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Spanish Multicenter Normative Studies (NEURONORMA Project): Norms for Boston Naming Test and Token Test

Jordi Peña-Casanova[a,b,*], Sonia Quiñones-Úbeda[b], Nina Gramunt-Fombuena[b], Miquel Aguilar[c], Laura Casas[c], José Luis Molinuevo[d], Alfredo Robles[e], Dolores Rodríguez[e,f], María Sagrario Barquero[g,†], Carmen Antúnez[h], Carlos Martínez-Parra[i], Anna Frank-García[j], Manuel Fernández[k], Ana Molano[k], Verónica Alfonso[l], Josep M. Sol[l], Rafael Blesa[m], for the NEURONORMA Study Team[‡]

[a]*Section of Behavioral Neurology and Dementias, Hospital del Mar, Institut Municipal d'Assistència Sanitària, Barcelona, Spain*
[b]*Institut Municipal d'Investigació Mèdica, Barcelona, Spain*
[c]*Service of Neurology, Hospital Mútua de Terrassa, Terrassa, Spain*
[d]*Service of Neurology, Hospital Clínic, Barcelona, Spain*
[e]*Service of Neurology, Hospital Clínico Universitario, Santiago de Compostela, Spain*
[f]*Clinical Psychology and Psychobiology Department, University of Santiago de Compostela, Spain*
[g]*Service of Neurology, Hospital Clínico San Carlos, Madrid, Spain*
[h]*Service of Neurology, Hospital Virgen Arrixaca, Murcia, Spain*
[i]*Service of Neurology, Hospital Virgen Macarena, Sevilla, Spain*
[j]*Department of Neurology, Hospital Universitario La Paz, Madrid, Spain*
[k]*Service of Neurology, Hospital de Cruces, Bilbao, Spain*
[l]*European Biometrics Institute, Barcelona, Spain*
[m]*Service of Neurology, Hospital de la Santa Creu i Sant Pau, Barcelona, Spain*

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Abstract

As part of the Spanish Multicenter Normative Studies (NEURONORMA project), we provide age- and education-adjusted norms for the Boston naming test and Token test. The sample consists of 340 and 348 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. Age and education affected the score of the both tests, but sex was found to be unrelated to naming and verbal comprehension efficiency. Our norms should provide clinically useful data for evaluating elderly Spaniards. The normative data presented here were obtained from the same study sample as all the other NEURONORMA norms and the same statistical procedures for data analyses were applied. These co-normed data allow clinicians to compare scores from one test with all tests.

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

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 second edition of the Boston naming test (BNT) and the Token test (TT).

* Corresponding author at: Institut Municipal d'Investigació Mèdica, Biomedical Research Park Building, Carrer Dr Aiguader, 88, 08003 Barcelona, Spain. Tel.: +34-933160765; fax: +34-933160723.

E-mail address: jpcasanova@imas.imim.es (J. Peña-Casanova).

† Deceased.

‡ The members of the NEURONORMA.ES Study Team are listed in the Appendix.

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Boston Naming Test

The BNT is a widely used neuropsychological instrument that was developed to assess visual naming ability (Kaplan, Goodglass, & Weintraub, 1983). It is often employed as one of many tests to evaluate cognitive impairment in cases with suspected dementia and possible anomia (Tallberg, 2005). It has undergone several modifications over the years (*see* Mitrushina, Boone, Razani, & D'Elia, 2005, for a review). In 2001, a second edition was published (Kaplan, Goodglass, & Weintraub, 2001) that included a multiple choice form. In the BNT, patients are presented with 60 line drawings of different objects. Items pertain to three groups representing objects of high (easy to name), medium, and low (hard to name) frequency of occurrence. The maximum score is 60.

Demographic effects such as age, education, and sex have been frequently associated with the BNT scores. Age effects have been shown by a series of studies in which a lower performance on the BNT in older people was a general and consistent conclusion (e.g., Au et al., 1995; Farmer, 1990; Fastenau, Denburg, & Maurer, 1998; Feyereisen, 1997; Goulet, Ska, & Kahn, 1994; Kimbarrow, Vangel, & Lichtenberg, 1996; LaBarge, Edwards, & Knesevich, 1986; Lansing, Ivnik, Cullum, & Randolph, 1999; MacKay, Connor, Albert, & Obler, 2002; Marien, Mampaey, Vervaet, Saerens, & De Deyn, 1998; Neils et al., 1995; Nicholas, Brookshire, MacLennan, Schumacher, & Porrazzo, 1989; Randolph, Lansing, Ivnik, Cullum, & Hermann, 1999; Ross et al., 1998; Saxton et al., 2000; Tallberg, 2005; Van Gorp, Satz, Kiersch, & Henry, 1986; Worrall, Yiu, Hickson, & Barnett, 1995). Education effects were reported by most of these studies, and high education levels were frequently associated with higher scores on the BNT (Borod, Goodglass, & Kaplan, 1980; Ivnik, Malec, Smith, Tangalos, & Petersen, 1996; Lansing et al., 1999; Lucas et al., 2005; Neils et al., 1995; Randolph et al., 1999; Tombaugh & Hubley, 1997; Welch, Doineau, Johnson, & King, 1996; Worrall et al., 1995). However, other reports concluded that education had less influence than an IQ rating (Steinberg, Bieliauskas, Smith, Langellotti, & Ivnik, 2005). A recent study by Zec, Burkett, Markwell, and Larsen, (2007a, 2007b) found "significantly poorer mean BNT scores and increasing variability with successively older age groups and decreasing educational levels, indicating the need for demographically normative data when determining an individual's degree of impairment" (Zec et al., 2007b, p. 617).

Conversely, sex has been shown in several studies to be unrelated to naming efficiency in normal samples (Cruice, Worrall, & Hickson, 2000; Fastenau et al., 1998; Henderson, Frank, Pigatt, Abramson, & Houston, 1998; Ivnik et al., 1996; LaBarge et al., 1986), although some studies (Ivnik et al., 1996; Lansing et al., 1999; Tombaugh & Hubley, 1997; Welch et al., 1996) found a slight, but insignificant, male advantage on the BNT. Contradictory results about the impact of ethnicity and culture on BNT performance have been provided. Although a large group of cross-cultural studies emphasized socio-economic status, ethnicity, and cultural factors as important variables for performance on the BNT (Boone, Victor, Wen, Razani, & Pontón, 2007; Kimbarrow et al., 1996; Lucas et al., 2005), others did not find notable differences in naming ability among elderly people of different ethnicity (Henderson et al., 1998; Manly, Jacobs, Touradji, Small, & Stern, 2002). Finally, some studies reported data from English–Spanish bilinguals (Acevedo & Loewenstein, 2007; Gollan, Fennema-Notestine, Montoya, & Jernigan, 2007; Kohnert, Hernández, & Bates, 1998).

There are a number of studies that provide normative data for the different languages that the BNT has been adapted to (Lezak, Howieson, & Loring, 2004; Mitrushina et al., 2005; Strauss, Sherman, & Spreen, 2006). Zec and colleagues (2007b) have recently published normative data for the BNT from a large group for older people. Several long-form versions exist in Spanish (Allegri et al., 1997; Ardila, Rosselli, & Puente, 1994). Allegri and colleagues (1997) reported normative data for the BNT which were collected from 200 residents of Buenos Aires across an adult age span. Recently, Quiñones-Úbeda, Peña-Casanova, Bohm, Gramunt-Fombuena, and Comas (2004) published an adaptation of the second edition of the BNT, but only normative data for young people were reported. In a more recent study, Rami and colleagues (2008) reported normative data for the BNT on 121 Spanish-speaking elderly people. The mean score was 49.6 ($SD = 5.6$) and was influenced by sex and the level of education.

Short forms of the BNT were developed in order to reduce the test time for patients (for a review see Kent & Luszcs, 2002; Mitrushina et al., 2005; Strauss et al., 2006). The second edition of the test (Kaplan et al., 2001) includes one of the 15-item short versions developed by Mack, Freed, Williams, and Henderson (1992). With regard to Spanish short forms, a 30-item form was developed for Spanish-speaking people in the USA (Pontón et al., 1996; Pontón, González, Hernández, Herrera, & Higareda, 2000). A 12-item version was developed by Serrano and colleagues (2001) and was used in the diagnosis of Alzheimer's disease. Finally, Calero, Arnedo, Navarro, Ruiz-Pedrosa, and Carnero (2002) presented a 12-item reduced version for assessing patients who required shorter testing methods.

Token Test

The TT was originally developed by De Renzi and Vignolo (1962; the so-called long form) and has been the object of multiple versions and modifications (*see* McNeil & Prescott, 1978, for an early review). Modifications of the original test include short forms (Benton, Hamsher, & Sivan, 1994 [multilingual aphasia examination, MAE]; De Renzi & Faglioni, 1975, 1978; Emery, 1986; Smith, Mann, & Shankweiler, 1986; Spellacy & Spreen, 1969; Van Harskamp & Van Dongen, 1977). The MAE version was included in the MOANS project (Ivnik et al., 1996; Lucas et al., 2005; Steinberg et al., 2005). Another version of the TT was that included in the Neurosensory Center Comprehensive Examination for Aphasia (NCCEA) by Spreen and Benton (1969, 1977).

There are a number of studies that provide normative data for the TT (Lezak et al., 2004; Strauss et al., 2006) including Spanish (Ardila et al., 1994; Rey, Sivan, & Benton, 1998 [MAE version, 3rd ed.]), Danish (Nielsen, Lolk, & Kragh-Sorensen, 1995), Portuguese (Fontanari, 1989), and French (Giroux, Salamé, Bédard, & Bellavance, 1992).

Demographic effects on the TT, mainly age and education, were shown to be minor. In fact, performance improves in childhood, reaching adult scores about age 11 (Strauss et al., 2006). Age-related effects were reported as few in a series of papers (De Renzi & Faglioni, 1978; Ivnik et al., 1996; Swisher & Sarno, 1969); however, Emery (1986), using the NCCEA, found an age-related decline in individuals aged 30–93 years, with lower scores in elderly (75–93) healthy subjects.

Concerning education, scores were found to be modestly associated with an adult's level of education (Orgass & Poeck, 1966), but De Renzi and Faglioni (1978) recommended a correction for education [+2.36 − (.30 × years of formal schooling)] for an item-by-item scoring.

The TT encapsulates a series of cognitive processes in addition to auditory comprehension, including working memory (Emery, 1986; Kitson, 1985; Lesser, 1976; Smith et al., 1986), analysis of the whole into a series of items, or the ability to adequately ignore automatically evoked, distracting stimuli (Strauss et al., 2006). There is also a general cognitive ability influence on the TT, with a high correlation with the MMSE ($r = .74$; Swihart, Panisett, & Becker, 1989), and a lower correlation ($r = .35$) with the Raven progressive matrices for brain-damaged subjects (Coupar, 1976). TT performance is mainly dependent on parietotemporal metabolism (Karbe, Herholz, Szelies, Pawlik, Wienhard, & Heiss, 1989). It shows a high correlation with other measures of receptive ability, such as the Peabody picture vocabulary test ($r = .71$; Lass & Golden, 1975), the Porch index of communicative abilities, and the Boston diagnostic aphasia examination (Morley, Lundgren, & Haxby, 1979). The TT also correlates with the measures of language production (Gutbrod, Meger, Meter, & Cohen, 1985).

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). Ethical approval for the study was granted by the Research Ethics Committee of the Municipal Institute of Medical Care of Barcelona, Spain, and from the different participating 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.

Recruitment procedures, sample characteristics, and other aspects of the NEURONORMA research program have been previously reported and will not be reiterated here (Peña-Casanova et al., 2009). Study participants were identified as normal based on criteria established for the NEURONORMA research. Following the MOANS model (Ivnik et al., 1992, 1996; Lucas et al., 2005), volunteers did not need to be completely medically healthy to participate. Demographic information concerning the BNT and the TT is presented in Table 1.

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.

Boston naming test

In order to adapt the test to Spain, an extra item was added: "magdalena" (a cupcake or fairy cake made in a small paper cup container [muffin]), as an alternative to "pretzel' (Quiñones-Úbeda et al., 2004). A multiple choice form was developed following a three-step process. First, three translations into Spanish were prepared by researchers (JP-C, Peter Bohm, NG-F). Second, the three translations were reconciled into one version, and words checked in the official dictionary of the Royal Academy of Spanish Language (2001). Finally, this version was tested empirically for clarity and acceptability of wording with four individuals who were native in Spanish. Standard instructions indicate beginning with Item 30 and proceeding forward unless an error is made prior to achieving eight consecutive correct responses. Instead of standard instructions, as this was a normative study, the test was administered entirely from Item 1 to Item 60. The reason for this method was that in order to develop

Table 1. Sample size by demographics and test

	Boston Naming Test		Token Test	
	Count	Percentage of Total	Count	Percentage of Total
Age group				
50–56	75	22.06	76	21.84
57–59	51	15.00	51	14.66
60–62	33	9.71	34	9.77
63–65	18	5.29	18	5.17
66–68	25	7.35	26	7.47
69–71	49	14.41	49	14.08
72–74	31	9.12	33	9.48
75–77	29	8.53	30	8.62
78–80	19	5.59	20	5.75
>80	10	2.94	11	3.16
Education (years)				
≤5	69	20.29	73	20.98
6–7	21	6.18	25	7.18
8–9	67	19.71	67	19.25
10–11	38	11.18	40	11.49
12–13	36	10.59	35	10.06
14–15	33	9.71	33	9.48
≥16	76	22.35	75	21.55
Gender				
Men	138	40.59	139	39.94
Woman	202	59.41	209	60.06
Total sample (*n*)	340		348	

future short forms, we wanted to know the specific contribution of each item on the final score. We also avoided the problem of rigorous or lenient interpretation of the discontinuation rule as discussed by Lucas and colleagues (2005).

Following the BNT instructions, participants were allowed up to 20 s to name each item. A stimulus cue was provided when no response was given after 20 s, the participant stated that he/she did not know the name, or the item was incorrectly perceived. As an example of the latter, if a participant misperceived the item "harmonica" as a "train", he/she would be given the semantic stimulus cue (sem-C) that the item was a picture of a musical instrument. The participant was again allowed up to 20 s to name the picture after being provided with the sem-C. If the participant still did not recognize the picture after receiving the sem-C, or misnamed the picture, the examiner proceeded to phonemic cueing (phon-C). In those cases in which the participant named the semantic class, or superordinate ("musical instrument" for "harp"), he/she was prompted to give the specific name. Finally, after the test was completed, the examiner returned to each item incorrectly named after a phon-C and presented the card with that item and four printed name choices. The examiner read each word and asked the participant to indicate the correct name. The total score (TS) on the test was the number of correct responses produced spontaneously (SR) and with the aid of sem-C (TS = SR + sem-C).

Token test

The TT version included in this project was De Renzi and Faglioni's (1978) short form. It was administered according to the standard procedures of the original publication. This version consists of 36 items in six parts. It uses 20 plastic tokens in five colors, two sizes, and two shapes. In the first five parts, should the participant fail or not to respond for 5 s, the examiner returns the misplaced tokens to their original positions and repeats the command. Success on the second try earns half a credit. In the last part, just one attempt to carry out the command correctly is permitted. The maximum TS is 36.

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 in this research project. 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 provides norms for individuals of that age, plus or minus 1 year; (b) Determination of age, sex, and education effects on raw sub-test scores.

Coefficients of correlation (r) and determination (r^2) of raw scores with age, years of education, and sex were determined for the BNT; (c) Creation of age-adjusted normative tables. To ensure a normal distribution, the frequency distribution of the raw scores (i.e. TS) was converted into age-adjusted scaled scores, NSS_A (NEURONORMA scaled score age-adjusted). For each age range, 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, percentile ranks were converted to scaled scores (from 2 to 18) based on percentile ranges. This transformation of raw scores to NSS_A produced a normalized distribution (mean $= 10$; $SD = 3$) on which linear regressions could be applied; (d) Education adjustments. Years of education were modeled using the following equation: $NSS_A = k + (\beta \times \text{Educ})$. The regression coefficient (β) from this analysis was 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: $NSS_{A\&E} = NSS_A - (\beta \times [\text{Educ} - 12])$. The obtained value was truncated to the next lower integer (e.g., 10.75 would be truncated to 10).

Results

Age distribution of the sample made it possible to calculate norms for the following 10 midpoint age groups: 54–56, 57–59, 60–62, 63–65, 66–68, 69–71, 72–74, 75–77, 78–80, >80. Sample sizes resulting from midpoint age intervals are presented in every normative table.

Correlations (Pearson's, r) and shared variance (determination coefficient, r^2) of BNT and TT scores with age (years), education (years), and sex are presented in Table 2. Age and education accounted significantly for the raw-score variance of both measures (age: 7% and education: 29% for BNT; age: 16% and education: 25% for TT). Sex differences were not observed, indicating no need to control this demographic variable.

Age-adjusted NEURONORMA scaled scores (NSS_A) for the BNT and TT are presented in Tables 3 and 4 and include percentile ranks, ranges of ages contributing to each normative sub-sample, and the number of participants contributing to each test's normative estimates. Owing to the less number of correct responses in naming the item "pretzel", we decided

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

	Age (years)		Education (years)		Sex	
	r	r^2	r	r^2	r	r^2
Boston naming test	−0.2787	0.0777	0.5467	0.2989	−0.0934	0.0087
Token test	−0.4091	0.1674	0.5033	0.2533	−0.0009	0.0000

Table 3. Age-adjusted NEURONORMA scores (NSS_A) for the BNT

Scaled Score	Percentile Range	Age Range (years)									
		50–56	57–59	60–62	63–65	66–68	69–71	72–74	75–77	78–80	81+
2	<1	≤34	≤31	≤31	≤30	≤30	≤30	≤30	≤29	≤29	≤29
3	1	—	—	—	31	—	31	—	30	30	—
4	2	35–37	32–33	32–33	—	31	32	—	—	—	30
5	3–5	38	34–36	34–36	32–35	32–36	33–36	31–35	31–32	31	—
6	6–10	39–41	37–39	37–38	36–38	37–38	37–39	36–37	34–35	32–35	31–32
7	11–18	42–44	40–42	39–42	39–42	39–41	40–42	38–40	36–40	36	33–34
8	19–28	45	43–45	43–44	43–44	42–44	43	41–43	41–42	37–41	35–37
9	29–40	46–49	46–48	45–47	45–46	45–46	44–46	44–45	43–44	42–43	38–43
10	41–59	50–52	49–51	48–51	47–51	47–51	47–49	46–48	45–48	44–46	44–45
11	60–71	53–54	52–53	52–53	52	52–53	50–52	49–50	49–50	47–48	46–47
12	72–81	55	54–55	54	53–54	54	53–54	51–52	51–52	49–51	48–51
13	82–89	56	56	55	55	55	55	53–54	53–54	52	52
14	90–94	57	—	56	56	56	56	55–56	55–56	53	53
15	95–97	—	57	57	57	57–58	57–58	57	57	54	54–55
16	98	58–59	58	58	58–59	—	—	58	—	55	56
17	99		59	59	—	59	59	59	58	56	—
18	>99	60	60	60	60	60	60	60	59–60	57–60	57–60
Age range		50–60	53–63	56–66	59–69	62–72	65–75	68–78	71–81	74–84	77+ (77–90)
Sample size		136	132	123	105	118	124	123	97	62	38

Table 4. Age-adjusted NEURONORMA scores (NSS_A) for Token test

Scaled Score	Percentile Range	Age Range (years)									
		50–56	57–59	60–62	63–65	66–68	69–71	72–74	75–77	78–80	81+
2	<1	<25	≤25	≤24.5	≤21.5	≤21.5	≤21.5	≤23.5	≤23.5	—	—
3	1	25.5–28	25.5–26	25	22–24.5	22–24.5	22–23.5	24–25	24	—	—
4	2	28.5–29.5	—	25.5–26	25	—	24–24.5	25.5–26	24.5–25	≤23.5	≤21.5
5	3–5	30–30.5	26.5–29	26.5–28	25.5–27	25–28.5	25–26	26.5–27	25.5–26	24–25	—
6	6–10	31–31.5	29.5–31.5	28.5–30.5	27.5–30	29–29.5	26.5–29	27.5–28.5	26.5–27.5	25.5–26	22–24
7	11–18	—	—	31–31.5	30.5–31	30–30.5	29.5–30	29–29.5	28–29.5	26.5–28	24.5–27.5
8	19–28	32–33	32–32.5	32–32.5	31.5–32	31–32	30.5–31	30–31	30–30.5	28.5–30	28–29
9	29–40	33.5	33–33.5	33	32.5	32.5	31.5–32.5	31.5	31–31.5	30.5–31	29.5–30.5
10	41–59	34–34.5	34–34.5	33.5–34.5	33–33.5	33–33.5	33–33.5	32–32.5	32–32.5	31.5–32	31–31.5
11	60–71	—	—	—	34	34–34.5	—	33–33.5	33–33.5	32.5	32
12	72–81	35–35.5	35–35.5	—	—	—	34–34.5	—	—	33	32.5–33
13	82–89	—	—	35–35.5	34.5–35.5	35	—	34–34.5	34.34.5	—	—
14	90–94	—		—	—	35.5	35	—	—	33.5–34	33.5–35
15	95–97	—	—	—	—	—	—	35	35–35.5	34.5–35	35.5
16	98	—	—	—	—	—	—	—	—	35.5	—
17	99	—	—	—	—	—	—	—	—	—	—
18	>99	36	36	36	36	36	35.5–36	35.5–36	36	36	36
Age range		50–60	53–63	56–66	59–69	62–72	65–75	68–78	71–81	74–84	77+ (77–90)
Sample size		137	133	124	107	122	128	127	101	64	40

not to include this item in the statistical analysis (3.6% of the participants named it spontaneously compared with 77.3% correct answers obtained from the item "magdalena"). To use the table, select the appropriate column corresponding to the patient's age, find the patient's raw score, and subsequently refer to the corresponding NSS_A and percentile rank (left part of the tables).

As expected, the normative adjustments reduce shared variance of age to virtually $<1\%$ in both tests ($r = 0.057$; $r^2 = 0.003$ for BNT and $r = 0.13735$; $r^2 = 0.01887$ for TT). Education, however, continues to account significantly for age-adjusted test-score variance in both cases: for up to 27.5% for BNT ($r = 0.525$; $r^2 = 0.275$) and for up to 20.7% for TT ($r = 0.45561$; $r^2 = 0.207$).

The transformation of raw scores to NSS_A produced a normalized distribution on which linear regressions could be applied. Regression coefficients from this analysis were used as the basis for education corrections. The resulting computational formulae were used to calculate $NSS_{A\&E}$ ($\beta = 0.27746$ for BNT and $\beta = 0.29451$ for TT). From these data, we have constructed adjustment tables (Tables 5 and 6) to help the clinician make the necessary changes. 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

Table 5. Boston naming test

SSS_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	5	4	4	4	3	3	3	3	2	2	2	2	1	1	1	0	0	0	0	−1
3	6	6	5	5	5	4	4	4	4	3	3	3	3	2	2	2	1	1	1	1	0
4	7	7	6	6	6	5	5	5	5	4	4	4	4	3	3	3	2	2	2	2	1
5	8	8	7	7	7	6	6	6	6	5	5	5	5	4	4	4	3	3	3	3	2
6	9	9	8	8	8	7	7	7	7	6	6	6	6	5	5	5	4	4	4	4	3
7	10	10	9	9	9	8	8	8	8	7	7	7	7	6	6	6	5	5	5	5	4
8	11	11	10	10	10	9	9	9	9	8	8	8	8	7	7	7	6	6	6	6	5
9	12	12	11	11	11	10	10	10	10	9	9	9	9	8	8	8	7	7	7	7	6
10	13	13	12	12	12	11	11	11	11	10	10	10	10	9	9	9	8	8	8	8	7
11	14	14	13	13	13	12	12	12	12	11	11	11	11	10	10	10	9	9	9	9	8
12	15	15	14	14	14	13	13	13	13	12	12	12	12	11	11	11	10	10	10	10	9
13	16	16	15	15	15	14	14	14	14	13	13	13	13	12	12	12	11	11	11	11	10
14	17	17	16	16	16	15	15	15	15	14	14	14	14	13	13	13	12	12	12	12	11
15	18	18	17	17	17	16	16	16	16	15	15	15	15	14	14	14	13	13	13	13	12
16	19	19	18	18	18	17	17	17	17	16	16	16	16	15	15	15	14	14	14	14	13
17	20	20	19	19	19	18	18	18	18	17	17	17	17	16	16	16	15	15	15	15	14
18	21	21	20	20	20	19	19	19	19	18	18	18	18	17	17	17	16	16	16	16	15

Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta^*(Education_{(years)} - 12))$, where $\beta = 0.27746$.

Table 6. Token test

SSS_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	5	4	4	4	4	3	3	3	2	2	2	2	1	1	1	0	0	0	−1	−1
3	6	6	5	5	5	5	4	4	4	3	3	3	3	2	2	2	1	1	1	0	0
4	7	7	6	6	6	6	5	5	5	4	4	4	4	3	3	3	2	2	2	1	1
5	8	8	7	7	7	7	6	6	6	5	5	5	5	4	4	4	3	3	3	2	2
6	9	9	8	8	8	8	7	7	7	6	6	6	6	5	5	5	4	4	4	3	3
7	10	10	9	9	9	9	8	8	8	7	7	7	7	6	6	6	5	5	5	4	4
8	11	11	10	10	10	10	9	9	9	8	8	8	8	7	7	7	6	6	6	5	5
9	12	12	11	11	11	11	10	10	10	9	9	9	9	8	8	8	7	7	7	6	6
10	13	13	12	12	12	12	11	11	11	10	10	10	10	9	9	9	8	8	8	7	7
11	14	14	13	13	13	13	12	12	12	11	11	11	11	10	10	10	9	9	9	8	8
12	15	15	14	14	14	14	13	13	13	12	12	12	12	11	11	11	10	10	10	9	9
13	16	16	15	15	15	15	14	14	14	13	13	13	13	12	12	12	11	11	11	10	10
14	17	17	16	16	16	16	15	15	15	14	14	14	14	13	13	13	12	12	12	11	11
15	18	18	17	17	17	17	16	16	16	15	15	15	15	14	14	14	13	13	13	12	12
16	19	19	18	18	18	18	17	17	17	16	16	16	16	15	15	15	14	14	14	13	13
17	20	20	19	19	19	19	18	18	18	17	17	17	17	16	16	16	15	15	15	14	14
18	21	21	20	20	20	20	19	19	19	18	18	18	18	17	17	17	16	16	16	15	15

Education adjustment applying the following formula: $NSS_{A\&E} = NSS_A - (\beta^*(Education_{(years)} - 12))$, where $\beta = 0.29451$.

$NSS_{A\&E}$. When these formulae are applied to the normative sample, the shared variances between demographically adjusted NEURONORMA scaled scores and years of education are irrelevant ($r = -0.02$; $r^2 = 0.0004$ for BNT and $r = -0.0005$; $r^2 = 0.00003$ for TT).

Discussion

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

Boston Naming Test

Demographic variables, age, and education affected the score of the BNT, whereas sex was found to be unrelated to naming efficiency in this normal sample. Concerning sex, our data confirm some previous studies in the sense that it is unrelated to naming efficiency in normal samples (Cruice et al., 2000; Fastenau et al., 1998; Henderson et al., 1998; Ivnik et al., 1996; LaBarge et al., 1986; Lansing et al., 1999; Marien et al., 1998; Randolph et al., 1999; Saxton et al., 2000; Welch et al., 1996; Zec et al., 2007a, 2007b).

This study also confirms that there is a decline in BNT performance with advancing age as was reported, for example, by Albert, Heller, and Milberg (1988) and Tsang and Lee (2003) who added that decline in naming in the elderly may be multifactorial. Furthermore, Vandenberghe (2004) reported that greater variation in performance in naming tasks was found in the higher-age groups and concluded that naming abilities slightly decline only in very elderly adults.

As stated previously, education was also found to be related to the BNT scores. In this aspect, our study is of particular interest because it includes a wide range of educational levels. The education effect that we found is in agreement with several studies in different cultural groups and languages including Spanish (Allegri et al., 1997; Borod et al., 1980; Deloche et al., 1996; Hawkins & Bender, 2002; Hawkins et al., 1993; Heaton, Avitable, Grant, & Matthews, 1999; Henderson et al., 1998; Kimbarrow et al., 1996; Lansing et al., 1999; Le Dorze & Durocher, 1992; Marien et al., 1998; Neils et al., 1995; Nicholas, Obler, Albert, & Goodglass, 1985; Pontón et al., 1996; Quiñones-Úbeda et al., 2004; Rami et al., 2008; Randolph et al., 1999; Ross, Lichtenberg, & Christensen, 1995; Saxton et al. 2000; Thompson & Heaton, 1989; Welch et al., 1996; Worrall et al., 1995).

According to this study, a combined effect of age and education should be taken into consideration (Heaton et al., 1999; Zec et al., 2007a). To help clinicians, NSS_A were adjusted to $NSS_{A\&E}$ using a table resulting from the application of computational formulae. In this table, figures were rounded to an integer. In the case of very extreme scores (e.g., a person with 1 year of education and a NSS_A of 18, or a person of 20 years of education and an 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.

Our study shows an extremely low frequency of correct responses in the naming of “pretzel” in a sample of Spanish healthy controls. The higher performance on naming the item “magdalena” justifies our recommendation to use “magdalena” as an alternative to “pretzel” in the Spanish population. These results are comparable to those obtained in previous Spanish norms in young people (Quiñones-Úbeda et al., 2004).

The presented norms for the BNT are only comparable in part to previous Spanish studies due to the fact that in this study, the original items were maintained. Even though other Spanish versions suggest adapting some items from the original test (e.g., Serrano et al., 2001), we believe that more studies about the suitability of each item for assessment of naming ability in Spanish would be necessary.

Token Test

Although age and education affected the score of the TT, sex was found to be unrelated to the TT scores in this normal sample. This study confirms that age-related effects are few, with lower scores in elderly subjects (De Renzi & Faglioni, 1978; Emery, 1986; Ivnik et al., 1996; Swisher & Sarno, 1969). In addition to the figures observed, Table 4 shows that an NSS_A of 10 decreased from 34–34.5 points, at 50–56 years, to 31–31.5 points, at age 81+.

Education has a more important role than age in our sample. We confirm early studies from Orgass and Poeck (1966) and De Renzi and Faglioni (1978). The education adjustment table of NSS_A (Table 6) will help the clinician to obtain the expected score considering the number of years of formal education ($NSS_{A\&E}$). In this table, figures were rounded to an integer. As in the case of the BNT, the resulting adjustment may be placed beyond the defined scaled score ranges (e.g., 20 or 0). In these extreme cases, the final score should be 18 or 2, respectively. In fact, the proposed adjustments are minor, as were the raw-score adjustments for education proposed by De Renzi and Faglioni (1978).

Owing to significant differences in samples, it is difficult to compare our data with other Spanish language studies; nevertheless, we are able to confirm the need of adjustments for age and education (Ardila et al., 1994).

Final Conclusions

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 samples. 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 in the Spanish population.

As concluded in other similar studies, it would not be accurate to apply these computational formulae to younger individuals due to the different impact of the demographic variables on the cognitive performance across the life span (e.g. Lucas et al., 2005).

Despite its limitations, this study reflects the largest normative study to date for neuropsychological performance of Spanish older subjects on the BNT and TT. 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 allow clinicians to compare scores from one test with all tests included in the project.

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Conflict of Interest

None declared.

Appendix

Members of the NEURONORMA.ES Study Team

Steering Committee: JP-C, Hospital del Mar, Barcelona, Spain; RB, Hospital de la Santa Creu i Sant Pau, Barcelona, Spain; MA, Hospital Mútua de Terrassa, Terrassa, Spain.

Principal Investigators: JP-C, Hospital de Mar, Barcelona, Spain; RB, Hospital de la Santa Creu i Sant Pau, Barcelona, Spain; MA, Hospital Mútua de Terrassa, Terrassa, Spain; JLM, Hospital Clínic, Barcelona, Spain; AR, Hospital Clínico Universitario, Santiago de Compostela, Spain; MSB, Hospital Clínico San Carlos, Madrid, Spain; CA, Hospital Virgen Arrixaca, Murcia, Spain; CM-P, Hospital Virgen Macarena, Sevilla, Spain; AF-G, Hospital Universitario La Paz, Madrid, Spain; MF, Hospital de Cruces, Bilbao, Spain.

Genetics Sub-study: Rafael Oliva, Service of Genetics, Hospital Clínic, Barcelona, Spain.

Neuroimaging Sub-study: Beatriz Gómez-Ansón, Radiology Department and IDIBAPS, Hospital Clínic, Barcelona, Spain. Research Fellows: Gemma Monte, Elena Alayrach, Aitor Sainz, and Claudia Caprile, Fundació Clinic, Hospital Clinic, Barcelona, Spain; Gonzalo Sánchez, Behavioral Neurology Group, Institut Municipal d'Investigació Mèdica, Barcelona, Spain.

Clinicians, Psychologists, and Neuropsychologists: NG-F (Coordinator), Peter Böhm, Sonia González, Yolanda Buriel, María Quintana, SQ-U, Gonzalo Sánchez, Rosa M. Manero, and Gracia Cucurella, Institut Municipal d'Investigació Mèdica, Barcelona, Spain; Eva Ruiz, Mónica Serradell, and Laura Torner, Hospital Clínic, Barcelona, Spain; Dolors Badenes, LC, Noemí Cerulla, Silvia Ramos, and Loli Cabello, Hospital Mútua de Terrassa, Terrassa, Spain; DR, Clinical Psychology and Psychobiology Department, University of Santiago de Compostela, Spain; María Payno, and Clara Villanueva, Hospital Clínico San Carlos, Madrid, Spain; Rafael Carles, Judit Jiménez, Martirio Antequera, Hospital Virgen Arixaca, Murcia, Spain; Jose Manuel Gata, Pablo Duque, and Laura Jiménez, Hospital Virgen Macarena, Sevilla, Spain; Azucena Sanz and María Dolores Aguilar, Hospital Universitario La Paz, Madrid, Spain; AM, Maitena Lasa, Hospital de Cruces, Bilbao, Spain.

Data Management and Biometrics: Veronica Alfonso, JMS, Francisco Hernández, Irune Quevedo, Anna Salvà, European Biometrics Institute, Barcelona, Spain.

Administrative Management: Carme Pla (†) and Romina Ribas, Department of Psychiatry and Forensic Medicine, Universitat Autònoma de Barcelona, and Behavioral Neurology Group, Institut Municipal d'Investigació Mèdica, Barcelona, Spain.

English Edition: Stephanie Lonsdale, Program of Neuropsychopharmacology, Institut Municipal d'Investigació Mèdica, Barcelona, Spain.

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