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Educational Effects on ROCF Performance

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The Rey-Osterrieth Complex Figure (ROCF) was designed by Rey (1941) to assess visual perception and visual memory in brain-damaged individuals. Osterrieth (1944) obtained some norms for children and adults with ages ranging from 4 to 15 years, and between 16 and 60 years old (Lezak, 1995). Since then, the ROCF has become one of the most common neuropsychological tests used to assess constructional abilities. Using E. M. Taylor's (1959) scoring system, a normal adult scores an average of 32 out of 36 points (Lezak). Age and educational level represent very significant variables (Ardila, Rosselli, & Rosas, 1989; Rosselli & Ardila, 1991).

The ROCF can be used not only as a constructional task, but also as a nonverbal memory test. The score from normal adults on the Immediate Recall trial of the ROCF is around 22 points in high educational level adults (Lezak, 1995). Normal adults can recall about 60% of the figure for the Immediate Recall testing, with little lost after a 1-hour delay (Mesulam, 1985).

Waber and Holmes (1985) analyzed the developmental changes in 454 children between the ages of 5 and 14 years old, with regard to organization, production, style, and accuracy of the figure. These authors found that by the age of 9 years, children can reproduce reliably all the parts of the design. Changes in performance occurring after that age reflect primarily the capacity to plan and organize reproduction of the ROCF in an effective fashion.

Osterrieth (1944) found two main approaches employed by adults when copying the figure: (a) draw the large rectangle first and add the details to it later on or (b) begin with the details attached to the central rectangle or with the subsection of the central rectangle, then complete the rectangle and add the remaining details in relation to the rectangle. The average score for children older than 8 years is 30, and from age 13 years and up, they tend to follow the same sequence of drawing use by adults (Lezak, 1995). A pattern of copying the ROCF by progressing from *right to left* has been described by Waber and Holmes (1985) in children under 7 years old. This pattern is also often found in illiterate adults (Ardila, Rosselli, & Rosas, 1989). Usually, older children, as well as literate adults, copy the design from *left to right*.

Kolb and Whishaw (1985) provide normative data on the ROCF for school children, ages 6 to 18 years. At the age of 6 years the average score is about 16.5, whereas 12-year-old children obtain scores similar to those scores observed in adult populations.

Ardila and Rosselli (1994) administered the ROCF to a sample of 233 5- to 12-year-old normal school children divided in four age groups (5-6, 7-8, 9-10, and 11-12 year-old), two socioeconomic levels (high and low), and two gender groups (boys and girls). Using E. B. Taylor's (1959) scoring system, Ardila and Rosselli observed that by the age of 5 to 6 years, the mean score was 14.5 out of 36 points. By the age of 11 to 12 years, the average score was about 28 points, which was roughly equivalent to the score expected in young adults. Average Immediate Recall (Memory) scores increased from 8.4 (in 5- to 6-year-old children) to 19.4 points (in 11- to 12-year-old children; see Table 33-1). This is also the average Immediate Recall score usually found in young adults. A statistically significant Age effect ($p < .001$) was found for both the ROCF Copy and for the Immediate Recall (Memory) conditions, as well as a minor Gender effect ($p < .05$), manifesting as a better performance in boys than in girls.

Normative results on the ROCF reported by Kolb and Whishaw (1990) in school children ages 6 to 18 years collected in Alberta, Canada, and those reported by Ardila and Rosselli (1994) using 5-year-old to 12-year-old normal school children from Bogotá, Colombia are virtually identical. No Gender effect was observed in the Kolb and Whishaw Canadian sample. However, Ardila and Rosselli divided their sample according to the parents' socioeconomic level, and found a significant gender differences in low socioeconomic level children. In high socioeconomic level children, no gender differences

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Table 33-1
Developmental Data on the Rey-Osterrieth Complex Figure by Age and Socioeconomic Level

		Age (years)							
		5-6		7-8		9-10		11-12	
SES Level	**ROCF Condition**	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
High	Copy	16.0	9.3	20.0	9.6	21.1	6.6	29.2	4.8
	Memory	8.3	5.6	13.0	7.1	18.0	6.8	19.2	5.7
Low	Copy	13.3	6.5	24.0	8.0	28.1	5.5	26.5	4.5
	Memory	8.5	6.8	14.8	7.5	16.0	5.8	19.6	4.6
Average	Copy	14.5	7.9	22.0	8.8	24.6	6.1	27.9	4.7
	Memory	8.4	6.2	13.9	7.3	17.0	6.3	19.4	5.2
	Memory/Copy Ratio Score	57.9%		63.2%		69.1%		69.5%	

Note. Norms were collected in a 233 children sample. The ratio "memory score/copy score" (Ratio M/C) is presented (Reproduced with permission from A. Ardila, & M. Rosselli, Developmental of Language, memory, and visuospatial abilities in 5 to 12-year-old children using a neuropsychological battery. *Developmental Neuropsychology*, *10*, p. 109).

were noted. Thus, gender differences can depend upon the socioeconomic status.

The ROCF can be used not only as a constructional task, but also as a nonverbal memory test. The score from normal adults for the Immediate Recall condition of the ROCF is about 22 (Lezak, 1995), but depends upon the adult's educational level. Normal adults can recall about 60% of the ROCF on average. There are no normative values for Delayed Recall, but studies using the L. B. Taylor Figure (1969) suggest that there is little lost after a 1-hour delay in normal adults (Mesulam, 1985).

The clinical use of this test has been extensive. The ROCF has been found to be particularly useful in the assessment of right-hemisphere damaged patients, and in cases of dementia (Lezak, 1995). Patients with right-hemisphere damage tend to do more poorly than left-hemisphere damage patients (Kaplan, 1988; Lezak, 1995), even though both groups produce significant numbers of errors (Binder, 1982). Poor performance on this test has been found in patients having various localizations of brain damage (Lezak, 1995; Messerli, Seron, & Tissot, 1979; Pillon, 1981a). Significantly decreased performance in the ROCF is observed in patients with dementia of the Alzheimer's type (Cummings & Benson, 1992; see also chapters 27, 28, and 29 in this handbook).

Although the ROCF is frequently used in the cognitive assessment of elderly populations, research focused on the normal performance of elderly people in the ROCF has been limited. Some norms, however, are available in the current literature (e.g., Ardila, Rosselli, & Puente, 1994; Spreen & Strauss, 1991). Significant visuospatial difficulties have been correlated with normal and very abnormal aging (e.g., Albert, 1988; Ardila & Rosselli, 1986, 1989). It is well known that one of the earliest signs of the dementia of the Alzheimer type is a decreased performance in constructional tasks; these patients do poorly in copying figures, particularly complex figures (e.g., Cummings & Benson, 1992; Rosen 1983). Thus, the ROCF's contribution as a constructional task makes it a potential core assessment instrument for evaluating this group of patients.

Significantly poorer ROCF performance has been reported at the age of 70 years (Boone, Lesser, Hill-Gutierrez, & Berman, 1993). Tupler, Welsh, Yaw, and Dawson (1995) studied a group of elderly adults and found that ROCF performance was most closely associated with age and IQ. They concluded that the ROCF scoring system yields excellent reliability when used with memory-impaired adults. Age-related deficits in ROCF performances are observed not only for the Copy condition, but also for the Immediate Recall and the Delayed Recall conditions (Chiulli, Haaland, LaRue, & Garry, 1995).

The present study is a component of a research program devoted to the norming of neuropsychological instruments, and the analysis of the impact of socioeducational factors on neuropsychological test performance (Ardila & Rosselli, 1988, 1989, 1994; Ardila, Rosselli, & Rosas, 1989; Ardila, Rosselli, & Puente, 1994; Ardila, Rosselli, & Ostrosky, 1992;

Ardila et al., 1989; Ostrosky et al., 1984, 1985, 1986; Rosselli & Ardila, 1991, 1993; Rosselli, Ardila, & Rosas, 1990; Rosselli, Ardila, Florez, & Castro, 1990). Previously, three normative studies on the ROCF have been published (Ardila & Rosselli, 1994; Ardila, Rosselli, & Puente, 1994; Rosselli & Ardila, 1991).

Method

Participants

A sample of 624 normal adults was assessed and divided into groups according to three variables: (a) *Age* (21-30, 31-40, 41-50, 51-60, 61-65, 66-70, 71-75, and 76 or more years old), (b) *Educational Level* (0-5, 6-12, and more than 12 years of schooling), and (c) *Gender*, resulting in a 8 x 3 x 2 statistical design. Table 33-2 presents the distribution of the sample.

The criteria for inclusion into the study were (a) no neurological or psychiatric background; for this purpose, a neurological and psychiatric screening was conducted; and (b) must perform adequately in everyday life activities. In addition, for adults 60 years and older, they had to have a score of 24 or higher on the Mini-Mental State Exam (Folstein et al., 1975), and no dementia according to the *Diagnostic and Statistical Manual for Mental Disorders, Third Edition Revised* (*DSM-III-R*, American Psychiatric Association, 1987) diagnostic criteria.

For screening purposes, a special questionnaire was prepared covering (a) motor and sensory integrity, (b) neurologic and psychiatric history, (c) current medications, (d) past hospitalizations, (e) alcohol or drug abuse, (f) recent significant memory loss, and (g) performance in daily activities. Only adults with motor and sensory integrity, no neurologic or psychiatric history (including alcohol and drug abuse), and no significant impairment in daily life activities were included in the normal sample. All participants were Colombians, living in Bogotá (population about 6,000,000), and native Spanish-speakers.

Procedure

The ROCF was administered as a part of a neuropsychological test battery to each individual. The ROCF stimulus model was placed in front of him/her and they were required to copy the ROCF on a white piece of paper. Time was measured, but there was no time limit imposed. When the individual finished copying the ROCF, both the stimulus card and the individual's copy were removed and the individual was then asked to draw the figure from memory "at your best." For both the Copy and the Memory reproductions, the 18 units of the ROCF were each rated separately then combined to produce a Total Score (Lezak, 1995; E. M. Taylor, 1959; and see chapter 5 in this text). The maximum score was 36.

Results

Copy Condition

Mean scores and standard deviations for the ROCF Copy condition are shown in Table 33-3. The average score for the lowest age group (21-30 year range) was 29.49, and was 17.36 for the oldest group (adults older than 75 years). In the subgroups comprising the 21- to 50-year-old range, no major differences in scores were observed. Mean Copy trial scores decreased in the 66- to 70-year-old subgroup,

Table 33-2
Number of Males and Females in Each Age x Education Subgroup for the 624 Neurologically Normal Adults

		Age (years)								
Education	**Gender**	21-30	31-40	41-50	51-60	61-65	66-70	71-75	>75	**Total**
0-5 years	Male	9	9	10	22	16	14	9	10	99
	Female	11	11	10	21	12	17	11	12	115
6-12 years	Male	9	10	10	19	19	17	11	11	106
	Female	9	8	10	22	15	16	11	12	103
>12 years	Male	9	10	10	22	16	16	11	12	106
	Female	6	9	10	18	12	18	11	11	95
Total	Male	27	29	30	63	51	47	31	33	311
	Female	26	28	30	61	39	51	33	35	313

Table 33-3
Rey-Osterrieth Complex Figure Copy Condition Means and Standard Deviation By Age, Education, and Gender for 624 Normal Adults

		Age (years)																
		21-30		31-40		41-50		51-60		61-65		66-70		71-75		>75		
Education	**Gender**	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	***M***
0-5 Years	Male	29.67	3.43	27.56	4.74	29.60	6.34	26.93	6.77	24.31	6.16	22.75	7.50	17.44	6.51	17.80	7.33	24.50
	Female	27.18	4.30	22.60	6.25	21.50	5.46	20.03	6.74	20.83	4.84	14.82	7.99	13.77	6.67	10.33	5.91	18.88
6-12 Years	Male	29.33	4.06	28.40	4.95	30.60	3.71	29.96	3.77	27.87	4.92	26.41	3.65	22.86	4.23	16.09	6.03	26.44
	Female	27.44	3.21	25.37	3.78	28.10	5.93	27.93	4.02	26.15	4.51	21.74	4.18	20.59	4.27	18.75	4.92	24.51
>12 Years	Male	32.00	2.50	31.04	3.74	32.30	3.62	32.11	2.66	31.16	2.82	30.53	2.31	26.64	3.18	21.79	4.27	29.69
	Female	32.33	1.75	31.78	3.80	33.70	1.83	32.55	2.73	31.98	2.97	30.11	4.23	24.68	4.31	19.36	6.23	29.56
Average	Male	30.33		29.00		30.83		29.66		27.78		26.56		22.31		18.56		26.88
	Female	28.98		26.58		27.76		26.83		26.32		22.22		19.68		16.15		24.31
Age Cohort *M*		29.49		27.77		29.29		28.24		27.05		24.39		20.99		17.36		25.60

and particularly those more than 70 years of age. The average score for the oldest group was 59% of the mean score in the youngest group.

Mean scores were found to increase correspondingly with educational level with about a 17% difference between the highest (over 12 years of schooling) and lowest (5 or less years of formal schooling) educational groups in men, and about a 36% difference in women. Gender differences were observed only in the lowest educational group. In the highest educational group, gender differences were nonexistent; in the middle group, differences were inconsistent.

Immediate Recall Condition

Table 33-4 presents the mean scores and standard deviations obtained for the various subgroups from the ROCF Immediate Recall trial. Decreased performances among the age subgroups was observed more for the Immediate Recall condition than for the Copy condition, where levels of performance remained relatively stable through the fifth decade. In contrast, the scores for the Immediate Recall condition started lower in each age subgroup and exhibited a steeper decline from the youngest to the oldest subgroup. This observation suggests the presence of a more rapid decline in nonverbal memory than in constructional ability. Performances among the subgroups in the 21- to 50-year range were fairly similar, but decreased scores are observed beginning with the 51- to 60-year-old subgroup. The mean score in the oldest group was about one quarter of the mean score of the youngest subgroup. The average subgroup scores for the Immediate Recall condition increased as educational level increased. Between the highest and lowest educational groups, a mean score difference of about 25% in men and of about 43% in women was found. Gender differences were the greatest in lower educational group, and minimal or nonexistent in the highest educational group.

Finally, a Construction/Memory Ratio Score was calculated (Immediate Recall/Copy score x 100).[1] This Construction/Memory score is the percentage of the ROCF recalled adjusted for the Copy trial score. The rationale for calculating this score is that the adequacy of the ROCF Copy may set an upper limit on subsequent memory, especially if the Copy is poor. Table 33-5 presents the results. It was observed that Construction/Memory score decreased from 69% (i.e., the Immediate Recall score was 69% of the Copy score) in the youngest group, to 29 in the oldest groups. That is, the Construction/Memory score decreases by about 40% between extreme age groups.

Discussion

These results show that the ROCF Copy scores depend upon the individual's age and educational level. Scores markedly decreased after age 65 years, and especially after 70 years of age. Scores in the low educational group are lower, particularly in women, pointing to the fact that the ROCF can be strongly education-dependent, as is often observed with drawing ability tests (Ardila & Rosselli, 1989; Ardila, Rosselli, & Rosas, 1989). It has been observed that figure drawing ability significantly declines with aging. Pruede, Milberg, and Cerella (1986) reported that older adults have more difficulties in drawing a cube than younger ones; this also holds true for perceiving a cube accurately. Other visuospatial and constructional tests, such as the WAIS-R Block Design and Object Assembly, show significant decline with age. Waugh and Barr (1980) found that low performance on Block Design and Object Assembly were significantly correlated in elderly with slowing in response time. Ardila and Rosselli (1989) observed that constructional tasks, in general, are the most sensitive tests to aging. A decline in visuospatial and visuomotor abilities seems to constitute the main and most basic aging factor.

Significant defects in visuospatial and constructional abilities are usually considered to be an early sign of dementia of the Alzheimer type (Ardila & Rosselli, 1986; Cummings & Benson, 1992; Rosen, 1983). However, norms about performance on the ROCF in normal aging adults are not readily available. Difficulties in determining a differential diagnosis between normal aging and dementia are particularly pronounced for persons in the early stages of a dementia of the Alzheimer type. Complex figure reproduction is one of the most widely used clinical neuropsychological procedures for testing visuospatial and constructional abilities. Well-constructed norms for normal elderly adults are needed for the ROCF and other complex figures in use (see chapters 9 and 28 in this text for some examples).

Immediate Recall trial scores began to show decreases in younger age cohorts and were more sensitive to aging effects than were the ROCF Copy trial scores. Performance differences between the most extreme age cohorts were particularly high. A steady decline in the Construction/Memory ratio (Immediate Recall score/Copy score x 100) was observed

[1] **Editors' Note:** The C/M ratio score described here is conceptually similar to scores calculated by others and referred to as: "% Retention," "% Retained," or "% Recalled."

Table 33-4
Rey-Osterrieth Complex Figure Immediate Recall Condition Means and Standard Deviation By Age, Education, and Gender for 624 Normal Adults

		Age (years)																
		21-30		31-40		41-50		51-60		61-65		66-70		71-75		>75		
Education	**Gender**	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	***M***
0-5 Years	Male	19.67	4.87	18.44	3.43	20.50	5.93	14.54	5.77	11.28	3.11	7.46	4.96	6.67	3.86	4.10	3.59	12.83
	Female	16.09	5.22	11.20	3.76	13.50	5.96	7.93	4.23	6.96	3.44	6.38	4.07	3.59	3.01	3.00	2.12	8.58
6-12 Years	Male	19.44	5.66	18.60	7.70	17.50	8.11	16.38	4.08	13.62	3.65	12.08	3.73	10.36	5.60	4.95	4.02	14.12
	Female	19.88	4.99	13.62	3.99	16.30	5.27	12.34	4.11	10.47	3.21	7.41	3.19	4.36	3.93	3.96	2.76	11.04
>12 Years	Male	25.55	6.77	21.70	5.03	20.40	5.14	19.66	4.74	16.32	3.99	14.06	3.21	10.91	4.27	8.75	3.80	17.17
	Female	22.67	3.44	22.22	5.61	21.10	4.70	13.77	4.53	13.09	4.17	11.21	3.56	10.36	4.15	5.73.	3.27	15.02
Average	Male	21.55		19.58		19.46		16.86		13.74		11.20		9.31		5.93		14.71
	Female	19.54		15.68		16.96		11.81		10.16		8.33		6.10		4.23		11.55
Age Cohort *M*		20.54		17.63		18.21		14.33		11.95		9.76		7.70		5.08		13.13

beginning with the 50-year-old cohort. It could be that in this context the ROCF may yield more results as an assessment of nonverbal memory than as a test of visuoconstructional problems. Conversely, it is also possible that nonverbal memory, as measured by the ROCF, is more sensitive than constructional ability to aging effects.

The average score of 30, expected from normal adults, in the Copy condition and of 22 in the Immediate Recall condition (Lezak, 1995) was replicated only within certain education and age parameters; in fact, they corresponded to the younger age cohorts (21- to 50-year-olds) who had obtained a minimum of a high school level education. They were not replicated for the older individuals of the the sample or those with limited educational backgrounds. Consequently, we believe a correction score is required. Table 33-6 presents a proposed correction score to adjust the individual's raw score to a mean of 30 (Copy condition) and 20 (Immediate Recall condition).

It is important to consider that the present research study was conducted with a specific population from a South American, Spanish-speaking country. Participants were urban inhabitants of a relatively large Latin American city. This is a particular strength, on the one hand, because it provides useful information that can be applied to test performances from Spanish-speaking patients. On the other hand, generalizability of the results might thus be somewhat restricted because the data were collected from this particular cultural group and under these specific conditions. The very same consideration applies to any culture-specific test norms. In support of the generalizability of these findings, the ROCF is not a verbal test, and thus, the effects of language differences should be minimized. Consistent with this point, our findings are fairly concordant with the

Table 33-5
Memory/Construction Ratio Scores (Immediate Recall/Copy Score x 100)

		Age (years)								
Education	**Gender**	21-30	31-40	41-50	51-60	61-65	66-70	71-75	>75	**Total**
0-5 Years	Male	66	67	69	54	46	32	38	23	49
	Female	59	49	63	39	33	43	29	26	43
6-12 Years	Male	66	65	57	54	49	46	45	31	52
	Female	72	53	58	44	40	34	21	21	43
>12 Years	Male	79	70	63	61	52	46	40	40	56
	Female	70	70	62	42	40	37	41	29	49
Average		69	62	62	49	43	39	35	29	49

Note. All values are percentages.

Table 33-6
Suggested Correction Values for the ROCF Copy and the Immediate Recall Based on Age and Educational Level

		Age (years)				
Education	**Condition**	21-50	51-60	61-70	71-75	>75
0-5 Years	Copy	+3	+5	+10	+15	+17
	Immediate Recall	+3	+10	+13	+15	+16
6-12 Years	Copy	+1	+2	+5	+9	+12
	Immediate Recall	+2	+5	+10	+12	+15
>12 Years	Copy	-2	-2	0	+4	+9
	Immediate Recall	-2	+3	+6	+10	+13

normative data obtained in relatively different cultural contexts (e.g., Alberta, Canada; Kolb & Whishaw, 1990). The main factor impacting the variability in ROCF performances in this sample, after the main effect for Age, seems to be the individual's educational level. Furthermore, within the western societies, the school context is quite similar across countries. As a matter of fact, school may be seen as a transnational culture (Jordan & Tharp, 1979).

In the current normative study, educational effects were carefully controlled, and the results analyzed according to the individual's level of schooling. Although visuospatial and constructional abilities have be characterized as culturally dependent (Deregowski, 1989; Pontius, 1989), this cultural effect is indeed a result of specific training in visuospatial abilities. In western-style urban societies (as it is the case in our sample), training in drawing skills are basically provided through formal education. Thus, within these western societies, the critical variable for visuospatial and visuoconstructional abilities is the level of schooling. Our research supports the view that visuospatial abilities are education-dependent (Ardila, Rosselli, & Rosas, 1989), and the current results confirm the importance of educational level for interpreting performances on visuospatial, constructional, and nonverbal memory tasks.

The effect of educational factors suggested by our findings highlights the need to carefully control for educational variables when developing norms for normal aging. It has been pointed out that cognitive changes during normal and abnormal aging are correlated with the educational level (Finley, Ardila, & Rosselli, 1991). The pattern of cognitive decline during normal and abnormal aging is not completely similar across individuals from different educational backgrounds. Educational level has been associated with the severity and even the duration of Alzheimer's disease (Stern et al., 1994; Stern, Ming, Denaro, & Mayeaux, 1995). Cultural and educational comparisons in age-related cognitive changes deserve much further research.

Recently, the significance of educational factors in neuropsychological test performance has been challenged. Based on their results from a sample of normal adults and brain-damaged patients, Reitan and Wolfson (1995) have suggested that "adjusting scores according to age and education may not be a clinically valid procedure for brain-damaged subjects and may only tend to invalidate the raw scores of neuropsychological tests" (p. 151). By the same token, based on their results from a sample of normal subjects, Saykin et al. (1995) have concluded that "Demographic factors infrequently account for more than 10% of the variance for many neuropsychological test scores" (p. 79). Their results, however, have to be interpreted with extreme caution because the education range they used is not necessarily valid for analyzing the effects of education on neuropsychological test performance. Educational effects are *not* linear; rather, they manifest as a kind of negatively accelerating curve. That is to say, differences in performance between zero and 3 years of education are highly significant; differences between 3 and 6 years of education are lower; between 6 and 9 are even lower; and so forth. Virtually no differences in ROCF performance are expected between 12 and 15 years of education. The reason for this may be that the ceiling on neuropsychological tests is usually low. Furthermore, the significance of the educational effect depends upon the specific neuropsychological test under review (Ardila, Rosselli, & Rosas, 1989; Rosselli, Ardila, & Rosas, 1990). Some tests are known to be more sensitive to educational variables than are others (e.g., language tests; the Wisconsin Card Sorting Test, Rosselli & Ardila, 1993). Extremely low scores from illiterate people have been observed on currently used neuropsychological tests (Rosselli, 1993). However, low scores on neuropsychological tests observed from illiterates may result, not only from differences in past educational opportunities, but also because illiterates are not used to being tested (i.e., they have not learned how to behave in a testing situation). For many illiterates, testing itself may seem nonsensical and irrelevant.

Unfortunately, Reitan and Wolfson (1995) did not present the mean education levels for their "lower" and "higher" groups. However, considering that the mean education was 12.78 years (*SD* = 2.28) in the normals, and 12.86 years (*SD* = 3.37) in the Brain-damaged group, and they divided at the median, it is likely that the "lower" group had a mean education level around 11 years and the "higher" group mean was around 14 years. Differences in neuropsychological test performance are expected to be minimal, and even nonexistent within this education range. Because of this, it is understandable that they did not find any effect of education on neuropsychological test performance in the brain-damaged group. Saykin et al. (1995) reported on a sample from which only a mild education effect could be expected, and then, only a mild education effect was found. Their participants had between 9 and 18 years of education with a mean of 14.6 years and a *SD* of 2.0 years. That is, most of their participants had an educational level of 12 or more years of schooling, and it can be assumed, based on the sample distribution, that only a slight percentage of the individuals had an educational level below 12 years of schooling. Their results are quite understandable, but their conclusion that, educational level has only a minor influence on neuropsychological test performance, is sample-dependent and stands in contrast to our data.

The gender effects on the ROCF are interesting. Frequently, it has been mentioned that males generate better performances in nonverbal tasks than females (Anastasi, 1988). Our results, however, demonstrated a complex interaction between gender and educational level. For low educational level adults, gender differences were quite important, but in people with a higher level of education, gender differences were minimal or nonexistent. This relationship between gender and educational level has been observed for different neuropsychological tests (e.g., Ardila, Rosselli, & Rosas, 1989; Ostrosky et al., 1985; Ostrosky & Ardila, 1987; Rosselli, Ardila, Flórez, & Castro, 1990; Rosselli, Ardila, & Rosas, 1990). In summary, ROCF is an extremely sensitive test not only to aging effect, but also to the educational level effects, and thus, ROCF performances in clinical and research contexts should be interpreted within according to individual educational levels.