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NEUROPSI: A brief neuropsychological test battery in Spanish with norms by age and educational level

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Abstract

The purpose of this research was to develop, standardize, and test the reliability of a short neuropsychological test battery in the Spanish language. This neuropsychological battery was named "NEUROPSI," and was developed to assess briefly a wide spectrum of cognitive functions, including orientation, attention, memory, language, visuoperceptual abilities, and executive functions. The NEUROPSI includes items that are relevant for Spanish-speaking communities. It can be applied to illiterates and low educational groups. Administration time is 25 to 30 min. Normative data were collected from 800 monolingual Spanish-speaking individuals, ages 16 to 85 years. Four age groups were used: (1) 16 to 30 years, (2) 31 to 50 years, (3) 51 to 65 years, and (4) 66 to 85 years. Data also are analyzed and presented within 4 different educational levels that were represented in this sample: (1) illiterates (zero years of school); (2) 1 to 4 years of school; (2) 5 to 9 years of school; and (3) 10 or more years of formal education. The effects of age and education, as well as the factor structure of the NEUROPSI are analyzed. The NEUROPSI may fulfill the need for brief, reliable, and objective evaluation of a broad range of cognitive functions in Spanish-speaking populations. (*JINS*, 1999, *5*, 413–433.)

Keywords: Neuropsychological battery, Spanish speaking norms, Illiterates, Educational level, Aging

INTRODUCTION

Different comprehensive evaluation instruments have been developed to assess cognitive dysfunctions in the neuropsychology domain. Some of these instruments represent extensive neuropsychological test batteries, such as the Halstead–Reitan Neuropsychological Battery (Reitan & Wolfson, 1993), the Luria–Nebraska Neuropsychological Battery (Golden, 1980), and the Scheme of Neuropsychological Assessment (Ardila & Ostrosky, 1991; Ardila et al., 1981). Such comprehensive batteries have two significant limitations: (1) their administration and scoring require many hours making them impractical for use in many clinical settings; and (2) administration and scoring require rather specialized training.

To overcome these difficulties, short mental status questionnaires (e.g., the Mini-Mental Status Exam; Folstein et al., 1975), and behavioral scales (e.g., Blessed Dementia Scale; Blessed et al., 1968) have been developed. They are easy to administer, score, and interpret. These instruments, however, are not completely satisfactory. Some limitations of these short questionnaires are (1) false negatives are high, and they are not sensitive to mild brain impairments (Bertolucci et al., 1994; Dick et al., 1984; Nelson et al., 1986; Schwamm et al., 1987); and (2) they may point to general cognitive impairments, but they are not specific enough.

As a potential solution to these difficulties, some short instruments have been proposed such as the instrument of the Consortium to Establish a Registry for Alzheimer's Disease (CERAD; Morris et al., 1989), or the Brief Neuropsychological Cognitive Examination (BNCE; Tonkonogy, 1997).

In Latin America it is necessary to have neuropsychological tests that are developed and standardized for a Spanish-speaking population. When tests developed in other countries are used within Latin America, frequently they are just translated and the norms of other populations used. This procedure undoubtedly invalidates the results. It is not only important to have data collected in Spanish-speaking populations, but also, given the influence that educational factors have on cognitive performance (Ardila et al., 1989b,

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1992; Finlayson et al., 1977; Lecours et al., 1987; Ostrosky et al., 1985, 1986), norms for neuropsychological tests should represent persons with different educational levels including illiterates.

Furthermore, frequently neuropsychological tests are simply translated to Spanish literally with little consideration of cultural relevance. For example, using backward word spelling for the evaluation of attention (such as in the Mini-Mental State Examination; Folstein et al., 1975), naming the fingers to evaluate language or word finding difficulty (as found in the Alzheimer's Disease Assessment Scale; Rosen et al., 1984), or asking for the seasons of the year to assess orientation, as included in several geriatric scales, may be inappropriate in certain countries and some cultural contexts. In many countries, instead of four seasons there are only a rainy and a dry season. In tropical areas, there may be two rainy and two dry seasons. The seasonal changes around the year may be so mild and unnoticed, that the concept of "season" is irrelevant and nonsense. In many world areas the names of the fingers are rarely used, even by highly educated neurologically intact people.

Given the current limitations in the neuropsychological assessment of Spanish speakers, the purpose of the research described here was to develop, standardize, and test the reliability of a short neuropsychological test battery for the use with Spanish-speaking adults. This test battery was named NEUROPSI (Ostrosky-Solís et al., 1997).

The NEUROPSI has standardized procedures for both administration and scoring. It includes items that are relevant for Spanish speaking individuals, and can be applied to persons who are illiterate or from low educational groups. The battery includes language and picture tests that have high, medium, and low frequency of occurrence in the Spanish language (Aveleyra et al., 1996).

The NEUROPSI was developed taking into account principles and procedures developed in cognitive neuroscience. Therefore, measures of specific cognitive domains that can be differentially impaired following brain damage are included.

The domains covered include Orientation, Attention / Concentration, Language, Memory, Visuo-Motor, Executive Function, Reading, Writing, and Calculation, each having its own subtests. Each area includes assessment of different aspects of that particular cognitive domain. Thus, memory assessment includes immediate and delayed recall of verbal and visual–nonverbal functioning. Retrieval is assessed by independent recall and by different types of cuing (semantic clustering or recognition). Language evaluation includes the assessment of several important parameters such as naming, repetition, comprehension, and fluency. Assessment of attention includes level of alertness, span or efficiency of vigilance–concentration, and selective attention. Executive function includes both problem solving (abstraction and categorization) and several motor programming tasks. Potentially, therefore, the NEUROPSI provides data regarding distinct clinical neuroanatomic syndromes.

Interpretation of NEUROPSI results is twofold: (1) quantitative, in that each item is scored, and can be further compared with normal performance in the general population; and (2) qualitative; different types of errors can be distinguished and specifically analyzed. For example, in addition to an overall memory performance score, the battery provides several memory parameters including rate of decay, primacy and recency effects, rate of acquisition across learning trials, intrusion and perseveration rates, semantic *versus* serial-order clustering and signal detection parameters (discriminability and response bias) of recognition performance.

Table 1. Age, gender, and education distribution

	Age (N = 800)			
Years of education	16 to 30 years	31 to 50 years	51 to 65 years	66 to 85 years
Illiterates (zero years)				
M age (*SD*)	21.3 (3.3)	39.6 (6.7)	58.8 (4.1)	71.2 (4.1)
Female/Male	25/25	25/25	25/24	27/23
1 to 4 years				
M age (*SD*)	21.7 (3.8)	39.8 (5.5)	58.9 (3.9)	73.5 (6.2)
M education (*SD*)	2.9 (1.0)	2.7 (1.1)	2.2 (1.0)	2.5 (1.1)
Female/Male	25/25	27/23	25/24	28/22
5 to 9 years				
M age (*SD*)	22.4 (4.5)	43.6 (4.2)	59.2 (3.7)	73.6 (5.4)
M education (*SD*)	8.6 (0.9)	7.7 (1.5)	7.5 (5.2)	7.6 (1.4)
Female/Male	25/25	28/22	26/25	28/22
10 to 24 years				
M age (*SD*)	23.9 (3.9)	38.6 (6.0)	58.3 (3.8)	72.9 (4.8)
M education (*SD*)	14.5 (2.6)	15.7 (3.3)	16.2 (4.3)	13.5 (2.8)
Female/Male	25/25	30/20	26/25	24/26

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In this paper, the normative data for 800 general population participants are provided and analyzed to determine age, education, and gender effects. Factor structure is also analyzed.

METHODS

Research Participants

The standardization sample consisted of 883 volunteers who were recruited from different community centers from five different states of the Mexican Republic (Mexico City, Colima, Toluca, Morelos, and Oaxaca) over a 4-year period (1993–1996). Sources of participants included in the present analysis were as follows: regional medical facilities (medical and paramedical people and spouses and/or friends and relatives of patients who attended for medical check-ups; 37.9%); nursing homes serving local residents (6.2%); social community centers (24.8%); high-school and university students (18.6%); volunteers and self-referred participants (12.4%). The obtained sample included 665 participants (83.12%) from urban areas, and 135 (16.88%) from rural areas. Ages ranged from 16 to 85 years (M age = 47.77; SD = 20.14). Education ranged from zero to 24 years (M education = 6.8; SD = 6.1). Fifty-two percent of the sample were women. Ninety-five percent of the sample was right-handed.

The following inclusion criteria were used: (1) absence of dementia according to DSM–IV criteria (American Psychiatric Association, 1994); and (2) no neurological or psychiatric history such as brain injury, cerebrovascular disease, epilepsy, Parkinson's disease, depression, substance abuse, psychiatric hospitalizations, and the like. All participants were nonpaid volunteers. All participants were native Spanish speakers and were active and functionally independent. Participants with questionable health histories were excluded, yielding a final sample of 800 participants.

Four age groups were formed: (1) 16 to 30 years, (2) 31 to 50 years, (3) 51 to 65 years, and (4) 66 to 85 years. In

Table 2. Means and standard deviations found in the different NEUROPSI neuropsychological tests according to age in the illiterate group

Test	16 to 30 yrs *M* (*SD*)	31 to 50 yrs *M* (*SD*)	51 to 65 yrs *M* (*SD*)	66 to 85 yrs *M* (*SD*)	Maximum score
Orientation					
Time	2.0 (0.9)	2.6 (0.6)	2.6 (0.6)	2.0 (0.9)	3
Place	1.9 (0.2)	1.9 (2.3)	1.9 (0.3)	1.9 (0.3)	2
Person	0.9 (0.2)	1.0 (0.0)	1.0 (0.0)	0.9 (0.3)	1
Attention					
Digits Backwards	2.2 (1.1)	2.8 (1.1)	2.9 (1.0)	2.7 (0.9)	6
Visual Detection	11.4 (3.5)	11.1 (3.6)	10.0 (4.3)	7.5 (5.6)	16
Twenty Minus Three	2.2 (1.6)	3.8 (1.5)	3.1 (1.8)	2.9 (1.8)	5
Encoding					
Verbal Memory	4.3 (3.6)	4.6 (0.7)	4.6 (0.8)	3.9 (1.0)	6
Copy of a Semicomplex Figure	8.2 (2.2)	7.9 (1.8)	7.7 (2.2)	7.3 (2.7)	12
Language					
Naming	7.3 (1.0)	7.4 (1.0)	7.3 (0.8)	7.5 (0.6)	8
Repetition	3.7 (0.5)	3.8 (0.4)	3.9 (0.3)	3.9 (0.3)	4
Comprehension	3.7 (1.2)	3.8 (1.2)	3.7 (1.4)	3.5 (1.5)	6
Verbal Fluency					
Semantic	13.2 (3.7)	13.7 (4.5)	12.7 (5.0)	13.1 (7.1)	—
Phonologic	3.5 (3.8)	3.5 (3.0)	3.6 (4.1)	3.3 (4.6)	—
Conceptual Functions					
Similarities	2.2 (2.3)	3.6 (2.3)	2.4 (2.3)	2.5 (2.2)	6
Calculation Abilities	1.0 (1.1)	1.4 (1.1)	1.6 (1.1)	0.9 (1.1)	3
Sequences	0.2 (0.4)	0.1 (0.3)	0.2 (0.4)	0.1 (0.2)	1
Motor Functions					
Changing Left-Hand Position	1.1 (0.8)	1.4 (0.6)	1.4 (0.6)	1.4 (0.6)	2
Changing Right-Hand Position	1.0 (0.7)	1.1 (0.6)	1.1 (0.6)	1.4 (0.6)	2
Alternating Movements	1.7 (0.7)	0.8 (0.7)	0.8 (0.6)	1.1 (0.8)	2
Opposite Reactions	2.0 (0.2)	1.7 (0.6)	1.7 (0.5)	1.6 (0.5)	2
Recall					
Words	4.4 (1.6)	3.6 (2.2)	2.4 (2.4)	2.1 (2.3)	6
Cuing	4.7 (1.2)	4.5 (1.4)	4.5 (1.4)	3.7 (1.9)	6
Recognition	5.5 (1.1)	5.7 (0.8)	5.7 (1.1)	5.7 (0.5)	6
Semicomplex Figure	7.5 (2.2)	6.6 (1.8)	6.9 (2.1)	6.4 (3.2)	12

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addition, each age group was divided into four different educational levels: (1) illiterates (zero years of education); (2) 1 to 4 years of education; (3) 5 to 9 years of education; and (4) 10 to 24 years of formal education. Table 1 presents the sample characteristics.

Instrument

The NEUROPSI consists of simple and short items (see Appendix). Some test items were adapted from current neuropsychological instruments. Based on several pilot studies, tests such as the Rey–Osterrieth Complex Figure Test (Osterrieth, 1944) or the Token Test (De Renzi & Vignolo, 1962) were adapted and simplified to be able to evaluate the elderly and low-education populations. Confrontation naming was evaluated with line drawings that were previously standardized in a Spanish speaking population (Aveleyra et al., 1996). By design, NEUROPSI represents a rather basic and simple neuropsychological test battery.

The following sections are included in the NEUROPSI neuropsychological test battery:

1. *Orientation*: *Time* (day, month, and year), *Place* (city and specific place), and *Person* (age or, when were you born). Maximum score = 6 points.
2. *Attention and Concentration* (maximum score = 27): (1) *Digits Backwards*, up to six digits. Maximum score = 6 points. (2) *Visual Detection*. On a sheet that includes 16 different figures, each one repeated 16 times, the respondents are requested to cross out those figures identical to the one presented as a model. The 16 matching figures are equally distributed at the right and at the left visual fields. The test is suspended after 1 min. Two scores are obtained: number of correct responses (maximum score = 16), and number of errors. (3) *Serial 3 Substraction* (from 20 to 5; maximum score = 5).
3. *Encoding* (maximum score = 18): (1) *Verbal Memory*. Six common nouns corresponding to three different se-

Table 3. Means and standard deviations found in the different NEUROPSI neuropsychological tests according to age in the 1-to-4 years of education group

Test	16 to 30 yrs *M* (*SD*)	31 to 50 yrs *M* (*SD*)	51 to 65 yrs *M* (*SD*)	66 to 85 yrs *M* (*SD*)	Maximum score
Orientation					
Time	2.0 (1.1)	2.6 (0.5)	2.7 (0.4)	2.8 (0.4)	3
Place	1.9 (0.2)	2.0 (0.0)	1.9 (0.2)	2.0 (0.0)	2
Person	1.0 (0.0)	0.9 (0.2)	0.9 (0.3)	1.0 (0.0)	1
Attention					
Digits Backwards	2.6 (1.0)	2.7 (0.7)	3.0 (1.0)	2.8 (0.8)	6
Visual Detection	13.8 (2.5)	12.3 (2.7)	9.7 (3.4)	8.9 (3.8)	16
Twenty Minus Three	3.5 (1.6)	3.6 (1.4)	4.3 (1.3)	4.4 (0.9)	5
Encoding					
Verbal Memory	4.4 (0.8)	4.6 (0.7)	4.5 (0.7)	4.5 (0.7)	6
Copy of a Semicomplex Figure	9.5 (2.0)	9.2 (2.6)	9.4 (1.7)	9.2 (2.5)	12
Language					
Naming	7.3 (1.0)	7.7 (0.5)	7.6 (0.7)	7.7 (0.8)	8
Repetition	3.9 (0.3)	3.8 (0.4)	3.9 (0.4)	3.9 (0.3)	4
Comprehension	4.5 (0.9)	4.8 (0.9)	4.6 (1.0)	4.7 (1.0)	6
Verbal Fluency					
Semantic	15.2 (5.6)	14.1 (4.3)	15.5 (4.0)	15.6 (4.1)	—
Phonologic	6.5 (4.3)	6.9 (3.5)	7.4 (4.2)	7.3 (3.7)	—
Conceptual Functions					
Similarities	3.5 (1.8)	4.6 (1.7)	3.8 (1.8)	3.2 (2.0)	6
Calculation Abilities	1.3 (1.1)	1.5 (1.1)	1.6 (1.1)	2.0 (0.9)	3
Sequences	0.4 (0.5)	0.3 (0.5)	0.3 (0.5)	0.2 (0.4)	1
Motor Functions					
Changing Left-Hand Position	1.3 (0.8)	1.4 (0.6)	1.2 (0.8)	1.1 (0.8)	2
Changing Right-Hand Position	1.1 (0.8)	1.2 (0.6)	1.1 (0.8)	1.3 (0.7)	2
Alternating Movements	1.3 (0.7)	1.2 (0.6)	1.0 (0.7)	1.1 (0.8)	2
Opposite Reactions	1.9 (0.3)	1.8 (0.4)	1.7 (0.4)	1.3 (0.7)	2
Recall					
Words	3.9 (2.2)	3.3 (1.8)	2.7 (2.2)	2.3 (1.8)	6
Cuing	4.8 (1.3)	5.1 (1.3)	4.1 (1.5)	3.0 (1.6)	6
Recognition	5.6 (0.7)	5.7 (0.6)	5.3 (0.7)	5.1 (0.9)	6
Semicomplex Figure	8.6 (2.3)	8.2 (2.7)	7.4 (2.2)	6.7 (2.9)	12

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mantic categories (animals, fruits, and body parts), are presented three times. After each presentation, the participant repeats those words that he or she remembers. The score is the average number of words repeated in the three trials (maximum score = 6). In addition, intrusions, perseverations, recency and primacy effects are noted. (2) *Copy of a Semicomplex Figure*. A figure similar to the Rey–Osterrieth Complex Figure, but much simpler, is presented to the participant. The participants are instructed to copy the best they can. A specified scoring system is used, with a maximum score of 12 points.

4. *Language* (maximum score = 26): (1) *Naming*. Eight different line drawing figures are presented to be named. They correspond to animals, musical instruments, body parts and objects. The names used are different from those names included in the Verbal Memory section. If the participant presents visual difficulties, an alternative procedure is used: The patient is required to name body parts and small objects placed in the hand. Maximum score = 8. (2) *Repetition*. The participant is asked to repeat one monosyllabic word, one three-syllable word, one phrase with three words, and one seven-word sentence. Successful repetition in each one is scored 1. Maximum score = 4. (3) *Comprehension*. On a sheet of paper two circles (small and large) and two squares (small and large) are drawn. Six commands, similar to those used in the Token Test are given to the participant. The easiest one is, "Point to the small square," and the hardest one is "In addition to the circles, point to the small square." Maximum score = 6. (4) *Verbal Fluency*: *Semantic Verbal Fluency* (animals). Two scoring systems are used: the total number of correct words; and an abbreviated 4-point scale. In the latter, 1 point is given to zero to 5 words; 2

Table 4. Means and standard deviations found in the different NEUROPSI neuropsychological tests according to age in the 5-to-9 years of education group

Test	16 to 30 yrs *M* (*SD*)	31 to 50 yrs *M* (*SD*)	51 to 65 yrs *M* (*SD*)	66 to 85 yrs *M* (*SD*)	Maximum score
Orientation					
Time	3.0 (0.0)	2.9 (0.3)	2.9 (0.2)	2.8 (0.5)	3
Place	2.0 (0.0)	2.0 (0.0)	2.0 (0.0)	1.9 (0.1)	2
Person	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1
Attention					
Digits Backwards	3.4 (0.7)	3.4 (1.2)	3.6 (0.8)	3.4 (0.8)	6
Visual Detection	15.0 (1.2)	14.0 (2.2)	10.2 (3.9)	9.4 (3.1)	16
Twenty Minus Three	4.3 (1.3)	4.6 (0.6)	4.4 (0.9)	4.6 (0.2)	5
Encoding					
Verbal Memory	4.8 (0.7)	5.1 (0.6)	5.0 (0.7)	4.6 (0.8)	6
Copy of a Semicomplex Figure	11.6 (0.8)	11.1 (1.0)	10.9 (1.0)	10.8 (1.5)	12
Language					
Naming	7.7 (0.5)	7.9 (0.3)	7.9 (0.4)	7.7 (0.7)	8
Repetition	4.0 (0.0)	4.0 (0.0)	3.9 (0.1)	3.9 (0.1)	4
Comprehension	5.9 (0.4)	5.7 (0.4)	5.5 (0.6)	5.3 (0.8)	6
Verbal Fluency					
Semantic	19.9 (5.8)	19.6 (6.0)	17.5 (3.6)	16.6 (4.4)	—
Phonologic	13.4 (4.5)	10.4 (4.4)	10.6 (3.8)	9.4 (4.2)	—
Reading	2.3 (0.9)	2.4 (0.9)	2.4 (0.9)	2.3 (0.9)	3
Writing	2.0 (0.0)	1.9 (0.2)	1.9 (0.1)	1.8 (0.5)	2
Conceptual Functions					
Similarities	5.1 (1.1)	5.2 (1.0)	5.0 (1.1)	4.7 (1.4)	6
Calculation Abilities	2.3 (0.8)	2.4 (0.6)	2.5 (0.6)	2.3 (0.9)	3
Sequences	0.7 (0.5)	0.8 (0.4)	0.9 (0.3)	0.8 (0.4)	1
Motor Functions					
Changing Left-Hand Position	1.5 (0.7)	1.6 (0.7)	1.6 (0.5)	1.6 (0.7)	2
Changing Right-Hand Position	1.5 (0.7)	1.6 (0.7)	1.6 (0.6)	1.5 (0.6)	2
Alternating Movements	1.5 (0.8)	1.4 (0.7)	1.4 (0.6)	1.5 (0.6)	2
Opposite Reactions	1.8 (0.4)	1.5 (0.8)	1.6 (0.5)	1.6 (0.5)	2
Recall					
Words	4.8 (1.1)	4.5 (1.3)	4.4 (1.6)	3.6 (1.9)	6
Cuing	4.7 (1.7)	5.0 (1.0)	4.9 (1.4)	4.2 (1.6)	6
Recognition	5.7 (0.6)	5.5 (0.7)	5.8 (0.5)	5.3 (1.2)	6
Semicomplex Figure	10.4 (1.9)	9.9 (1.9)	9.5 (1.8)	7.9 (2.6)	12

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points to 6 to 8 words; 3 points to 9 to 14 words; and 4 points to 15 or more words in 1 min. Intrusions and perseverations are noted. For the current analyses, only the first scoring system was used. *Phonological Verbal Fluency* (words beginning with the letter 'F'). Two scoring systems are used: the total number of correct words, and an abbreviated 4-point scale. One point is given to zero to 3 words; 2 points to 4 to 6 words; 3 points to 7 to 9 words; and 4 points to 10 or more words in 1 min. Intrusions and perseverations are noted. For the current analyses, only the first scoring system was used.

5. *Reading*: Participants are asked to read aloud a short paragraph (109 words). Next, three questions about the paragraph are orally presented. The correct answer to each question is scored 1. Maximum score = 3. Paralexias are noted.
6. *Writing*: This involves writing a six-word sentence to dictation, and copying a different six-word sentence. Maximum score = 2. Paragraphias are noted.
7. *Conceptual Functions* (maximum score = 10): (1) *Similarities*. Three pairs of words (e.g., orange–pear) are presented and participants are asked to report the similarity. An example is provided. Each one is scored as zero (physical similarity: *both are round*), 1 (functional similarity: *both can be eaten*), or 2 (the answer corresponds to the supraordinate word: *fruits*). Maximum score = 6. (2) *Calculation Abilities*. Three simple arithmetic problems are presented. Maximum score = 3. (3) *Sequences*. The participant is asked to continue a sequence of figures drawn on a paper: one circle, one cross, two circles, two crosses, three circles ("What figure follows?"). Maximum score = 1.

Table 5. Means and standard deviations found in the different NEUROPSI neuropsychological tests according to age in the 10-to-24 years of education group

Test	16 to 30 yrs *M* (*SD*)	31 to 50 yrs *M* (*SD*)	51 to 65 yrs *M* (*SD*)	66 to 85 yrs *M* (*SD*)	Maximum score
Orientation					
Time	2.9 (0.2)	2.9 (0.2)	2.9 (0.1)	2.9 (0.4)	3
Place	1.9 (0.1)	2.0 (0.0)	2.0 (0.0)	1.9 (0.3)	2
Person	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	0.9 (0.1)	1
Attention					
Digits Backwards	4.3 (0.9)	4.4 (0.9)	4.0 (0.9)	3.9 (1.0)	6
Visual Detection	14.0 (2.5)	14.3 (2.6)	12.9 (2.7)	10.9 (2.9)	16
Twenty Minus Three	4.7 (0.8)	4.7 (0.7)	4.9 (0.4)	4.8 (0.6)	5
Encoding					
Verbal Memory	5.0 (0.9)	5.0 (0.7)	5.3 (0.7)	4.7 (0.9)	6
Copy of a Semicomplex Figure	11.8 (0.5)	11.7 (0.5)	11.3 (1.2)	10.9 (1.4)	12
Language					
Naming	7.9 (0.3)	7.9 (0.2)	7.9 (0.6)	7.8 (0.4)	8
Repetition	4.0 (0.0)	3.9 (0.1)	3.9 (0.1)	3.9 (0.2)	4
Comprehension	5.9 (0.2)	5.9 (0.3)	5.8 (0.4)	5.7 (1.1)	6
Verbal Fluency					
Semantic	21.6 (5.4)	22.3 (5.0)	20.1 (5.1)	18.4 (4.8)	—
Phonologic	13.4 (4.3)	14.5 (4.1)	13.4 (3.9)	11.9 (4.1)	—
Reading	2.8 (0.4)	2.8 (0.5)	2.9 (0.4)	2.4 (0.1)	3
Writing	1.9 (0.1)	2.0 (0.0)	2.0 (0.0)	1.9 (0.2)	2
Conceptual Functions					
Similarities	5.7 (0.7)	5.5 (0.9)	5.2 (0.8)	5.1 (1.1)	6
Calculation Abilities	2.6 (0.6)	2.6 (0.7)	2.7 (0.6)	2.5 (0.8)	3
Sequences	0.9 (0.2)	0.9 (0.3)	0.9 (0.2)	0.8 (0.4)	1
Motor Functions					
Changing Left-Hand Position	1.7 (0.5)	1.6 (0.6)	1.7 (0.6)	1.6 (0.6)	2
Changing Right-Hand Position	1.8 (0.5)	1.6 (0.6)	1.5 (0.6)	1.4 (0.6)	2
Alternating Movements	1.9 (0.3)	1.8 (0.4)	1.8 (0.5)	1.6 (0.6)	2
Opposite Reactions	1.9 (0.3)	1.8 (0.4)	1.7 (0.4)	1.6 (0.5)	2
Recall					
Words	5.3 (0.9)	4.8 (1.2)	4.6 (1.5)	3.6 (1.8)	6
Cuing	5.5 (0.9)	5.1 (1.2)	5.1 (1.3)	4.3 (1.5)	6
Recognition	5.6 (0.6)	5.5 (0.8)	5.7 (0.6)	5.3 (1.1)	6
Semicomplex Figure	10.9 (1.2)	10.5 (1.6)	10.2 (1.9)	8.8 (2.7)	12

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8. *Motor Functions* (maximum score = 8): (1) *Changing the Position of the Hand*. Participants are asked to repeat three positions with the hand (right and left). The task is demonstrated by the examiner up to three times. A maximum score of 2 is used for each hand. Maximum score = 4. (2) *Alternating Hand Movements*. To alternate the position of the hands (right hand closed, left hand open, and to switch). Maximum score = 2. (3) *Opposite Reactions*. If the examiner shows a finger, the respondent must show a fist; if the examiner shows a fist, the subject must show a finger. Maximum score = 2.

9. *Recall* (maximum score = 30): (1) *Recall of Verbal Information*. Recall of the six words presented in 3.1. (2) *Spontaneous Recall*. Maximum recall = 6. (3) *Cued Recall*. Recall by categories (*animals*, *fruits*, and *body parts*). Maximum score = 6. (4) *Recognition*. The examiner reads 14 different words, and the participant must tell which ones were previously presented. Maximum score = 6. (5) *Recall of the Semicomplex Figure*. Maximum score = 12.

In total, 26 different scores are obtained. The maximum total score is 130. Reading and writing sections were not used with participants having fewer than 5 years of education.

Procedure

Administration

The NEUROPSI neuropsychological battery was administered independently by trained psychologists. Testing was performed in single sessions. Administration time was 25 to 30 min. In order to assure standardized procedures a detailed instruction manual for both administration and scoring was developed.

Table 6. *F* values, level of significances, and differences among the different educational groups in the NEUROPSI subtest scores

Test	*F*	*p*	Differences observed
Orientation			
Time	52.48	.0001	E1 *vs.* E2, E3, E4; E2 *vs.* E3, E4
Place	4.53	.0105	E1 *vs.* E2, E3, E4
Person	2.48	.0555	none
Attention			
Digits Backwards	109.70	.0001	E1 *vs.* E3, E4; E2 *vs.* E3, E4; E3 *vs.* E4
Visual Detection	20.79	.0001	E1, E2, E3 *vs.* E4
Twenty Minus Three	64.09	.0001	E1 *vs.* E2, E3, E4; E2 *vs.* E3, E4
Encoding			
Verbal Memory	27.27	.0001	E1, E2, E3 *vs.* E4
Copy of a Semicomplex Figure	196.96	.0001	E1 *vs.* E2, E3, E4; E2 *vs.* E3, E4; E3 *vs.* E4
Language			
Naming	28.52	.0001	E1, E2 *vs.* E3, E4
Repetition	14.77	.0001	E1, E2 *vs.* E3, E4
Comprehension	224.01	.0001	E1 *vs.* E2, E3, E4; E2 *vs.* E3, E4; E3 *vs.* E4
Verbal Fluency			
Semantic	87.92	.0001	E1 *vs.* E2, E3, E4; E2 *vs.* E3, E4; E3 *vs.* E4
Phonologic	195.61	.0001	E1 *vs.* E2, E3, E4; E2 *vs.* E3, E4; E3 *vs.* E4
Reading	33.59	.0001	E3 *vs.* E4
Writing	27.32	.0001	E3 *vs.* E4
Conceptual Functions			
Similarities	125.46	.0001	E1 *vs.* E2, E3, E4; E2 *vs.* E3, E4; E3 *vs.* E4
Calculation Abilities	91.34	.0001	E1 *vs.* E2, E3, E4; E2 *vs.* E3, E4; E3 *vs.* E4
Sequences	168.74	.0001	E1 *vs.* E2, E3, E4; E2 *vs.* E3, E4; E3 *vs.* E4
Motor Functions			
Changing Left-Hand Position	15.58	.0001	E1, E2 *vs.* E3, E4
Changing Right-Hand Position	22.40	.0001	E1, E2 *vs.* E3, E4
Alternating Movements	69.57	.0001	E1, E2 *vs.* E3, E4; E3 *vs.* E4
Opposite Reactions	8.01	.0001	E1 *vs.* E2; E3 *vs.* E4
Recall			
Words	30.52	.0001	E1, E2 *vs.* E3, E4; E3 *vs.* E4
Cuing	13.30	.0001	E4 *vs.* E1, E2, E3
Recognition	1.26	.5739	none
Semicomplex Figure	73.28	.0001	E1 *vs.* E2, E3, E4; E2 *vs.* E3, E4; E3 *vs.* E4

Note. E1 = zero years of education; E2 = 1–4 years of education; E3 = 5–9 years of education; E4 = 10–24 years of education.

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With the purpose of obtaining a test–retest reliability score, the NEUROPSI was administered twice to a group of 30 normal participants, with a 3-month interval. Interrater reliability was determined by independent scores of the NEUROPSI performance of 20 respondents by two different examiners.

Statistical analyses

Statistical analyses were carried out using the Statistical Package for Social Science (SPSS 8.0 for Windows 1997). Analysis of variance (ANOVA) investigated the effects of age, and education, as well as interaction between both variables. For this analysis age was divided into four age groups (16–30, 31–50, 51–65, and 66–85 years) and education included four different levels (illiterates, 1–4 years, 5–9 years, and 10–24 years of education). The significance level was set at $p < .05$ after Bonferroni correction. Correlations were of the Pearson product–moment type. Factor components were obtained using varimax (orthogonal) rotated factor matrix to identify groups of variables in the neuropsychological battery.

RESULTS

Tables 2, 3, 4, and 5 present the general results obtained in the whole sample according to age within the illiterate group, 1 to 4 years of education, 5 to 9 years of education, and 10 to 24 years of education, respectively. It is observed that in most tests, scores steadily increase between the first and fourth educational group. Differences between the first and fourth group, however, are variable depending upon the particular test. In some tests, differences are evident, whereas

Table 7. Means and standard deviations found in the different NEUROPSI neuropsychological tests in the three subgroups with a higher educational level

Test	10 to 12 years ($N = 76$) M (SD)	13 to 17 years ($N = 93$) M (SD)	18 to 24 years ($N = 31$) M (SD)	Differences
Orientation				
Time	2.9 (0.3)	2.9 (0.3)	3.0 (0.4)	
Place	2.0 (0.1)	2.0 (0.1)	2.0 (0.0)	
Person	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	
Attention				
Digits Backwards	3.9 (1.0)	4.3 (0.9)	4.4 (1.6)	E1 *vs.* E2, E3
Visual Detection	12.2 (3.4)	13.3 (2.9)	13.6 (2.8)	
Twenty Minus Three	4.7 (0.7)	4.8 (0.6)	4.9 (0.3)	
Encoding				
Verbal Memory	4.8 (0.8)	5.0 (0.9)	5.3 (0.6)	E1 *vs.* E3
Copy of a Semicomplex Figure	11.3 (1.0)	11.5 (0.9)	11.4 (1.2)	
Language				
Naming	7.9 (0.3)	7.9 (0.5)	8.0 (0.1)	
Repetition	3.9 (0.2)	3.9 (0.1)	4.0 (0.0)	
Comprehension	5.8 (0.8)	5.8 (0.5)	6.0 (0.0)	
Verbal Fluency				
Semantic	19.9 (5.0)	21.0 (5.3)	21.4 (5.6)	
Phonologic	12.6 (4.5)	14.0 (4.1)	13.7 (4.0)	E1 *vs.* E2
Reading	2.6 (0.7)	2.7 (0.6)	3.0 (0.0)	E1, E2 *vs.* E3
Writing	2.0 (0.0)	2.0 (0.0)	2.0 (0.0)	
Conceptual Functions				
Similarities	5.2 (0.8)	5.5 (0.9)	5.7 (0.6)	
Calculation Abilities	2.5 (0.6)	2.6 (0.7)	2.8 (0.5)	E1 *vs.* E3
Sequences	0.9 (0.3)	0.9 (0.3)	0.9 (0.2)	
Motor Functions				
Changing Left-Hand Position	1.6 (0.6)	1.6 (0.6)	1.9 (0.3)	
Changing Right-Hand Position	1.5 (0.6)	1.6 (0.6)	1.7 (0.5)	
Alternating Movements	1.6 (0.5)	1.8 (0.4)	1.9 (0.3)	
Opposite Reactions	1.8 (0.4)	1.8 (0.4)	1.8 (0.3)	
Recall				
Words	4.3 (1.6)	4.7 (1.5)	4.9 (1.3)	
Cuing	4.9 (1.2)	4.9 (1.4)	5.3 (1.0)	
Recognition	5.5 (0.8)	5.5 (0.9)	5.6 (0.6)	
Semicomplex Figure	9.7 (2.3)	10.2 (2.1)	10.6 (1.2)	

Note. E1 = 10–12 years; E2 = 13–17 years; E3 = 18–24 years.

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in others, differences are minimal. A general tendency for scores to decrease across the age ranges is observed. This tendency was particularly evident in the memory test scores. In general, it was evident that the educational variable was much more influential on the neuropsychological test scores than the age variable.

Using ANOVAs, differences among the four education groups were calculated (Table 6). It is observed that in all the tests except for Orientation in Person and Recognition of Verbal Information, the education variable was significant. In some tests, significant differences were found among all four educational groups (Copy of a Semicomplex Figure, Language Comprehension, Semantic Verbal Fluency, Phonological Verbal Fluency, Similarities, Calculation Abilities, Sequences, and Recall of the Semicomplex Figure).

Because 10 to 24 years is such a large educational span, a further analysis of the participants in the 10 to 24 years of education range was performed. These participants were subdivided into three educational groups: 10 to 12, 13 to 17, and 18 to 24 years of formal education. According to the Mexican educational system, 10 to 12 years corresponds to *preparatoria* (preparatory; similar to high school). A university degree (*licenciatura*) requires 5 additional years (i.e., 13–17 years of education). Over 17 years corresponds to a postgraduate (post-*licenciatura*) training. Results are presented in Table 7. A slight tendency for test scores to increase with increasing education is observed. Within this group, nonetheless, statistically significant differences are observed in only four test scores: Digit Backwards, Encoding–Verbal Memory, Phonologic Verbal Fluency, and Reading. These results imply that after 10 years of formal education, performance in this set of neuropsychological tests is fairly homogenous. Thus, in the 10 to 24 years of education group a ceiling effect was evident.

Using ANOVAs, differences among the four age groups were calculated (Table 8). Only in some tests was the age

Table 8. *F* values, level of significances, and differences among the different age groups in the NEUROPSI subtest scores

Test	*F*	*p*	Differences observed
Orientation			
Time	8.96	.001	A1 *vs.* A2, A3; A3 *vs.* A4
Place	1.59	.190	none
Person	2.56	.053	none
Attention			
Digits Backwards	3.69	.037	A2 *vs.* A4
Visual Detection	41.01	.0001	A1, A2 *vs.* A3; A1, A2, A3 *vs.* A4
Twenty Minus Three	9.00	.0001	A1 *vs.* A2, A3, A4
Encoding			
Verbal Memory	14.92	.0008	A1, A2, A3 *vs.* A4; A1 *vs.* A3
Copy of a Semicomplex Figure	2.53	.056	none
Language			
Naming	2.00	.115	A2 *vs.* A1, A4
Repetition	1.48	.328	none
Comprehension	1.83	.315	none
Verbal Fluency			
Semantic	9.84	.0001	A1, A2 *vs.* A4; A2 *vs.* A3
Phonologc	3.59	.013	A2 *vs.* A4
Reading	12.08	.0001	A1, A2, A3 *vs.* A4
Writing	8.34	.0001	A1, A2, A3 *vs.* A4
Conceptual Functions			
Similarities	3.98	.0078	A2 *vs.* A3, A4
Calculation Abilities	2.32	.073	none
Sequences	1.17	.318	none
Motor Functions			
Changing Left-Hand Position	0.68	.560	none
Changing Right-Hand Position	0.33	.795	none
Alternating Movements	4.28	.005	A1 *vs.* A3
Opposite Reactions	19.72	.0001	A4 *vs.* A1, A2, A3; A1 *vs.* A2
Recall			
Words	30.80	.0001	A1, A2, A3 *vs.* A4; A1, A2 *vs.* A3
Cuing	30.63	.0001	A1, A2, A3 *vs.* A4
Recognition	6.92	.0001	A1, A2, A3 *vs.* A4
Semicomplex Figure	35.90	.0001	A1, A2, A3 *vs.* A4; A1 *vs.* A3

Note. A1 = 16–30 years; A2 = 31–50 years; A3 = 51–65 years; A4 = 66–85 years.

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variable statistically significant. This significant age effect was observed in the Orientation tests (Time), Attention (Visual Detection, Serial Three Substractions), Encoding section subtests (Verbal Memory), in the Language subtests, except language repetition and comprehension tests, in some motor tests (Alternating Movements and Opposite Reactions), and most importantly, in all the recall tests. With the exception of Similarities, no differences were observed in the conceptual function tests. No differences were observed in changing the position of the hand.

Interactions between education and age also were analyzed (Table 9). Few interactions were statistically significant: Orientation (Time and Person), Serial Three Substractions, Language Repetition, Calculation Abilities, Sequences, and Cuing Recall. For the rest of the test scores, interactions did not reach statistical significance. It follows that both schooling and age represent rather independent factors on neuropsychological test performance, even though some interactions are evident.

Gender effects were analyzed. Only a few differences were statistically significant (see Table 10). No Sex × Age interaction effect was found. The Sex × Education effect was minimal. Statistically significant differences between men and women were observed only in a few tests and in some education groups. No significant differences in any tests were found across the four educational groups. Interestingly, in the three tests that include numerical information (Digits Backwards, Twenty Minus Three, and Calculation Abilities) statistically significant differences were observed in two out of the four educational groups. Performance was higher in men than in women. For the remaining tests, only a few were significant and only within a specific education range. Those tests and educational ranges that were statistically significant are: Orientation in Place (illiterates), Alternating Movements (il-

Table 9. *F* values for education and age variables, and interactions between education and age

Test	E: Education *F*	A: Age *F*	E × A *F*
Orientation			
Time	59.60***	12.87***	7.71***
Place	4.59*	0.58	0.68
Person	38.00***	6.50***	4.53***
Attention			
Digits Backwards	108.00***	1.85	2.09
Visual Detection	23.71***	44.32***	2.01
Twenty Minus Three	63.46***	6.27***	3.37***
Encoding			
Verbal Memory	29.36***	14.75***	0.72
Copy of a Semicomplex Figure	199.46***	5.81**	0.53
Language			
Naming	26.98***	2.27	1.56
Repetition	14.89***	1.88	2.52*
Comprehension	226.59***	2.75	0.98
Verbal Fluency			
Semantic	88.87***	4.54**	1.69
Phonologic	198.71***	2.62	1.89
Reading	26.00***	6.26**	1.52
Writing	22.66***	3.64*	1.16
Conceptual Functions			
Similarities	122.38***	6.76***	1.80
Calculation Abilities	95.57***	3.21	2.60*
Sequences	166.18***	3.46	36.11***
Motor Functions			
Changing Left-Hand Position	14.28***	0.74	1.11
Changing Right-Hand Position	20.82***	0.99	1.92
Alternating Movements	68.67***	3.10	1.41
Opposite Reactions	4.44**	13.86***	1.79
Recall			
Words	32.91***	30.16***	1.74
Cuing	11.91***	23.66***	3.14**
Recognition	0.96	3.81*	1.39
Semicomplex Figure	80.95***	20.36***	1.06

*$p < .01$; **$p < .001$; ***$p < .0001$.

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Table 10. *F* values and level of significance for sex differences in the four educational groups

	Education							
	Zero years		1 to 4 years		5 to 9 years		10 to 24 years	
Test	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*
Orientation								
Time	1.19	0.27	0.00	0.95	1.21	0.27	1.12	0.29
Place	3.87	0.02	1.28	0.25	0.40	0.52	1.30	0.25
Person	0.18	0.66	2.26	0.13	0.41	0.51	0.00	0.99
Attention								
Digits Backwards	2.11	0.14	0.98	0.32	3.98	0.05	6.23	0.01
Visual Detection	0.00	0.92	0.85	0.35	1.84	0.17	2.63	0.10
Twenty Minus Three	5.89	0.02	0.07	0.91	2.41	0.12	8.15	0.01
Encoding								
Verbal Memory	0.34	0.55	0.33	0.56	1.01	0.31	1.78	0.18
Copy of a Semicomplex Figure	0.00	0.94	0.28	0.59	2.34	0.12	0.54	0.45
Language								
Naming	1.11	0.29	0.09	2.76	4.60	0.03	3.34	0.06
Repetition	0.39	0.53	0.07	0.78	0.83	0.36	0.67	0.41
Comprehension	0.09	0.76	2.23	0.13	0.00	0.92	0.51	0.47
Verbal Fluency								
Semantic	0.11	0.73	0.78	0.37	0.56	0.45	2.16	0.14
Phonologic	2.72	0.10	0.01	0.90	2.65	0.10	0.05	0.82
Conceptual Functions								
Similarities	0.52	0.46	7.27	0.01	2.38	0.12	0.52	0.46
Calculation Abilities	2.76	0.09	0.27	0.60	2.22	0.01	7.14	0.01
Sequences	1.26	0.26	0.00	0.97	0.66	0.41	0.59	0.44
Motor Functions								
Changing Left-Hand Position	0.04	0.83	4.09	0.04	1.37	0.24	0.44	0.50
Changing Right-Hand Position	2.13	0.15	1.09	0.30	1.84	0.18	3.40	0.06
Alternating Movements	5.50	0.02	1.33	0.24	1.89	0.17	4.05	0.05
Opposite Reactions	2.85	0.09	1.28	0.25	0.84	0.35	3.48	0.06
Recall								
Words	0.71	0.39	2.43	0.12	0.58	0.44	0.32	0.56
Cuing	0.97	0.32	1.29	0.25	0.59	0.44	0.57	0.44
Recognition	0.40	0.52	0.24	0.62	0.17	0.67	0.09	0.75
Semicomplex Figure	1.18	0.27	0.06	0.79	4.35	0.04	6.43	0.01
Total NEUROPSI score	0.52	0.47	0.23	0.62	2.89	0.09	5.06	0.03

literates), Similarities (1–4 years of education), Naming (5–9 years of education), and Alternating Movements (10–24 years of education). Performance in these tests was again higher in men than in women. In general, however, the gender effect was minimal on the NEUROPSI.

A factor analysis with varimax rotation of the neuropsychological test battery was performed with the quantitative scores and general results are shown in Table 11. Seven different factors with an eigenvalue higher than 1.00 were disclosed. These seven factors accounted for 61.8% of the total variance.

The loadings of the different subtests on the seven factors are presented in Table 12. It is observed that for each factor, except the first, only a few test scores have a high loading on each factor.

Factor I (28.6% of the variance) best correlated with Digits Backwards (.64), Copy of a Semicomplex Figure (.74), Calculation Abilities (.64), Language Comprehension (.70) and Sequences (.66). Factor I would appear to include several attention and frontal lobe related functions (*Executive Function* factor). Factor II (9.6% of the variance) is mainly represented by Writing–Dictation (.91) and Writing–Copy (.77) scores, while the rest of the subtest loadings were moderate to low. Factor II was in consequence a writing, and maybe, fine movements factor or motor programming factor (*Writing* factor). Factor III (6.1% of the variance) best correlated with the two verbal fluency tests: semantic (.83), and phonologic (.63). Obviously, it is a verbal generation factor (*Verbal Fluency* factor). Factor (5.7% of the variance) IV most involved motor functions—alternating (.92), the changing hand position right hand (.79), and left hand (.79). It may be considered as a motor sequencing factor (*Motor Sequencing* factor). Factor V (4.3% of the variance) primarily involves the four recall scores (Delayed Recall Semicomplex Figure (.52), Spontaneous Verbal Delayed Recall (.64), Recognition (.52) and Categories (.76). Obvi-

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Table 11. Factor analysis of the NEUROPSI neuropsychological test battery

Factor	Eigenvalue	Percent of variance	Cumulative percent
I	8.852	28.6	28.6
II	2.984	9.6	38.2
III	1.885	6.1	44.3
IV	1.754	5.7	49.9
V	1.343	4.3	54.3
VI	1.117	3.9	58.2
VII	1.103	3.6	61.7

ously, it is a memory factor (*Memory* factor). Factor VI (3.9% of the variance) involves orientation in space (.64), and Motor Functions—Opposite Reactions (.49). And finally, Factor VII (3.6% of the variance) involves Orientation to Person (.78) and Language Repetition (.63). These two last factors are not easy to interpret.

The test–retest reliability with a 3-month interval, administered and scored by the same examiner for the total NEUROPSI score was .89. Table 13 presents the reliability scores found in the different subtests. Interrater agreement was substantial; correlation coefficients for the NEUROPSI scales ranged from 7.7 (Phonologic Frequency) to 1.0 (Orientation to place and person). These high interrater reliability coefficients indicate that standard-

Table 12. Correlations between the different test scores and the seven factors

	Factor						
Test	I	II	III	IV	V	VI	VII
Orientation							
Time	.58	−.03	.06	.06	.10	.32	.08
Place	.09	−.05	.09	.03	.13	.64	.08
Person	.03	.11	.06	.05	.12	.03	.78
Attention							
Digits Backwards	.64	.10	.20	.17	.04	.09	.18
Visual Detection	.38	−.18	.15	.03	.33	−.15	.04
Twenty Minus Three	.54	−.04	.15	−.06	−.05	.10	.31
Encoding							
Verbal Memory	.39	.09	.24	.24	.08	.06	.16
Copy of a Semicomplex Figure	.74	.17	.14	.12	.24	−.11	−.09
Language							
Naming	.36	.06	.05	.03	.15	.23	.11
Repetition	.35	−.07	.00	.13	−.08	.04	.63
Comprehension	.70	.11	.23	.12	.16	.07	.04
Reading	.06	.25	.35	.02	.44	−.03	.03
Writing							
Dictation	.13	.91	.02	.04	.03	.05	.01
Copy	.05	.77	.17	.02	.30	−.18	.14
Verbal Fluency							
Semantic	.30	−.04	.83	.07	.17	.13	.07
Phonologic	.58	.02	.63	.16	.03	−.09	.01
Conceptual Functions							
Similarities	.58	.04	.28	.15	.21	.08	.00
Calculation Abilities	.64	.49	.16	.14	.15	−.06	.15
Sequences	.66	.22	.07	.22	.01	.08	.00
Motor Functions							
Changing Hand Position							
RH	.28	.09	.04	.79	−.08	.15	.01
LH	.15	.12	.10	.79	.23	.05	.11
Alternating Movements	.23	.01	.15	.92	.19	.03	.08
Opposite Reactions	.00	.43	.03	.21	−.02	.49	.07
Recall							
Words	.38	−.01	.04	.11	.64	.20	.07
Cuing	.22	−.08	.01	.17	.76	.12	.01
Recognition	−.07	.07	.02	.00	.52	.47	.02
Semicomplex Figure	.52	.02	.22	.12	.52	−.02	−.06

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Table 13. Reliability in the different subtests

Test	First testing		Second testing		
	M	*SD*	*M*	*SD*	*r*
Orientation					
Time	2.82	0.27	2.84	0.37	.80
Place	2.00	0.00	2.00	0.00	1.00
Person	1.00	0.00	1.00	0.00	1.00
Attention					
Digits Backwards	3.46	1.05	3.23	0.83	.78
Visual Detection	13.25	2.86	13.57	2.82	.87
Twenty Minus Three	4.66	0.63	4.91	0.35	.82
Encoding					
Verbal Memory	5.00	1.35	4.76	1.23	.79
Copy Semicomplex Figure	10.73	1.58	10.73	0.83	.89
Language					
Naming	7.53	0.87	7.69	0.63	.94
Repetition	4.00	4.00	4.00	0.00	.00
Comprehension	5.69	0.63	5.61	0.50	.89
Fluency					
Semantic	19.38	5.59	19.07	3.70	.80
Phonologic	11.92	2.78	12.31	2.92	.77
Conceptual Functions					
Similarities	5.15	0.89	5.15	1.46	.88
Calculation	1.92	0.75	2.15	0.80	.78
Sequences	0.84	0.37	1.00	0.00	.82
Motor Functions					
Left-Hand	1.46	0.66	1.69	0.63	.81
Right-Hand	1.69	0.48	1.61	0.76	.84
Alternating	1.46	0.66	1.53	0.51	.79
Opposite Reactions	1.61	0.50	1.69	0.48	.82
Recall					
Words	5.00	1.35	4.76	1.23	.79
Cuing	5.53	0.66	4.76	1.16	.84
Recognition	5.76	0.59	5.76	0.60	.92
Semicomplex Figure	9.11	2.31	10.03	1.24	.83
Total NEUROPSI score	91.46	8.65	91.07	6.45	.89

Note. $N = 30$.

ized instruction assures that scoring of the test is consistent across examiners.

DISCUSSION

In Latin America and in Spanish-speaking countries there is a need for brief, reliable, and norm-based neuropsychological instruments to assess cognitive abilities of geriatric, neurological, and general medical populations. Standardized neuropsychological instruments in Spanish are still few. Notably, Spanish is the first language for about 10% of the world population. Interestingly, the United States represents the fifth-largest Spanish speaking country in the world (Mexico, Spain, Colombia, Argentina, and the U.S.) with over 20,000,000 Spanish speakers. To a certain extent, therefore, the United States might be considered a Latin American country. The NEUROPSI was developed to help fill this need of the Spanish-speaking world, and eventually, it might be adapted to other languages. However, it has to be emphasized that current results were obtained in Mexico. There is, as a consequence, a limitation in generalizability of results to other populations. Furthermore, sensitivity at higher educational level has to be taken with caution, considering the ceiling effect observed in participants with over 10 years of education.

Results point out that educational level had a significant effect on most tests. Strongest educational effects were noted in visuoconstructional abilities, phonological verbal fluency and conceptual functions, including similarities, calculating abilities, and motor sequences. On most of the NEUROPSI tests, just 1 to 4 years of education was enough to show highly statistically significant NEUROPSI performance differences. Reading and writing were not even given to the lowest two educational groups. This finding has both theoretical and practical implications. Our results agree with several other studies that have shown effects of educational level on neuropsychological test performance (Ardila et al., 1989b, 1992; Finlayson et al., 1977; Heaton et al., 1986; Ostrosky et al.,

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1985, 1986). Learning opportunities play a crucial role in the development of some abilities frequently included in neuropsychological tests (Ardila, 1995). As Vygotsky (1962) and Luria (1976) have pointed out, complex psychological processes such as oral and written language, decision making, and the solution of problems have a social origin and they depend upon internalized social relations. Therefore, living conditions and learning opportunities influence the development and organization of such processes. Furthermore, recent studies have shown that literacy may somehow influence the brain organization of cognition, including language (Matute, 1988) and handedness (Ardila et al., 1989a). Studies about the consequences of brain damage in illiterate populations evidence a more bilateral representation for linguistic and visuospatial abilities (Rosselli et al., 1985).

The effect of education on neuropsychological test performance, however, is uneven. In reviewing current results, it is evident that some subtests are extremely sensitive to education (e.g., Copy of a Semicomplex Figure, Language Comprehension, Phonologic Verbal Fluency), whereas others are minimally and even not associated with educational level (e.g., Motor: Opposite Reactions; Recall: Recognition)

A ceiling effect in the 10- to 24-years of education group was observed. This ceiling effect is not unusual in many neuropsychological instruments, particularly, screening instruments. Furthermore, the educational effect is *not* a linear effect. It is, in fact, represented by a negatively accelerated curve: differences between zero and 3 years of education are huge; differences between 3 and 6 years of education are lower; between 6 and 9 are even lower; and so on (Ardila, 1998; Ardila & Rosselli, 1989; Rosselli & Ardila, 1991, 1993; Rosselli et al., 1990). Beyond some 10 to 12 years of education, barely any education effect can be found in these measures. So, when comparing people with 12 and 18 years of education, virtually no educational effect is usually found.

It should be emphasized that the NEUROPSI is a rather easy screening test battery. If harder items were selected, a stronger educational effect could be anticipated. In the current research, only very few differences were observed when participants with over 10 years of education were further divided into increasing educational groups: Encoding–Verbal Memory, Phonological Verbal Fluency, Reading, Calculation Abilities and Digits Backwards.

With regard to aging effects, there was a general tendency toward a decrease in test scores with increasing age. However, some tests appear particularly sensitive to the effects of aging, such as Visual Detection, Verbal Memory, Opposite Reactions, and delayed recall of verbal and visuo–visuospatial information. For other tests, the effect of aging was minimal. These tests included Orientation (Place and Person), Language (Repetition and Understanding) and some Executive functions (e.g., Sequences).

Our findings regarding age-related test scores are consistent with previous studies (Ardila & Rosselli, 1989; Catell, 1971; Heaton et al., 1986; Ostrosky-Solís et al., 1992, 1995). In general, those tests that depend on past accumulated knowledge or "crystallized intelligence" tend to be less sensitive to the effects of normal aging. According to Cattell (1971), crystallized intelligence is measured by tests of knowledge and skills that were acquired in previous learning experience. In the NEUROPSI, these measures are related to Language (Repetition and Understanding), and some Motor skills. These tests with no particular sensitivity to normal aging effects may nevertheless be useful when diagnosing pathological aging (i.e., dementia). By contrast, tests that require learning, conceptual and problem solving operations, are related to fluid intelligence. In our battery these measures were represented by immediate and delayed recall of verbal and visuospatial material. In these tests, previously stored knowledge is not especially useful.

Only a few Age × Education interactions were statistically significant: Orientation (Time and Person), Twenty Minus Three, Language Repetition, Calculation abilities, and Sequences. It follows that both schooling and age represent rather independent factors on NEUROPSI performance. Nonetheless, seemingly the level of education can somehow and at least in some tests influence the cognitive changes associated with aging. Recently, it has been proposed that education provides protection against dementia (Mortiner, 1988). It was proposed that psychosocial factors reduce the margin of "intellectual reserve" to a level where a minor level of brain pathology results in a dementia. Mortiner further proposed that "psychosocial risk factors" (i.e., no or low education) will present the strongest association in the late onset dementia of the Alzheimer type (DAT). During the last decade, several studies (e.g., Bonaiuto et al., 1990; Caramelli et al, 1997; Korczyn et al., 1991), but not all studies (e.g., Christensen & Henderson, 1991; O'Connor et al., 1991) have supported this notion. Our current results point to a complex relationship between education and cognitive ability associated with age. The interaction between age and education may be different depending upon the specific cognitive domain. This type of heterogenous relationship between age associated changes and educational level has been previously proposed in the literature (Capitani et al., 1996). Undoubtedly, this is an area that deserves more research and analysis.

Factor analysis disclosed seven NEUROPSI factors that accounted for 62% of the total variance. Factors were related to Executive Functions (Factor I); Memory (Factor V); Writing (Factor II); Orientation and Attention (Factor I, VI, and VII); Verbal Fluency (Factor III); and Motor Functions (Factor IV). Thus, factor analysis confirms the presence of the independent cognitive domains that underlie the NEUROPSI quantitative scores. However, as in any neuropsychological instrument, quantitative analysis should be complemented with qualitative interpretation. For example, because quantitative scoring of a visuomotor task such as copying of a semicomplex figure emphasizes a number of details, factor analysis of the NEUROPSI subtest, grouped this test with attention related tasks. Therefore, in order to analyze the visuospatial and visuomotor component of this task, qualitative analysis of the mistakes in the drawing (i.e., wrong orientation of line and angles, or spatially disarticulated) should also be performed before making a final interpretation.

Total test–retest reliability in cognitively intact participants over a period of 3 months was excellent at .89 for the NEUROPSI total score. Interrater agreement was substantial suggesting that that scoring of the test is consistent across examiners.

It is important to emphasize that the data presented in this study were collected only in Mexico. Individuals from other Spanish-speaking countries were not included. As a consequence, results have to be applied to people from other countries with caution. Currently, additional data are being collected in Colombia, and eventually the NEUROPSI will be also administered in other Latin American countries. Thus, it can be anticipated that in the future a significantly broader data base with samples from diverse countries will become available.

The NEUROPSI is currently also under testing in various clinical groups including dementia, depression, schizophrenia, lupus, closed head injury, and focalized left and right hemisphere lesions. Results are not yet available for presention, but preliminary results appear encouraging. Nevertheless, at the moment, the absence of validity, and sensitivity data is still a limitation.

In summary, the NEUROPSI may help fill the need for brief, reliable and objective evaluation of a broad range of cognitive functions in Spanish-speaking people. It is the only available Spanish instrument that provides norms across a broad range of ages and educational levels including illiterates, primary school, high school, and professional level.

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APPENDIX
NEUROPSI: EVALUACIÓN NEUROPSICOLÓGICA BREVE EN ESPAÑOL

Observación general. Para los criterios de calificación cualitativos y cuantitativos de cada reactivo, es necesario consultar el *Manual*.

I. ORIENTACIÓN

		Respuesta	Puntaje
A. *Tiempo*:	¿En qué día estamos?	_____	0 1
	¿En qué mes estamos?	_____	0 1
	¿En qué año estamos?	_____	0 1
B. Espacio:	¿En qué ciudad estamos?	_____	0 1
	¿En qué lugar estamos?	_____	0 1
C. Persona:	¿Cuántos años tiene usted?	_____	0 1
		Total _____	(6)

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II. ATENCIÓN Y CONCENTRACIÓN

A. *Dígitos en regresión*

Pida que repita cada serie en orden regresivo, es decir, del último al primero; ej., 2–5, respuesta "5–2." Si logra repetir al primer ensayo, se pasa a la serie siguiente. Si fracasa, aplique los dos ensayos.

4-8 _____ 2
9-1 _____ 2
2-8-3 _____ 3
7-1-6 _____ 3
8-6-3-2 _____ 4
2-6-1-7 _____ 4
6-3-5-9-1 _____ 5
3-8-1-6-2 _____ 5
5-2-7-9-1-8 _____ 6
1-4-9-3-2-7 _____ 6

Total _____ (6)

B. *Detección visual*

Se coloca la hoja de detección visual frente al sujeto y se le pide que marque con una "X" todas las figuras que sean iguales al modelo. Suspender a los 60 segundos.

Total de errores _____
Total de aciertos _____ (16)

C. *20 menos 3*

Pida que a 20 le reste 3. Suspenda luego de 5 operaciones

17-14-11-8-5 Respuestas _____ Total _____ (5)

III. CODIFICACIÓN

A. *Memoria verbal*

Lea las siguiente palabras y pida al sujeto que las repita una vez que usted termine. Utilice siempre los tres ensayos.

1er ensayo	2o ensayo	3er ensayo	Observaciones
gato _____	mano _____	codo _____	Intrusiones _____
pera _____	vaca _____	fresa _____	Perseveraciones _____
mano _____	fresa _____	pera _____	Primacia _____
fresa _____	gato _____	codo _____	Recencia _____
vaca _____	codo _____	gato _____	
codo _____	pera _____	mano _____	
Total _____	_____	_____	Promedio _____ (6)
1 ensayo	2 ensayo	3 ensayo	

B. *Copia de una figura semi-compleja*

Pida al sujeto que copia la lámina 1 del material anexo. Utilice la reproducción presentada abajo para registrar la secuencia de la copia.

AQUI LA REPRODUCCIÓN DE LA
FIGURA SEMI-COMPLEJA

Tiempo _____ Total _____ (12)

IV. LENGUAJE

A. *Denominación*

Pida al sujeto que nombre las figuras que aparencen en las láminas de la 2 a la 9 del material anexo y anote la respuesta.

Respuesta	Puntaje	Respuesta	Puntaje
chivo _____	0 1	llave _____	0 1
guitarra _____	0 1	serpiente _____	0 1
trompeta _____	0 1	reloj _____	0 1
dedo _____	0 1	bicicleta _____	0 1

Total _____ (8)

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Nota. Si el paciente presenta problemas de agudeza visual que le limiten realizar la actividad anterior, en su lugar, pida que denomine los siguientes elementos preguntándole "¿Qué es esto?."

lápiz	reloj	botón	techo	codo	tobillo	zapato	llave
1	2	3	4	5	6	7	8

Total _____ (8)

B. *Repetición*

Pida al sujeto que repita las siguientes palabras y frases:

Respuesta		Puntaje
Sol	_____	0 1
Ventana	_____	0 1
El niño llora	_____	0 1
El hombre camina lentamente por la calle	_____	0 1

Total _____ (4)

C. *Comprensión*

Presente la lámina 10 y evalúe la comprensión de las siguientes instrucciones, considerando que para que este reactivo tenga validez, debe asegurarse que el sujeto comprenda los términos "cuadrado' y "círculo." De no ser así, intente con otras palabras como por ejemplo "bolita" y "cuadro."

	Puntaje
señale el cuadrado pequeño	0 1
señale un círculo y un cuadrado	0 1
señale un círculo pequeño y un cuadrado grande	0 1
toque el círculo pequeño, si hay un cuadrado grande	0 1
toque el cuadrado grande en lugar del círculo pequeño	0 1
además de tocar los círculos, toque el cuadrado pequeño	0 1

Total _____ (6)

D. *Fluidez verbal*

Pida al sujeto que nombre en un minuto todos los animales que conozca. Posteriormente, empleando el mismo tiempo, solicite que mencione todas las palabras que recuerde que inicien con la letra "F" sin que sean nombres propios o palabras derivadas.

Animales		Palabras con F	
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Total semántico _____ Total fonológico _____

Intrusiones _____ Intrusiones _____

Perseveraciones _____ Perseveraciones _____

V. LECTURA

Pida que realice en voz alta la lectura de la Lámina 11 del material anexo. Mencione que se le harán preguntas sobre su contenido.

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Respuesta		Puntaje
¿Por qué se ahogó el gusano?……	_____	0 1
¿Que pasó con el otro gusano?……	_____	0 1
¿Cómo se salvó el gusano……	_____	0 1
	Total _____	(3)

VI. ESCRITURA

Pida al sujeto que escriba al dictado (primera frase) y por copia (segunda frase Lámina 12).

	Puntaje
El perro camina por la calle	0 1
Las naranjas crecen en los árboles	0 1
Total _____	(2)

VII. FUNCIONES CONCEPTUALES

A. *Semejanzas*

Pregunte en que se parecen los siguientes estímulos. Proporcione el ejemplo: "Silla-mesa…son muebles."

Respuesta		Puntaje
naranja-pera	_____	0 1 2
perro-caballo	_____	0 1 2
ojo-nariz	_____	0 1 2
	Total _____	(6)

B. *Cálculo*

Pida al sujeto que resuelva mentalmente las siguientes operaciones. Límite de tiempo para cada problema: 60 segundos. Se puede leer nuevamente el problema dentro del límite de tiempo.

Respuesta		Puntaje
¿Cuánto es 13 + 15? (28)……	_____	0 1
Juan tenía 12 pesos, recibió 9 y gastó 14.		
¿Cuánto le quedó? (7)……	_____	0 1
¿Cuántas naranjas hay en dos docenas y media? (30)	_____	0 1
	Total _____	(3)

C. *Secuencia*

Presente la Lámina 13 del material anexo y pida que continúe la secuencia (¿Qué figura sigue?)

Total _____ (1)

VIII. FUNCIONES MOTORAS

Para su aplicación, siga las instrucciones del *Manual*.

A. *Cambio de posición en la mano*

0 = no lo hizo
1 = los hizo entre el segundo y el tercer ensayo
2 = lo hizo correctamente al primer ensayo

Ejecución:		
	Mano derecha	0 1 2
	Mano izquierda	0 1 2
	Total _____	(4)

B. *Movimientos alternos de las manos*

0 = no lo hizo
1 = lo hizo desautomatizado
2 = los hizo correctamente

Total _____ (2)

C. *Reacciones opuestas*

0 = no lo hizo
1 = lo hizo con errores
2 =lo hizo correctamente

Total _____ (2)

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IX. EVOCACIÓN

A. *Evocación de la información verbal*
1. Evocación espontánea
Pida al sujeto que recuerde las palabras previamente memorizadas.
gato _____ pera _____ Intrusiones _____
mano _____ vaca _____ Perseveraciones _____
codo _____ fresa _____
Total _____ (6)

2. Evocación por claves
Pida que recuerde las palabras anteriormente memorizadas de acuerdo con las siguientes categorias:
partes del cuerpo _____ Intrusiones _____
frutas _____ Perseveraciones _____
animales _____
Total _____ (6)

3. *Reconocimiento*
Lea las siguientes palabras y pida que reconozca aquellas que pertenecen a la serie memorizada anteriormente.
dedo _____ codo* _____ zorro _____ vaca* _____
gato* _____ árbol _____ mano* _____ flor _____
cama _____ gallo _____ fresa* _____
pera* _____ lápiz _____ ceja _____
Total _____ (6)

B. *Evocación de la figura semi-compleja*

Pida al sujeto que dibuje de memoria la figura semi-compleja. Registre la secuencia observada.
Tiempo _____ Total _____ (12)

RESUMEN DE LOS PUNTAJES

I. ORIENTACIÓN

A. Tiempo _____ (3)
B. Espacio _____ (2)
C. Persona _____ (1)
Total _____ (6)

II. ATENCIÓN Y CONCENTRACIÓN

A. Dígitos en regresión Total _____ (6)
B. Detección visual Total _____ (16)
C. 20 menos 3 Total _____ (5)

III. CODIFICACIÓN

A. Memoria verbal Total _____ (6)
B. Copia figura semi-compleja Total _____ (12)

IV. LANGUAJE

A. Denominación Total _____ (8)
B. Repetición Total _____ (4)
C. Comprensión Total _____ (6)
D. Fluidez verbal Total semántica _____ (4)
Total fonológica _____ (4)

V. LECTURA

Total _____ (3)

VI. ESCRITURA

Total _____ (2)

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VII. FUNCIONES CONCEPTUALES

A. Semejanzas Total _____ (6)
B. Cálculo Total _____ (3)
C. Secuencias Total _____ (1)

VIII. FUNCIONES MOTORAS

A. Cambio de posición de la mano Total _____ (4)
B. Movimientos alternos con las manos Total _____ (2)
C. Reacciones opuestas Total _____ (2)

IX. EVOCACIÓN

A. Evocación de información verbal
   1. Evocación espontánea Total _____ (6)
   2. Evocación con claves Total _____ (6)
   3. Reconocimiento Total _____ (6)
B. Evocación de la figura semi-compleja Total _____ (12)

Total _____ (130)

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