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Effects of Culture and Education on Neuropsychological Testing: A Preliminary Study With Indigenous and Nonindigenous Population

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We analyzed the influence of education and of culture on the neuropsychological profile of an indigenous and a nonindigenous population. The sample included 27 individuals divided into four groups: (a) seven illiterate Maya indigenous participants, (b) six illiterate Pame indigenous participants, (c) seven nonindigenous participants with no education, and (d) seven Maya indigenous participants with 1 to 4 years of education . A brief neuropsychological test battery developed and standardized in Mexico was individually administered. Results demonstrated differential effects for both variables. Both groups of indigenous participants (Maya and Pame) obtained higher scores in visuospatial tasks, and the level of education had significant effects on working and verbal memory. Our data suggested that culture dictates what it is important for survival and that education could be considered as a type of subculture that facilitates the development of certain skills.

Key words: Maya Indians, Pame Indians, educational level, cognitive test performance, illiteracy, culture, neuropsychology, assessment

The level of education has proven to have an important impact on the cerebral organization of cognitive skills and on performance in neuropsychological tests (Ardila, in press; Ardila, Ostrosky-Solís, Rosselli, & Gomez, 2000; Ardila, Rosselli, & Rosas, 1989; Castro-Caldas, Petersson, Stone-Elander, & Ingvar, 1998; Castro-Caldas & Reis, 2000; Manly et al., 1999; Matute, Leal, Zarobozo, Robles, & Cedillo, 2000; Ostrosky-Solís, Ardila, Rosselli, Lopez-Arangó, & Uriel Mendoza, 1998; Ostrosky, Canseco, Quintanar, Navarro, & Ardila, 1985; Ostrosky et al., 1986; Ostrosky-Solís, 2002; Rosselli & Ardila, 2003; Rosselli, Ardila, & Rosas, 1990). It has been suggested that illiterate people solve cognitive problems functionally and specifically, and respond better to the perceptual and functional attributes of stimuli whereas educated participants responded to abstract concepts and to logic relations between stimuli (Luria, 1976).

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Although the level of education has a significant influence on the nature of performance on traditional neuropsychological measures of verbal and nonverbal skills, it is often difficult to distinguish between education and culture. Ardila (1996), for example, emphasized that the differences found in the performance on tests between "Anglos" and "Hispanics" in the United States are frequently attributed to cultural variables, without taking into account that a great part of these differences are simply the result of different educational levels.

Culture may be broadly defined as "the way of living of a human group." It involves everything we learn as members of a society, whether it is within social, political, economic, religious, or linguistic institutions. This learning includes not only the knowledge of skills to survive physically or socially, but even how to express emotions, appreciate music, or to experience pain (Chinoy, 1992). Although it is recognized that culture is an important variable involved in the development and use of specific cognitive and behavioral skills, currently there are very few studies that have analyzed how culture influences neuropsychological test performance (Fletcher-Janzen, Strickland, & Reynolds, 2000).

Information about neuropsychological test performance in Amerindian cultural groups is extremely limited. Just a few studies are found to date. Pontius (1989), for example, selected 19 adult nomadic Auca Indians of the Ecuatorian basin. A four-colored Kohs Block Design test was administered. Deficits in block design particularly related to representations and construction of certain intrapattern spatial relations and graphic representational skills were found. Pontius (1995) hypothesized that this strategy is also observed in other hunting societies. Hunter-gatherer's survival depends on prompt assessment of the salient shape of prey and attackers.

Recently, Ardila and Moreno (2001) evaluated a group of Arauco Indians in Colombia, using a neuropsychological test battery. Twenty participants were selected: 12 men and 8 women. The age range was between 8 and 30, and an education level between 0 and 6 years. The adults were monolingual (indigenous language) and illiterate; the minors were bilingual and educated. The battery with which they were assessed included the following: copying a cube, copying and recalling the Rey–Osterrieth figure, the Spanish version of the Wechsler Intelligence Scale for Children–Revised block design, identification of overlapped figures, identification of multiple choice figures, ideomotor praxis, drawing a map, spatial memory, verbal fluency, modified Wisconsin Card Sorting Test, and a laterality questionnaire. The authors report that in some of the tests, the performance of the indigenous group was almost perfect (identification of overlapped figures and ideomotor praxis skills), whereas their performance in other tests was impossible (cubes design, map drawing, Rey–Osterrieth Complex Figure copying, spatial memory, and modified Wisconsin Card Sorting Test). They concluded that there are three variables that affected the performance of the participants: (a) educational level, in which a significant correlation was found between the scoring in the test and this level; (b) cultural relevance, in which some tests were significant and important whereas others did not make sense and were impossible to understand, and finally; (c) age, in which a significant association was found between the performance in the tests and this variable. One of the limitations of this study is that it included a small sample of participants (n = 20) with different levels of education (0–6 years), and a wide range of ages (8–30), and therefore it is not clear whether the results are due to effect of culture, age, or differences in the educational level of the participants.

The limitation of the studies performed to date is due to the fact that the effects of culture and education are sometimes difficult to separate. The purpose of this research was to analyze the influence of each one of these variables (culture and education) while administering a neuropsychological test to an indigenous population.

Method

Participants

The total sample included 27 individuals: 20 were illiterates and 7 had 1 to 4 years of education, with an average age of 54.60 years, with a range of 43 to 73 years. The illiterate sample was divided into three groups: seven Maya participants, six Pame, and seven nonindigenous. To further study how learning to read and write affects the neuropsychological profile, we studied a group of seven Maya participants who had 1 to 4 years of education. This group was compared to the seven illiterate Maya participants. The individuals were matched by age and educational level. The descriptive characteristics of the sample are shown in Table 1.

The indigenous population under study lived in two different states of Mexico: the Maya culture that lived in the state of Yucatan and the Pame culture that lived in the state of San Luis Potosí. The Mayan language is spoken by 800,291 people (Instituto Nacional de Estadística, Geografía e Informática, 2000). Mayas are the majority population in the state of Yucatan, outnumbering nonindigenous residents. Yucatan is the state.

Table 1. *Descriptive Characteristics of the Sample*

		Age in Years		Range of Age (Years)	Sex		Level of Education (Years)	
	n	**x**	***SD***		**M**	**F**	**X**	***SD***
Pame illiterates	6	53.67	6.18	43–69	3	3	0	0.00
Maya illiterates	7	58.43	8.88	43–73	5	2	0	0.00
Nonindigenous illiterates	7	57.71	9.06	43–71	2	5	0	0.00
Maya 1–4	7	55.29	9.76	43–73	2	5	2.07	0.84
Total	27	54.60	8.47	43–73	12	15	0.51	0.21

Mayan language is part of the Maya–Totonaco group; this language is spoken by peninsular indigenous and by a great number of *mestizos* or persons of mixed race, who use it as an interaction element in their social relationships. Women use the Mayan language more than men, and the new generations speak Spanish more often than Mayan, because this language is used only at home (Instituto Nacional Indigenista, 2002). The traditional Mayan houses have walls made of interwoven branches, with guano, palm leaves, or hay on top of a soil base. The furnishings are very simple; they generally consist of wooden chairs with leather seats, tree trunk benches, a table, and hammocks made of henequen or cotton thread. Their social organization is made up of municipal authorities that, together with the *nojoch tata* (chief), the (holy) *escribientes* or clerks, and the *rezadores* (people who pray), administer justice and solve the problems of the community.

The Pame culture is a relatively small community integrated by 8,312 people who live in the state of San Luis Potosí. They call themselves *xi úi,* which means indigenous. The majority is fully bilingual (Pame-Spanish) and people are devoted to farming and basketry manufacturing for economic survival. The traditional Pame houses have soil and wooden bases. They have one to two rooms: one is used as the kitchen and the other is the bedroom. The furnishings are very simple; they generally consist of wooden chairs, a table, and a cloth mattress that is used as a bed. Their social organization is made up of municipal authorities who administer justice and solve the problems of the community.

The nonindigenous sample was selected in Mexico City. This sample was made up of individuals born in the city, who did not speak any indigenous language, and who were merchants, workers, and domestic employees. The participants of this population were Spanish monolinguals.

Instruments

The following battery was administered for the assessment of the participants.

1. Clinical history—A neurologic and psychiatric screening questionnaire was used to rule out previous neurological and psychiatric conditions, such as brain injury, cerebrovascular disease, epilepsy, Parkinson's disease, psychiatric hospitalizations, and so forth.

2. *Guide for the Exploration, Comprehension and Expression of Basic Spanish* (Ostrosky-Solís et al., 2002)—This was applied to select participants who were completely bilingual with an adequate comprehension and expression of Spanish. A score of 70 and above is equivalent to "completely bilingual" (Maya-Spanish and Pame-Spanish).

3. NEUROPSI neuropsychological test battery—The NEUROPSI neuropsychological test battery is a brief neuropsychological test battery developed and standardized in Mexico (Ostrosky, Ardila, & Rosselli, 1997, 1999). Table 2 presents a description of the test. In total, 26 different scores are obtained. The maximum total score is 130. Administration time is 25 to 30 min. Normative scores were obtained in a sample of 1,680 participants, corresponding to four age ranges (16–30, 31–50, 51–65, and 66–85 years) and four educational levels (illiterates, 1–4, 5–9, and more than 10 years of formal education; Ostrosky et al., 1999). The NEUROPSI Manual distinguishes four levels of performance by age and by educational level: normal (within 1 standard deviation), mildly abnormal (between 1 and 2 standard deviations), moderately abnormal (between 2 and 3 standard deviations), and severely abnormal (over 3 standard deviations with regard to the means scores in that age and education group). Participants were compared with the norms corresponding to their educational level (illiterates or 1–4 years of formal education). The NEUROPSI is sensitive to cognitive alterations associated with several clinical groups. An index of 83.53% of sensitivity and 82.07% of specificity has been reported in patients with mild and moderate dementia (Mejia, Gutierrez, Villa & Ostrosky-Solís, 2004; Ostrosky-Solís et al., 1997).

Procedure

The following inclusion criteria were used: (a) scoring equal or above 70 in the *Guide for the Exploration, Comprehension and Expression of Basic Spanish* (Ostrosky-Solís et al., 2002); and (b) the participants had to be functionally independent, without history of neurological and psychiatric conditions, such as brain injury, cerebrovascular disease, epilepsy, Parkinson's disease, psychiatric hospitalizations, and so forth. A brief screening questionnaire was administered to all the participants.

The participation of the participants was voluntary. The assessment was explained to the participants and they gave their oral consent. For the Maya and Pame sample, the administration of the instruments was done individually in a place chosen by the participants where they felt at ease.(i.e., in their house or below the shadow of a tree, but noisy places were avoided). For the non-

Table 2. *NEUROPSI: A Brief Neuropsychological Test Battery Developed and Standardized in Mexico (Ostrosky, Ardila & Rosselli, 1997, 1999)*

SUBTEST	CONTENT	SCORE
Orientation	Time (day, month, and year), place (city and specific place), and person (how old are you?).	6
Attention and concentration	Digits backward: up to six digits.	
	Visual detection: In a sheet, which includes 16 different figures each, one repeated 16 times, the participants are requested to cross out those figures equal 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.	27
	20 minus 3: 5 consecutive times.	
Verbal memory: Encoding and delay recall	Immediate recall: Six common nouns corresponding to three different semantic categories (animals, fruits, and body parts) are presented three times. After each presentation, the participants repeats those words that he or she remembers. Intrusions, perseverations, recency, and primacy effects are noted.	24
	Delay recall: Spontaneous recall.	
	Cue recall: Recall by categories (animals, fruits, and body parts).	
Visuospatial copy and delay recall	Copy of a semicomplex figure: A figure similar to the Rey–Osterrieth Complex Figure, but notoriously simpler, is presented to the participant. The participant is instructed to copy the figure at his or her best.	24
	Recall of the semi-complex figure.	
Language	Naming: Eight different line drawing figures are presented to be named.	31
	Repetition: The participant is asked to repeat one monosyllabic word, one three-syllabic word, one phrase with three words, and one seven word sentence.	
	Comprehension: On a sheet of paper, two circles (small and large) and two squares (small and large) are drawn. Six consecutive commands, similar to those used in the Token Test, are given to the participant.	
	Semantic verbal fluency (animals).	
	Phonological verbal fluency (words beginning with the letter F).	
	Reading: The participant is asked to read aloud a short paragraph.	
	Writing: To write under dictation a six-word sentence, and to write by copy a different six-word sentence.	
Ejecutive Function	Conceptual functions	
	Similarities: Three pairs of words (e.g., orange-pear) are presented to find the similarity.	
	Calculation abilities: Three simple arithmetical problems are presented.	
	Sequences: The participant is asked to continue a sequence of figures drawn on paper (what figure continues?).	
	Motor functions	
	Changing the position of the hand: To repeat three positions with the hand (right and left). The model is presented by the examiner up to three times. Alternating the movements of the hands: To alternate the position of the hands (right hand close, left hand open, and to switch).	
	Opposite reactions: If the examiner shows the finger, the participant must show the fist; if the examiner shows the fist, the participant must show the finger.	
TOTAL		130

indigenous sample, administration was done individually in a separate room within the university setting.

Statistical Analysis

Descriptive statistics were obtained for each one of the neuropsychological variables per group. A Kruskal-Wallis analysis was used to compare the effect of culture (Pame, Maya, and nonindigenous with no education) and a *t* test for independent groups was used to compare the effects of education of Maya illiterates versus Maya indigenous with 1 to 4 years of education.. The significance level was established at $p < 0.05$ for all the statistical analyses.

Results

The effects of the culture, Pame and Maya versus nonindigenous without education, can be observed in Table 3. This table shows the mean, standard deviation, and significance level obtained in the NEUROPSI subtests. Significant differences were found only in 5 out of the 21 subtests. The differences were found in the following: copy and delay recall of the semicomplex figure, hand position, and immediate and delayed verbal memory. Both indigenous participants scored higher in copy and delay recall of the semicomplex figure and in hand position and lower scores than the nonindigenous in immediate and delayed verbal memory.

Table 4 presents the neuropsychological profile of the Maya indigenous population with no education versus the Maya indigenous population with 1 to 4 years of education. The group with 1 to 4 years of education obtained higher scores on the following: visual detection, copy and delay recall of the semicomplex figure, delay verbal memory in spontaneous and cue recall, and in the total NEUROPSI.

Discussion

Examining the influence of the cultural factor, the results obtained in this research indicate that illiterate indigenous (Pame and Maya) people show a better execution in visuoperceptual and constructive tasks (copy of the semicomplex figure and hand position), but obtained lower scores on a subtest related to immediate and delayed verbal memory. These results suggest that the cultural environment where the indigenous people live may have a significant influence in their cognitive

Table 3. *Mean, standard deviation, and significance level obtained in the NEUROPSI subtests for illiterate groups Pame, Maya, and nonindigenous.*

Subtest	Pame Illiterates $n = 6$	Maya Illiterates $n = 7$	Nonindigenous Illiterates $n = 7$	*F*	
Orientation time	2.83 (0.40)	2.86 (0.37)	2.43 (0.78)	.366	—
Orientation space	2.00 (0.00)	2.00 (0.00)	1.86 (0.37)	.395	—
Orientation person	0.83 (0.40)	1.00 (0.00)	1.00 (0.00)	.311	—
Digit backwards	2.17 (1.94)	1.43 (1.39)	1.57 (1.13)	.934	—
Visual detection	10.33 (3.77)	6.43 (3.15)	9.71 (4.75)	.242	—
20 minus 3	2.17 (2.48)	1.29 (2.21)	1.57 (2.07)	.751	—
Immediate verbal memory	3.00 (0.54)	2.86 (1.34)	4.29 (0.75)	.045	N vs. M, P
Copy of semicomplex figure	9.73 (1.08)	8.95 (0.89)	6.21 (1.41)	.002	P,M vs. N
Naming	6.67 (1.03)	7.71 (0.48)	7.57 (0.78)	.070	—
Repetition	3.67 (0.56)	3.43 (0.53)	3.86 (0.37)	.260	—
Comprehension	4.00 (1.26)	4.14 (0.69)	4.14 (1.57)	.908	—
Semantic fluency	11.83 (4.49)	11.00 (2.58)	12.00 (2.44)	.910	—
Similarities	2.50 (2.16)	3.57 (1.90)	1.86 (1.67)	.203	—
Hand position	2.33 (0.81)	1.71 (0.48)	1.00 (0.99)	.046	P,M vs. N
Alternating movements	0.67 (0.51)	0.71 (0.75)	0.57 (0.53)	.937	—
Opposite reactions	1.67 (0.51)	1.43 (0.78)	1.29 (0.75)	.636	—
Delayed visuospatial memory	8.16 (0.68)	7.78 (1.34)	4.14 (2.1)	.002	P,M vs. N
Delayed verbal memory	0.83 (2.04)	0.14 (0.37)	2.57 (1.90)	.013	N vs. P,M
Cue recall	2.33 (1.36)	1.43 (1.39)	2.85 (2.30)	.446	—
Recognition recall	5.83 (0.48)	5.57 (0.53)	5.86 (0.37)	.417	—

Note. Significant differences were found only in 5 of the 21 subtests: Both indigenous participants scored higher in copy and delay recall of the semicomplex and hand position and lower scores than the nonindigenous in immediate and delay verbal memory.
N = nonindigenous; M = Maya; P = Pame.
* $p = .05$. ** $p = .01$.

Table 4. *Effects of education on the cognitive profile of the Maya indigenous participants.*

Subtest	Mayas Illiterate *n* = 7 x ± s.d.	Mayas 1–4 *n* = 7 x ± s.d.	*Test*	*P*
Orientation time	2.86 ± 0.38	2.86 ± 0.37	.000	1.000
Orientation space	2.00 ± 0.00	2.00 ± 0.00	—	—
Orientation person	1.00 ± 0.00	0.71 ± 0.48	1.549	.172
Digit backwards	1.43 ± 1.40	2.57 ± 0.78	–1.886	.090
Visual detection	6.43 ± 3.15	11.71 ± 5.64	–2.162	.056
20 minus 3	1.29 ± 2.21	3.14 ± 2.41	–1.501	.159
Immediate verbal memory	2.86 ± 1.35	3.86 ± 1.06	–1.540	.151
Copy of semicomplex figure	8.35 ± 0.90	9.57 ± 2.14	–1.379	.205
Naming	7.71 ± 0.49	7.86 ± 0.37	–.612	.552
Repetition	3.43 ± 0.53	3.71 ± 0.48	–1.044	.317
Comprehension	4.14 ± 0.69	4.71 ± 0.75	–1.477	.166
Semantic fluency	11.00 ± 2.58	12.71 ± 1.97	–1.395	.190
Similarities	3.57 ± 1.90	3.14 ± 1.86	.926	.678
Hand position	1.71 ± 0.49	1.86 ± 1.77	–2.06	.843
Alternating movements	0.71 ± 0.76	0.71 ± 0.95	.000	1.000
Opposite reactions	1.43 ± 0.79	1.71 ± 0.75	–.693	.502
Delayed visuospatial memory	6.78 ± 1.34	8.57 ± 3.15	–1.377	.205
Delayed verbal memory	0.14 ± 0.38	2.86 ± 2.19	–3.227	.017
Cue recall	1.43 ± 1.40	3.86 ± 2.11	–2.534	.026
Recognition recall	5.57 ± 0.53	5.00 ± 1.14	1.000	3.48

Note. Mean, standard deviation, and significance level obtained in the NEUROPSI subtests for illiterate indigenous participants and indigenous participants with 1 to 4 years of education. The group with 1 to 4 years of education obtained higher scores on delay verbal memory in spontaneous and cue recall.

organization and therefore, in the expression of their skills. As a matter of fact, their culture demands the use of visuospatial skills because they are people devoted to farming and basketry manufacturing for economic survival. Nevertheless, delayed verbal memory skills are probably not used constantly or demanded in their environment. On the contrary, nonindigenous participants that live in the city probably require more verbal memory than visuospatial skills, and therefore scores in verbal memory tests are higher.

These results concur with Ardila and Moreno (2001), who found in their study on Arauco indigenous participants, who are devoted to fishing and hunting, a good execution in ideomotor skills. However, the opposite was found when copying figures: they reported a poor performance. In this study, we found that the performance of indigenous participants was above the nonindigenous (Mexico City) participants. These differences are probably due to the dissimilar demands of the environment.

Culture intervenes in the development and use of some cognitive processes. Education also influences the reinforcement of certain cognitive skills. It has been said that education is not limited to the acquisition of reading and writing (and other types of knowledge); it also requires the practical use and adaptation of such skills to the contexts and situations where they are required (Ardila, 1996, in press; Manly et al., 1999; Morais, Kolinsky, Alegria, & Scliar-Cabral, 1998).

To determine the influence of education on the cognitive profile of the illiterate Maya group once members acquired basic reading and writing skills, we compared the neuropsychological profile of illiterate versus the profile of participants with 1 to 4 years of formal education. We found significant differences in favor of the participants with 1 to 4 years of schooling in attention and visuoperceptual processing (visual detection, copy of a figure), visual and verbal memory (delay recall of complex figure, verbal memory), and in total NEUROPSI score. These data show that even if it is true that culture influences the development and use of certain skills (e.g., visuospatial and hand position), education also affects cognitive test performance. Results lead us to suppose that education relates with the reinforcement of some specific skills such as attention and memory abilities.

The former data agree with several investigations that have found lower performance in illiterates in memory tasks and digit retention (e.g., Ardila in press; Ardila et al., 2000; Ardila et al., 1989; Castro-Caldas & Reis, 2000; Ostrosky et al., 1999; Ostrosky-Solís, Ardila, Rosselli, Lopez-Arango, & Uriel Mendoza, 1998; Rosselli et al., 1990). As Morais and Kolinsky (2000) have pointed out, the written language and its inherent characteristics have deep consequences on the ability to process linguistic and nonlinguistic information. For example, the linguistic domain affects the phonological and lexical knowledge; semantics influences the ability to categorize and conceptualize, as well as in the strategies used for codification and recall during memory, and in executive functions as expressed in selective attention and inhibition of inappropriate responses. Likewise, education provides training and improves the ability to process information from concrete stimulus to a model of abstract representation of the real world. Those skills acquired at school are essential to perform the operations required for the execution of neuropsychological tests (Grossi et al., 1993). Thus, once reading and writing are acquired, significant changes in the way stimuli are memorized and conceptualized are observed.

When using quite different groups of illiterates (Pame, Maya, and Mexico City), our results showed that culture could influence different skills. The Pame and Maya groups performed better on visuospatial tasks whereas the nonindigenous group scored higher on delayed verbal memory. No significant differences were found in other cognitive processes (orientation, comprehension, and some executive functions). Our data showed that culture relates to what is important for survival and, as a matter of fact, education could be considered as a type of subculture that emphasizes the development of certain skills instead of others.

Both education and culture may impact neuropsychological test scores. The effect of both variables can be found, however, on different abilities. The interpretation of neuropsychological tests and therefore accurate assessment of normal cognition and cognitive dysfunction is dependent on both education and cultural variables.

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