagues (1997) recognized the need for special caution when using MOANS norms with persons having fewer than 8 years of formal education.

Present norms for the FCSRT are hardly comparable with other studies due to the different populations and versions of the test used by researchers. For example, the MOANS project (Ivnik et al., 1997) included pictures as stimuli, and previous Spanish studies used different words and two letters as cues (Campo & Morales, 2004; Campo et al., 2000, 2003).

General Discussion

As in the MOANS projects, NEURONORMA volunteers did not need to be completely medically healthy to participate (Pedraza et al., 2005). Patients with active, chronic medical, psychiatric, or neurological conditions or with physical disabilities

Table 21. FCSRT: delayed free recall. Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times [Education_{(years)} - 12])$, where $\beta = 0.16171$

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	3	3	3	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	0	0
3	4	4	4	4	4	4	3	3	3	3	3	3	3	2	2	2	2	2	2	1	1
4	5	5	5	5	5	5	4	4	4	4	4	4	4	3	3	3	3	3	3	2	2
5	6	6	6	6	6	6	5	5	5	5	5	5	5	4	4	4	4	4	4	3	3
6	7	7	7	7	7	7	6	6	6	6	6	6	6	5	5	5	5	5	5	4	4
7	8	8	8	8	8	8	7	7	7	7	7	7	7	6	6	6	6	6	6	5	5
8	9	9	9	9	9	9	8	8	8	8	8	8	8	7	7	7	7	7	7	6	6
9	10	10	10	10	10	10	9	9	9	9	9	9	9	8	8	8	8	8	8	7	7
10	11	11	11	11	11	11	10	10	10	10	10	10	10	9	9	9	9	9	9	8	8
11	12	12	12	12	12	12	11	11	11	11	11	11	11	10	10	10	10	10	10	9	9
12	13	13	13	13	13	13	12	12	12	12	12	12	12	11	11	11	11	11	11	10	10
13	14	14	14	14	14	14	13	13	13	13	13	13	13	12	12	12	12	12	12	11	11
14	15	15	15	15	15	15	14	14	14	14	14	14	14	13	13	13	13	13	13	12	12
15	16	16	16	16	16	16	15	15	15	15	15	15	15	14	14	14	14	14	14	13	13
16	17	17	17	17	17	17	16	16	16	16	16	16	16	15	15	15	15	15	15	14	14
17	18	18	18	18	18	18	17	17	17	17	17	17	17	16	16	16	16	16	16	15	15
18	19	19	19	19	19	19	18	18	18	18	18	18	18	17	17	17	17	17	17	16	16

Note: FCSRT = free and cued selective reminding test.

Table 22. FCSRT: delayed total recall. Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times [Education_{(years)} - 12])$, where $\beta = 0.26748$

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

Note: FCSRT = free and cued selective reminding test.

were included if the researcher judged that the condition was correctly controlled or resolved and did not cause cognitive impairment. The same criterion was applied in the case of use of psychoactive medications. This broader definition of normality provided a more accurate representation of the normative population of interest (Pedraza et al., 2005).

In order to use the present normative data adequately, it is important to pay attention to the method of administration, the scoring criteria, and the similarity between the characteristics of the studied subject and the demographic features of the NEURONORMA normative samples.

The education adjustment tables of NSS_A (Tables 14–17 for the ROCF and Tables 18–23 for the FCSRT) will help the clinician obtain the expected score considering the number of years of formal education ($NSS_{A\&E}$). In these tables, figures were rounded to an integer and the use of the regression formula described above was avoided. In the case of extreme and

Table 23. FCSRT: retention index (total delayed recall/Trial 3 total recall). Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta \times [Education_{(years)} - 12])$, where $\beta = 0.12962$

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	3	3	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	0
3	4	4	4	4	4	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	1
4	5	5	5	5	5	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	2
5	6	6	6	6	6	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	3
6	7	7	7	7	7	6	6	6	6	6	6	6	6	5	5	5	5	5	5	5	4
7	8	8	8	8	8	7	7	7	7	7	7	7	7	6	6	6	6	6	6	6	5
8	9	9	9	9	9	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	6
9	10	10	10	10	10	9	9	9	9	9	9	9	9	8	8	8	8	8	8	8	7
10	11	11	11	11	11	10	10	10	10	10	10	10	10	9	9	9	9	9	9	9	8
11	12	12	12	12	12	11	11	11	11	11	11	11	11	10	10	10	10	10	10	10	9
12	13	13	13	13	13	12	12	12	12	12	12	12	12	11	11	11	11	11	11	11	10
13	14	14	14	14	14	13	13	13	13	13	13	13	13	12	12	12	12	12	12	12	11
14	15	15	15	15	15	14	14	14	14	14	14	14	14	13	13	13	13	13	13	13	12
15	16	16	16	16	16	15	15	15	15	15	15	15	15	14	14	14	14	14	14	14	13
16	17	17	17	17	17	16	16	16	16	16	16	16	16	15	15	15	15	15	15	15	14
17	18	18	18	18	18	17	17	17	17	17	17	17	17	16	16	16	16	16	16	16	15
18	19	19	19	19	19	18	18	18	18	18	18	18	18	17	17	17	17	17	17	17	16

Note: FCSRT = free and cued selective reminding test.

unexpected cases, the resulting adjustment may be placed beyond the defined scaled score ranges (e.g., 19 or 1, respectively). In these extreme cases, the final score should be 18 or 2, respectively.

Despite limitations (restricted representation of very elderly participants and the convenience sample of community volunteers), this study reflects the largest normative study to date for neuropsychological performance of Spanish older subjects on the ROCF and the FCSRT.

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

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Conflict of Interest

None declared.

Appendix

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