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BRIEF COMMUNICATION

Neuropsychological test performance in Aruaco Indians: An exploratory study

ALFREDO ARDILA[1] AND SONIA MORENO[2]

[1]Instituto Colombiano de Neuropsicología, Bogotá, Colombia
[2]University of Antioquia, Medellín, Colombia

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Abstract

A sample of 20 right-handed Aruaco Indians (12 male, 8 female; age 8–30 years) from the Sierra Nevada de Santa Marta (Colombia) participated in this study. A brief neuropsychological test battery (visuoconstructive and visuoperceptual abilities, memory, ideomotor praxis, verbal fluency, spatial abilities, concept formation) was individually administered. In addition, a handedness questionnaire was included. In some neuropsychological tests performance was virtually perfect (Recognition of Overlapped Figures and Ideomotor Praxis Ability test), whereas performance in other tests was impossible (e.g., Block Design using a time limit). It was proposed that two types of variables were significantly affecting performance: (1) educational level; and (2) cultural relevance. Some tests appeared significant and meaningful whereas others were meaningless and even impossible to understand. The appropriateness of current neuropsychological instruments for cross-cultural assessment is discussed. (*JINS*, 2001, *7*, 510–515.)

Keywords: Neuropsychological testing, Cross-cultural neuropsychology, American Indians, Illiteracy

INTRODUCTION

Cognitive abilities measured by neuropsychological tests represent, at least in their contents, culturally learned abilities. Basic cognitive processes are universal and cultural differences in cognition reside more in the situations to which particular cognitive processes are applied than in the existence of the process in one cultural group and the absence in the other (Altarriba, 1993; Ardila, 1995; Berry, 1971, 1979). Culture prescribes what should be learned and at what age (Ferguson, 1954; Irvine & Berry, 1988). The evaluation of an alien cultural group using our current neuropsychological instruments, procedures and norms, results in conceptual errors in assessment.

In neuropsychology, cognitive disturbances associated with brain pathology of a very limited subsample of the human species—contemporary Western, and most often, urban middle-class, and literate brain-damaged individuals—have been relatively well analyzed. Our understanding about the brain's organization of cognitive abilities, and their disturbances in cases of brain pathology, is therefore not only partial but, undoubtedly, culturally biased. Cultural and linguistic diversity is an enormous, but frequently, overlooked moderating variable (Irvine & Berry, 1988).

Neuropsychological instruments have been rarely administered to indigenous people in the Americas. Pontius (1989) 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. Excepting Pontius' study, the literature yields no further research in this area.

The purpose of this research was to analyze test performance in a sample of Amerindians. A brief and simple neuropsychological test battery was developed, and administered to a small sample of Aruaco Indians in Colombia. Tests were selected or constructed according to the following criteria: (1) short and easy to administer; (2) to be adapted to the Indian living conditions; and (3) sampling a large

Correspondence: Alfredo Ardila, Ph.D., ABPN, 12230 NW 8 Street, Miami, FL 33182. E-mail: aardila@compuserve.com

range of cognitive abilities (language, memory, spatial, constructive, perceptual, praxis, and conceptual abilities).

METHODS

Geographical Location and Cultural Background

Located about 150 km away SSE from Santa Marta City (Colombia) is the Sierra Nevada de Santa Marta. Four Indian groups live in this area: Kogis, Aruacos (Ijka), Kankuamos, and Sanha (Arsarios). The two major groups are the Aruacos (28,000 people) and the Kogis (22,000 people). The Aruaco language is known as Ijka. Aruacos are mainly agricultural, but they also hunt, fish, and have some domestic animals. They live in small communities of about 2,000 to 3,000 inhabitants.

Each Indian group speaks a different language. Many people, however, speak two or more languages. Bilingual schools (local Indian language and Spanish) are found in the different Indian villages. Colombian school programs are used in these Indian schools. As a result, younger people can speak Spanish, but older people usually only speak Indian languages.

Aruaco Indians have their own political administration. A General Council takes responsibility for most important social and administrative decisions. So-called *Mamos* (leaders) participate in this General Council. Mamos are leaders or experts in different areas. There are different kinds of Mamos: health Mamos, spiritual Mamos, agriculture Mamos, etc. There is also a Major Mamo. The Major Mamo has a broader knowledge and authority in different domains: It is accepted that he knows how to control diseases, is knowledgable about the rain season, agriculture, etc. Mamos are only male and do not attend formal school.

Aruacos live in predominantly nuclear families, but also frequently other family members are present in the household. Houses are typically 8×6, 8×4 or 4×4 m. Inside the houses virtually nothing is found except a fireplace that is maintained all the time. In the houses there is also a sleeping area for all the family, but no beds or hammocks are found. They sleep on the floor.

Aruaco people use a long dress, sandals, a hat or cap, and carry two sidebags, one for diverse objects, and the other for the *poporo* (a kind of wood bottle). In the poporo they keep crushed coca leaves and a powder obtained from seashells.

In 1916 a missionary group (Capuchins) settled in the Sierra Nevada de Santa Marta. Capuchins remained there until mid-1970s, when they had to leave by direct Indian request. During this time they introduced the Catholic religion and different Western elements. Currently, a mixture of traditional and Catholic religion is found. During the last decades, many non-Indian people have moved to the Sierra Nevada de Santa Marta looking for farming land. Nonindigenous people also introduced diverse Western cultural elements (agricultural tools, radios, etc.) in the area.

The Aruaco village that was examined in this study is known as Nabusimake or San Sebastian de Rabago.

Research Participants

Twenty individuals ranging in age from 8 to 30 years were selected. Twelve males and 8 females were included in the sample. Educational level ranged from zero to 6 years of school. All the participants 15 years of age and younger were students. Older people were devoted to agriculture and to household activities. All were healthy, according to the medical report. For some analyses, participants were divided in two age ranges: 8 to 14, and 15 to 30 years.

Instruments

A brief and simple neuropsychological test battery was used, included the following:

1. *Copying a Cube*: A 4-point scoring system was used. One point was given when tridimentionality was used. One point was given when the front side of the cube was correctly oriented; 1 point when the internal lines were correctly oriented; and 1 point when the opposite sides were drawn in a parallel way. Total score ranged from zero to 4.
2. *Rey-Osterrieth Complex Figure Copy (ROCF; Osterrieth, 1944)*: There was no time limit but time was recorded. Both the copy and the memory designs were scored considering 18 units separately (Lezak, 1995; Taylor, 1959) . Maximum score was 36.
3. *ROCF–Immediate Memory*: Maximum score was 36.
4. *Block Design from the WISC–R, Spanish version (Wechsler, 1993)*: The first three designs were used. As the time required by all participants to complete the task was extremely long (usually several minutes), it was simply scored as 2 if the design was correct regardless of the time limit. The total score ranged from zero to 6.
5. *Recognition of Overlapped Figures*: Three cards each one containing four overlapped figures (tree, fish, eye, spoon, Indian bag, Indian cap, *poporo*, canoe, tree leaves, flower, and an Indian pot) were presented. Participants were required to name the drawings. Total score ranged from zero to 12.
6. *Recognition of Figures–multiple choice*: If the participant failed in recognizing the overlapped figures, a multiple-choice trial was given. Participants were required to point to the four figures out of eight possibilities.
7. *Ideomotor Praxis Test*: Participants were required to perform under verbal command the following movements: whistle, blow, to wave good-bye with the hand, to ask somebody to come with the hand, to throw a stone, to paint oneself, to use a machete, to use an axe, and to row. Total score ranged from zero to 9.

8. *Draw-a-Map Test*: Using a sheet of paper, participants were told that the paper represented the house space. It was explained, "We are now at this point, and here is located that wall. Now, point on the paper where the fireplace and the sleeping area would be located?" Total score ranged from zero to 2.

9. *Spatial Memory*: Nine everyday elements with approximately the same size were used (bean, two different pebbles, corn, small piece of wood, two different seeds, piece of coal, and chickpea). They were distributed in a 3×3 arrangement, three columns with three rows. The participant was instructed to carefully watch them for 10 s. The examiner then mixed the elements and the participant was asked to place them in their original positions. Each element placed in the correct position was scored 1. Total score ranged from zero to 9.

10. *Verbal Fluency*: Participants were required to say aloud as many fruits and animals as possible. One minute was used in each condition. Total score was the addition of correct responses for fruits and animals.

11. *Modified Wisconsin Card Sorting Test (WCST; Nelson, 1976)*: Only 48 cards are used. Correct Responses, Errors, Categories, and Perseverative Responses were recorded.

12. *Handedness Questionnaire*: A brief handedness questionnaire was used including three questions (to paint oneself, to throw a stone, and to strike a match).

Procedure

Frequently the Colombian Ministry of Health organizes health brigades in Indian communities. During brigade visits, immunization is provided to children, and medical and dental consultation is given to people requiring them. A professional neuropsychologist participating in a health brigade collected the information used in this study. Participants were individually tested inside the Indian houses. Testing was performed in Spanish, excepting in the three older participants because they only spoke Indian languages. For testing these three individuals, an Indian interpreter was used.

Ethical Considerations

Following the Indian tradition, the purpose of this study was initially explained to the Major Mamo of the community and permission was obtained to test each person. Each participated voluntarily. No special reward was given to the participants.

RESULTS

Table 1 and Table 2 present the general results in the two age groups. In some tests, performance was virtually perfect in all participants. In most of the tests, performance was higher in the younger than in the older group. One younger and two older participants were unable to understand the WCST and administration was impossible. Most failed in the Drawing-a-Map test. In several tests, performance was similar in both age groups. Interesting to note, all were right-handed, and all answered "with the right" to the three questions included in the handedness questionnaire.

Correlations between test scores and age and education were calculated. All correlations between age and test performance—excepting WCST Perseverative Responses—

Table 1. Distribution of the younger sample (4M, 5F) and raw scores in the neuropsychological tests

Variable	S1*	S2**	S3*	S4*	S5**	S6**	S7**	S8*	S9**	*M* (*SD*)
Age	8	8	9	10	11	11	12	13	14	10.67 (2.12)
Education	1	1	4	1	2	3	6	5	4	3.00 (1.87)
Cube	1	2	1	2	0	1	4	1	2	1.56 (1.13)
ROCF–Copy	27.0	14.5	12.0	8.0	20.5	25.0	26.5	29.0	25.0	20.83 (7.53)
ROCF–Memory	9.0	0.0	0.0	0.5	6.0	7.0	20.0	10.5	4.0	6.33 (6.43)
Block Design	4	4	4	4	2	4	2	6	4	3.77 (1.20)
Overlapped Figures	12	12	12	12	12	12	12	12	12	12.00 (0.00)
Recognition Figures	12	12	12	12	12	12	12	12	12	12.00 (0.00)
Ideomotor Praxis	9	9	9	9	9	9	9	9	9	9.00 (0.00)
Map	0	0	0	0	2	0	2	2	0	0.66 (1.00)
Spatial Memory	3	3	6	4	7	7	7	5	5	5.22 (1.80)
Verbal Fluency	14	14	18	20	20	15	28	17	19	18.33 (4.33)
WCST										
Correct	22	—	34	21	31	36	36	37	30	30.87 (6.28)
Errors	26	—	14	27	17	12	12	11	18	17.12 (6.28)
Categories	3	—	5	2	5	6	6	6	4	4.62 (1.50)
Persv resp	17	—	10	14	14	12	8	6	11	11.50 (3.54)

*male. **female.

Table 2. Distribution of the older sample and raw scores in the neuropsychological tests

Variable	S10*	S11*	S12*	S13*	S14*	S15*	S16*	S17**	S18**	S19**	S20*	*M* (*SD*)
Age	15	15	18	20	20	21	23	24	26	28	30	21.82 (4.94)
Education	5	5	5	5	5	5	(†)	2	0	0	0	3.20 (2.39)
Cube	3	1	2	2	3	0	4	0	1	0	0	1.45 (1.44)
ROCF–Copy	19.0	10.0	12.0	11.0	17.5	15.5	32.5	10.5	6.5	10.5	6.5	13.77 (7.39)
ROCF–Memory	3.5	7.0	6.5	3.5	9.5	6.0	24.5	4.5	4.0	4.5	0.0	6.68 (6.38)
Block Design	0	2	2	0	4	4	2	0	0	0	0	1.27 (1.61)
Overlapped Fig	12	12	12	12	12	9	10	12	10	9	12	11.09 (1.30)
Recognition Fig	12	12	12	12	12	12	12	12	12	12	12	12.00 (0.00)
Ideomotor Praxis	9	9	9	9	9	9	9	9	9	9	9	9.00 (0.00)
Map	0	0	0	0	2	0	2	0	0	0	0	0.36 (0.80)
Spatial Memory	3	6	5	5	9	4	7	6	4	4	3	5.09 (1.61)
Verbal Fluency	21	16	17	21	22	17	19	20	17	22	17	19.00 (2.28)
WCST												
Correct	15	18	26	24	34	28	31	18	—	12	—	22.88 (7.54)
Errors	33	30	22	24	14	20	17	30	—	36	—	25.11 (7.54)
Categ	2	3	4	4	5	4	4	2	—	2	—	3.33 (1.11)
Persv	17	20	11	17	11	12	12	21	—	25	—	16.22 (5.01)

*male. **female.
(†) Corresponds to a Mamo trainee who has no formal education.

were negative. Correlations between age and test performance were significant in the following tests: ROCF–Copy ($r = -.572$, $p < .011$), Block Design ($r = -.676$, $p < .001$), Overlapped Figures ($r = -.533$, $p < .019$), and WCST Perseverative Responses ($r = .532$, $p < .033$). All correlations between education and test performance—excepting WCST Perseverative Responses—were positive. Correlation between education and tests performance was statistically significant in the following tests: Cube ($r = .527$, $p < .020$), ROCF–Memory ($r = .509$, $p < .020$), WCST Categories ($r = .500$, $p < .049$) and Perseverative Responses ($r = -.568$, $p < 0.021$).

DISCUSSION

This study has two significant limitations: a small and heterogeneous sample, and limited testing. Furthermore, a very narrow age band was used. As a result of the heterogeneity, it is extremely difficult to draw conclusions for the whole sample. However, current results allow exploring neuropsychological test performance in a sample of previously unstudied people—the Aruaco Indians. Our participants were Westernized to variable degrees, and conclusions can be only tentative. Children had exposure to Western cultural elements not only through direct contact, but also through the school. Older people were more traditional and much less exposed to Western cultural influence.

The last 3 participants (S18, S19, and S20) are relatively homogenous (age 26–30 years; zero years of school; they only speak Ijka, suggesting a very low level of Western acculturation); 2 were female and 1 was male. All 3 participants were virtually unable to draw a cube or to copy the ROCF. As a matter of fact, they had never used a pencil before, nor had they engaged in drawing or copying anything before. Block Design was zero in these 3 participants, even though no time limit was used. Nonetheless, Recognition of Overlapped Figures and performance in the Ideomotor Praxis test was virtually perfect. They completely failed in representing spatial relationships on paper (Draw-a-Map test), and performance in the Spatial Memory test was very low (they were able to correctly locate an average of 3.6/9 everyday elements). Verbal Fluency for the two semantic categories was, on average, 18.6, equivalent to the rest of the sample. Two out of the 3 participants could not even understand what was requested with the WCST, and the other was able to get only two categories, well below the group average. Summing up, only three tests (Recognition of Overlapped Figures, Ideomotor Praxis Test, and Verbal Fluency) appeared appropriate, meaningful, and understandable for these 3 Indian adults. The rest of the tests were extremely confusing, unusual, or simply impossible to comprehend for these individuals.

A significant correlation was observed between neuropsychological test performance and years of school. This correlation supports the assumption that abilities tapped in neuropsychological test are to a significant extent school-trained abilities (Ardila, 1995, 1999; Ostrosky et al., 1998, 1999). Correlations were particularly high for Copy-a-Cube, copying the ROCF, and WCST Perseverative Responses.

It can be hypothesized that bilingualism represented a confounding variable in the correlations that were found between age and education, and test performance. In Aruaco Indians, the ability to communicate in Spanish is significantly associated with age and schooling. Furthermore, in 3 older participants an interpreter was required to admin-

ister the testing, introducing an uncontrolled bias. Usually younger and schooled people can speak Spanish better than older and illiterate people. Negative correlations between age and test performance, and positive correlations between school and test performance may have been inflated as a consequence of a confounding variable.

The Block Design test deserves special consideration. As no participant was able to reproduce the three designs within the time limit, time limit was not considered. Slowness in performance was evident in other tests. For instance, to copy the ROCF took on average 8 min, 12 s. As time restrictions do not make any sense in the Aruaco culture, all activities are performed in an extremely slow pace according to Western standards. Understanding a culture requires knowledge of its orientation to time. Aruaco people in general do not use any rigid timetable. They frequently refer to "later" as a kind of indefinite future. "Later" can be 2 hr, 10 hr, or 5 days later. However, as any people devoted to agriculture, they distinguish years and separate seasons of the year.

Of note, contrary to expectations, nonverbal measures were the least appropriate tests for cross-cultural use in relation to verbal measures. Performance was particularly low in the WISC–R Block Design subtest, and Draw-a-Map Test, whereas Verbal Fluency Test performance was notoriously higher. This finding emphasizes that nonverbal tests are not necessarily more appropriate for cross-cultural testing than verbal tests. Some time ago, it was supposed that the effect of culture could be controlled if verbal items were eliminated, and only nonverbal, performance items were used. However, this assumption turned out to be wrong. Researchers using a wide variety of cultural groups in many countries, have sometimes observed even larger group differences in performance and other nonverbal tests than in verbal tests (Anastasi, 1988; Vernon, 1969). Therefore, not only verbal, but also nonverbal tests may be culturally biased. The use of pictorial representations itself may be unsuitable in cultures unaccustomed to representative drawings, and marked differences in the perception of pictures by individuals of different cultures have been reported (Miller, 1973). Furthermore, nonverbal tests often require specific strategies and cognitive styles characteristic of middle-class Western cultures (Cohen, 1969).

In summary, it can be proposed that three types of variables impacted the performance of our sample in neuropsychological tests:

1. *Formal educational level*: A significant correlation between test scores and educational level was observed in several tests.

2. *Cultural relevance*: Some tests appeared significant and meaningful whereas others were meaningless and even impossible to understand. Figure Recognition, Ideomotor Praxis and Verbal Fluency using well-known semantic categories appeared as good neuropsychological instruments for Aruaco Indians. Copying a complex figure, drawing a map, and Block Design appeared as frankly inappropriate tests. Spatial Memory and the WCST are somewhere in between. Tests using time restrictions appear as evidently inappropriate when testing Aruaco individuals.

3. *Age*: A significant association between test performance and age was found.

It is difficult to know how well these conclusions generalize to other Amerindian groups. Nonetheless, some general principles can be valid; for example, drawing tests are inappropriate to use with illiterates. Tests tapping abilities related to the everyday life (meaningful functional movements used in the everyday life, naming of animals, etc.) seems to be valid for every human group.

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