Chapter 10

Illiterates and Cognition: The Impact of Education

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Illiterates represent a nonneglectable percentage of the world population (about one fifth of the world population; www.uis.unesco.org/en/stats/statistics/literacy2000.htm). Average educational level of contemporary man is about 3–4 years of school. Just a few centuries ago, reading and writing abilities were simply uncommon among the general population. Writing, as a matter of fact, has only existed during the past 5 to 6,000 of years of human history. It may be conjectured that the acquisition of these skills may have somehow changed the brain organization of cognitive activity in general.

It has been well established that educational attainment highly correlates with scores on standard tests of intelligence. This correlation ranges from about 0.57 to 0.75 (Matarazzo, 1979); thus, education accounts for nearly 50% of the intelligence test performance. Correlations with verbal intelligence subtests are usually higher (from about 0.66 to 0.75) than correlations with performance intelligence subtests (from about 0.57 to 0.61). Evidently, education represents the most crucial variable in cognitive test scores.

Several studies have demonstrated a similarly strong association between educational level and performance on various neuropsychological measures (e.g., Ardila, Ostrosky-Solis, Rosselli, & Gomez, 2000; Ardila, Rosselli, Ostrosky, & Puente, 1992; Ardila, Rosselli, & Puente, 1994;

Bornstein & Suga, 1988; Finlayson, Johnson, Reitan, 1977; Heaton, Grant, & Mathews, 1986; Ostrosky, Conseco, Quintanar, Navarro, & Ardila, 1985; Ostrosky et al., 1986; Ostrosky, Ardila, Rosselli, López-Arango, & Uriel-Mendoza, 1998; Ostrosky, Ardila, & Rosselli, 1999; Reis, Guerrero, & Petersson, 2003). Educational level accounts for a significant percentage of the variance in neuropsychological tests (Table 10.1). Ardila and Rosselli

TABLE 10.1

Percentage of the Variance Accounted by the Educational Variable in the Different NEUROPSI Subtests

Test	Correlation	Percentage of the variance
Verbal fluency: phonologic	0.62	38.5%
Language comprehension	0.59	35.3
Copy of a figure	0.57	32.9
Sequences	0.57	32.9
Digits backwards	0.54	29.5
Similarities	0.52	27.3
Verbal fluency: semantic	0.49	23.6
Calculation	0.48	22.6
Recall of a figure	0.46	21.1
Alternating movements	0.45	20.6
20 minus 3	0.44	19.0
Visual detection	0.41	17.1
Orientation: Time	0.35	12.0
Recall: Words	0.32	10.3
Coding: Verbal memory	0.31	9.7
Recall: Cuing	0.29	8.5
Language: Naming	0.28	7.9
Opposite reactions	0.27	7.2
Language: Repetition	0.26	7.0
Motor functions: Right-hand	0.26	6.9
Motor functions: Left-hand	0.24	5.7
Recall: Recognition	0.12	1.5
Orientation: Person	0.08	0.7
Orientation: Space	0.07	0.6

Note. From "Learning to Read Is Much More Than Learning to Read: A Neuropsychologically-Based Learning to Read Method," by A. Ardila, F. Ostrosky, and V. Mendoza, 2000, *Journal of the International Neuropsychological Society, 6,* p. 000. Copyright 2000 by . Adapted with permission of the authors.

(1989) reported that the educational variable was even more influential on neuropsychological performance than the age variable. As a matter of fact, Albert and Heaton (1988) argued that, when education is controlled, there is no longer evidence of an age-related decline in verbal intelligence. Clearly, formal education represents the most important variable accounting for score dispersion on cognitive test scores (Greenfield, 1997).

Some tests have been observed to be notoriously more sensitive to educational variables (e.g., language understanding) than others (e.g., orientation tests). Extremely low scores in current neuropsychological tests are observed in illiterate people (e.g., Ardila, Rosselli, & Rosas, 1989; Lecours et al., 1987a, 1987b; Ostrosky et al., 1985, 1998; Rosselli, Ardila, & Rosas, 1990). Reis et al. (2003) compared the performance of illiterates with literates with a similar socioeconomic status in a series of neuropsychological tests. The results indicated that naming and identification of real objects, verbal fluency using ecologically relevant semantic criteria, verbal memory, and orientation are not affected by literacy or level of formal education. In contrast, verbal working memory assessed with digit span, verbal abstraction, long-term semantic memory, and calculation (i.e., multiplication) are significantly affected by the level of literacy (Table 10.2).

Low scores on neuropsychological tests observed in illiterates can be partially due, not only to differences in learning opportunities of those abilities that the examiner considers relevant (although, evidently, they are not the really relevant abilities for illiterates), but to the fact that illiterates are not accustomed to being tested (i.e., they have not learned how to behave in a testing situation), and testing itself represents a nonsense (nonrelevant) situation.

Illiterates do not represent a homogenous group. Illiteracy has not the same causes in an industrialized and in a developing country. Quite often, in developing countries illiteracy is associated with poverty and lack of available schools. In industrialized countries, illiteracy is often associated with limited intellectual development. Illiteracy is also frequently increased in women due to some cultural attitudes found in some countries. By the same token, illiteracy has no the same causes in younger and older people. Today it is notoriously easier and more important to attend school than it was several decades ago. Illiteracy is also frequently associated with poverty and low socioeconomic status (SES). An association between nervous system disorders and low SES has been pointed out (e.g., Alvarez, 1983). Some research studies have shown that low SES subjects may receive quantitatively and qualitatively less stimulation at home in comparison with the high SES subjects. This differential stimulation contributes to the development of different behavioral styles (Cravioto & Arrieta, 1982). Some nervous system pathologies (for example, epilepsy) are significantly more frequent in developing countries and in low SES subjects than in industrialized countries

TABLE 10.2

Performance in the NEUROPSI Neuropsychological Test Battery Subtests in Different Educational Groups with Regard to the Group with the Highest Education

	Years of school						
Test	0	1–2	3–4	5–9	10–12	13–17	18–24
Orientation: Time	73	77	80	97	97	97	100%
Place	95	95	100	100	100	100	100%
Person	90	90	90	100	100	100	100%
Attention: Digits backwards	54	59	61	79	88	98	100%
Orientation: Time	73	77	80	97	97	97	100%
Place	95	95	100	100	100	100	100%
Person	90	90	90	100	100	100	100%
Attention: Digits backwards	54	59	61	79	88	98	100%
Visual detection	73	82	92	92	92	98	100%
20 minus 3	63	63	84	92	96	98	100%
Coding: Verbal memory	79	9	81	88	90	94	100%
Copy semi-complex figure	66	77	82	97	99	99	100%
Language: Naming	91	91	94	97	99	99	100%
Repetition	95	97	97	99	99	100	100%
Comprehension	62	73	77	93	97	97	100%
Verbal fluency: Semantic	63	68	72	86	93	98	100%
Phonol	23	47	51	57	92	100	100%
Conceptual functions: Similarities	37	61	68	87	91	96	100%
Calculation abilities	32	53	57	85	89	92	100%
Sequences	11	22	44	77	100	100	100%
Motor functions: left-hand	58	63	68	82	84	84	100%
right-hand	59	65	70	88	91	94	100%
Alternating movements	42	58	68	76	84	95	100%
Opposite reactions	94	94	100	100	100	100	100%
Recall: Words	57	63	77	88	88	96	100%
Cueing	77	81	89	90	92	92	100%
Recognition	96	98	100	100	100	100	100%
Semi-complex figure	59	66	79	87	92	96	100%

Note. Adapted from the information presented in the paper "Neuropsi: A brief neuropsychological test battery in Spanish with norms by age and educational level" by F. Ostrosky, A. Ardila, and M. Rosselli, 1999, *Journal of the International Neuropsychological Society, 5,* 413–433. Adapted with permission of the authors.

and high SES individuals (e.g., Gomez, Arciniegas, & Torres, 1978; Gracia, Bayard, & Triana, 1988). It means that illiteracy is potentially associated with a diversity of variables.

Three different issues are approached in this chapter: (1) neuropsychological test performance of illiterates in different cognitive domains; (2) some characteristics of the neuropsychological syndromes observed in illiterate people; and (3) how neuropsychological testing could be approached in illiterate populations. In this last section, the issue of disadvantage of illiterates is analyzed, and some suggestions are presented.

NEUROPSYCHOLOGICAL TEST PERFORMANCE IN ILLITERATES

The significant schooling effect on neuropsychological test performance has been reported for different types of abilities. There is converging evidence that illiterate subjects obtain significantly low scores on most neuropsychological tests. Several research groups have approached the question of neuropsychological test performance of illiterates: Matute and Ostrosky in Mexico; Ardila and Rosselli in Colombia; Lecours, Mehler, and Parente in Brazil; Castro-Caldas and Reis in Portugal; Manly and Jacobs in the United States; Dellatolas, Caramelli, Braga, and colleagues in Brazil; Folia and Kosmidis in Greece.

Language

Language abilities are significantly correlated with socioeducational level. Robinson (1974) observed that low socioeconomic parents use more nonverbal strategies in their relations with children. Bernstein (1974) pointed out that the language used by low SES people is less fluent and has a simpler grammatical structure; it relies much more on emotional and contextual rather than logical strategies. Bruner, Oliver, and Greenfield (1966) suggested that rural unschooled children may lack symbolic representation skills because their linguistic ability is tied to immediate context of the referent. They proposed that formal education facilitates the development of language into a fully symbolic tool. Lantz (1979), however, showed that rural unschooled children performed better than Indian or American school children in coding and decoding culturally relevant objects, such as grain, seeds, and so forth. Thus, children without formal schooling are able to separate language symbols from the physical referent and to use those symbols for communicating accurately, but display of this ability depends on the stimuli used (Laboratory of Comparative Human Cognition, 1983). Luria (1976) pointed out that the significance of schooling lies not just in the acquisition of new knowledge, but in the creation of new motives and formal modes of discursive verbal and logical thinking divorced from the immediate practical experience.

Several studies have reported quite similar findings in language test performance of illiterates (da Silva, Petersson, Faisca, Ingvar, & Reis, 2004; Lecours et al., 1987a; Manly et al., 1999; Ostrosky et al., 1998; Reis & Castro-Caldas, 1997; Reis, Guerreiro, & Castro-Caldas, 1994). The single verbal test most sensitive to schooling effect is probably phonemic verbal fluency. Scores of illiterates are about 20% of the scores found in people with a university level of education (Ostrosky et al., 1998; Rosselli et al., 1990). Conversely, scores of illiterates in semantic verbal fluency are notoriously higher and closer to scores of educated people; they are about 60% of the scores found in highly educated people.

da Silva et al. (2004) compared literate and illiterate subjects in two verbal fluency tasks: “supermarket fluency task” (items that can be found in a supermarket), and animals. The quantitative analysis indicated that the two literacy groups performed equally well on the supermarket fluency task. In contrast, results differed significantly during the animal fluency task. They suggested that there is not a substantial difference between literate and illiterate subjects related to the fundamental workings of semantic memory.

Loureiro et al. (2004) analyzed the phonological and metaphonological skills in illiterate and semiliterate adults. Phonemic awareness was strongly dependent on the level of letter- and word-reading ability. Phonological memory was very low in illiterates and unrelated to letter knowledge. Rhyme identification was relatively preserved in illiterates and semiliterates, and unrelated to letter- and word-reading level. Phonetic discrimination (minimal pairs) was fairly good and marginally related to reading ability. Awareness is clearly and strongly dependent on the alphabetical acquisition.

Differences in naming ability between illiterate and educated people are also found, but the differences between both groups depend on two variables: (1) Word frequency differences are observed particularly in low and middle frequency words, not in high frequency words; and (2) stimuli presentation (naming line-drawn figures is harder for the illiterate than naming real objects; Reis et al., 1994). Illiterate subjects perform significantly worse on immediate naming of two-dimensional representations of common everyday objects as compared to literate subjects, both in terms of accuracy and reaction times. In contrast, there is no significant difference when the subjects named the corresponding real objects (Reis et al., 2001)

Language repetition can be normal for meaningful words, but abnormal for pseudowords or unfamiliar words (Reis & Castro-Caldas, 1997; Rosselli et al., 1990). Language understanding is also decreased in illiterates, particularly when relatively complex grammar is used (Lecours et al., 1987a;

Manly et al., 1999). A study by Ostrosky et al. (1998) that used a simplified Token Test version, revealed that language comprehension scores of illiterates were approximately 60% of the language-understanding scores observed in individuals with a university level of education.

Visuospatial and Visuoconstructive Abilities

Educational variables significant by impact visuospatial, visuoconstructive and visuoperceptual test performance (Rosselli & Ardila, 2003). Ardila et al. (1989) administered a basic neuropsychological test battery to two extreme educational groups: illiterate and professional individuals. Subjects were matched according to gender and age. All of the analyzed visuospatial tasks (copying a cube, a house, and Rey-Osterrieth Complex Figure; telling the time on a clock; recognizing superimposed figures; recognizing the national map; and drawing the plan of the room) showed highly significant differences between the two extreme educational groups. In all of these subtests, gender interacted with educational level. In the illiterate group, men outperformed women, but no gender differences were observed in the professional sample.

Ostrosky et al. (1998) reported defects in copying figures. The correlation between educational level and test performance was close to 0.60. Matute, Leal, Zaraboso, Robles, and Cedillo (1997) found significant differences in the ability to reproduce different stick constructions. The influence of literacy was most evident with regard to the fidelity of reproductions of the figures. Dellatolas et al. (2003) studied the effect of the degree of illiteracy (complete or incomplete) on visuospatial skills. Tasks tapping visual recognition of nonsense figures distinguished the best nonreaders and beginning readers.

Memory

Statistically significant differences between illiterates and professionals were reported in memory tests by Ardila et al. (1989). For instance, professionals memorized a 10-word list after an average of 3.22 presentations, whereas illiterates required 6.55 repetitions. Significant differences were also found in the 10-word delayed recall. There was a statistically significant interaction between age and educational level, with illiterates presenting a more notable variation across age groups. Immediate and delayed logical memory tests were also sensitive to educational level.

Differences in digits backward have been reported to be larger than differences in the digits forward test. Immediate and delayed recall of verbal and nonverbal information is significantly decreased in illiterates (Ardila et al., 1989). Nonetheless, differences are found under certain recall strategies (spontaneous recall and cueing recall), but not when using recognition techniques (Ostrosky et al., 1998).

Barltlett (1932) proposed that illiterates more frequently use procedures of rote learning, whereas literate people refer to more active information integration procedures (metamemory strategies). Cole and Scribner (1974) observed that, when memorizing information, literates and illiterates make use of their own groupings to structure their recall; for instance, high school subjects rely mainly on taxonomic categories, whereas illiterate farmers make little use of this principle.

Nitrini et al. (2004) compared the performance of illiterate and literate nondemented elderly individuals in two tests of long-term memory—the delayed recall of a word list from the CERAD and the delayed recall of common objects presented as simple drawings from the Brief Cognitive Screening Battery (BCSB). Fifty-one elderly subjects (23 illiterates) were evaluated, and the performance of the illiterates and literates differed in the CERAD memory test, but not in the BCSB memory test. In consequence, difficulties in memory test performance in illiterates depend on the specific memory test that is used. Illiterate people use different memory strategies, and our current evaluation instruments are not necessarily appropriate to test people with low levels of formal education.

Praxic and Motor Abilities

Education has shown to be an important variable on motor performance subtests (Ostrosky et al, 1985, 1986). Rosselli et al. (1990) observed differences according to educational level in the performance of buccofacial, ideomotor, and finger alternating movement tests. Illiterate subjects presented some errors in these tasks whereas subjects with a high educational level presented virtually no mistakes. Use of body part as instrument was the most common type of error found in illiterates. Interaction between education and age in performing buccofacial movements under verbal command was observed, and older illiterates presented the highest number of errors. In ideomotor praxis subtests, a significant interaction between education and gender was observed. Illiterate women presented roughly twice the number of mistakes of illiterate men. Illiterate subjects in the Rosselli et al. study poorly performed fine finger movements. The absence of training and practice in fine movements (particularly, writing) may account for the difference in fine movement test performance between the illiterates and highly educated subjects. Ostrosky et al. (1985, 1986) reported significant differences in performing programmed movements between subjects coming from different educational levels. Ostrosky et al. (1998) found that illiterates have very significant difficulties reproducing three positions with the hand (either) and alternating positions of the hands (right hand closed, left hand open, and switching). However, they perform normally on the "opposite reaction test" (If the examiner shows the finger, the subject must show the fist; if the examiner shows the fist, the subject must show the finger).

Executive Functions

Defects in performing executive function tests also have been documented in illiterate individuals. Finding similarities (Similarities test) has been the test most frequently administered in several studies (Manly et al., 1999; Ostrosky et al., 1998, 1999). According to Ostrosky et al. (1998), scores of illiterates are about one third of the scores found in people with a university level of education. Extremely low scores were found by Ostrosky et al. in the Sequences test (the subject is asked to continue a sequence of figures drawn on a paper; "what figure continues?"). Performance of illiterates was about one tenth of the performance found in people with high education. Of course, lack of practice in writing and drawing represents a significant confounding variable in this result. Phonemic verbal fluency can also be interpreted as an executive function test, and as mentioned before, it is a test extremely sensitive to the effect of educational variables.

To summarize, illiterate individuals present significant difficulties in neuropsychological tests directed to assess different domains. The magnitude of the educational effect, however, is variable.

BRAIN DAMAGE AND ILLITERACY

Two opposite points of view are found in neuropsychological literature regarding the influence of education on brain organization of language in particular and cognitive activity in general. Cameron, Currier, and Haerer (1971) reported that there is a lower frequency of aphasias associated with injuries of the left hemisphere among right-handed illiterate patients than among educated ones. The authors concluded that language is more bilaterally represented in the illiterate group. Damasio et al. (1976) claimed that there is no qualitative or quantitative difference between the aphasias of educated and illiterate patients. The aphasias of literates and illiterates did not differ in expectancy rate, distribution of clinical types, or semiological structure.

Matute's research studies (1988) provide some support to Damasio et al.'s conclusion. She compared three groups of right-handed Mexican subjects: brain-damaged illiterates, brain-damaged literates, and normal illiterates. An aphasia test was given to all three groups as part of a large neuropsychological assessment battery. All left-hemisphere damaged illiterate subjects presented aphasia, and no illiterates presented aphasia after right-hemisphere damage. The aphasia was, however, less severe in the illiterate group than in the literate one. The literate group presented a higher number of errors, with lower scores on the aphasia subtests than the illiterate brain-damaged individuals.

Lecours et al (1988) studied some relationships between brain damage and schooling with regard to aphasic impairments of language. The authors concluded from their results that: (1) There was a greater right-hemisphere language involvement in illiterates than in the well-educated subjects; and (2) school-educated left-stroke subjects seemed to be "sicker," as it were, than their illiterate counterparts. That is: (a) the classical symptoms of aphasia (suppression stereotype, jargonaphasia) are more apparent among left-stroke literates than among left-stroke illiterates; and (b) auditory comprehension was more frequently impaired among the literate left-stroke patients.

Lecours et al. (1987b) also studied the influence of education on unilateral neglect syndrome. They analyzed a large sample of right-handed unilingual brain-damaged subjects: illiterates (left stroke and right stroke) and literates (left stroke and right stroke). Evidence of unilateral neglect syndrome was found in both left and right brain-damaged literates and illiterates. Their results provided no indication that tropisms were globally stronger depending on the side of the lesion or on the educational level of the subjects. Rosselli, Rosselli, Vergara, and Ardila (1985), however, reported a higher frequency of right hemispatial neglect in low-educated subjects.

Interesting to note, it has been pointed out that brain functional organization can influenced by literacy. Castro-Caldas, Peterson, Reis, Stone-Elander, and Ingvar (1998), using PET, found that during the repetition of real words, literates and illiterates activated similar brain areas. In contrast, illiterates with more difficulty in repeating pseudowords did not activate the same neural structures as literates. Castro-Caldas et al. (1999) referred to some differences in the region of the corpus callosum where parietal fibers are thought to cross. This means that brain organization of cognition may be influenced by literacy.

Studies of brain-damaged illiterates when compared with brain-damaged literates indicate that: (1) Literacy does not change the dominance of the left hemisphere for language (illiterates as well as literates present aphasia most often after left-brain damage, and not after right-brain damage); and (2) it seems, however, that the right hemisphere has more participation in language in illiterate subjects. There is a general consensus that left-damaged literates present a higher number of errors on aphasia tests than do left-damaged illiterates (Lecours et al., 1988; Matute, 1988), and that right-damaged illiterates more frequently present lower performance on aphasia tests than do right brain-damage literates (Lecours et al., 1988).

ARE ILLITERATES NECESSARILY AT A DISADVANTAGE?

Cornelious and Caspi (1987) found that educational level has a substantial relationship with performance on verbal tests, but is not systematically related to everyday problem solving (i.e., functional criterion). This is an extremely important observation that is frequently overlooked. Illiterates are handicapped when using laboratory cognitive tests, but they can perform normally on functional intelligence tests.

The diagnosis of dementia or any other neuropsychological syndrome using psychometric procedures necessarily penalizes low-educated individuals. The use of psychometric instruments may inflate the severity of the cognitive defects, and hence, the prevalence of neuropsychological disturbances. The theoretical interpretation of this observation has been a matter of ongoing discussion during the last few years.

In 1988, Mortiner proposed that education provides protection against dementia. He assumed that psychosocial factors reduce the margin of "intellectual reserve" to a level where a minor level of brain pathology results in a dementia. He further supposed 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 have in general, albeit not always, supported this hypothesis. A positive association between DAT and low education have been observed in research studies carried out across quite different countries: Brazil (Caramelli et al., 1997), China (Hill et al., 1993; Hsiu-Chih et al., 1994; Yu et al., 1989), Finland (Sulkava et al., 1985), France (Dartigues et al., 1991), Italy (Bonaiuto, Rocca, & Lippi, 1990; Rocca et al., 1990), Israel (Korczyn, Kahana, & Galper, 1991), Sweden (Fratiglioni et al., 1991), and the United States (Stern et al., 1994). Negative results, however, also have been reported (Christensen & Henderson, 1991; Knoefel et al., 1991; O'Connor, Pollitt, & Treasure, 1991).

Katzman (1993) has pointed out that, "when the very mild cognitive changes of normal aging are superimposed on lifelong cognitive impairment in some subjects with no or low education, an erroneous diagnosis of dementia could occur" (p. 15). Even though we certainly agree with his basic idea (mild cognitive changes in low-educated people may result in the erroneous diagnosis of dementia), we cannot share his departing point: Low educated people present a "lifelong cognitive impairment." This assumption supposes that what is normal is to be educated and that either no or low education is a kind of abnormality ("impairment"). It should be kept in mind that most of the world population is low educated, and even nowadays, about one fifth of the world people are illiterates. One or 200 years ago, most of the world population was illiterate. One thousand to 2,000 years ago perhaps some 99% of the world population was illiterate. Low education or illiteracy obviously is not an abnormality, at least from the statistical point of view. The average educational level of contemporary man is about 3–4 years of school. We are afraid that Katzman is taking as "normal" what indeed is "abnormal" (or at least, "unusual"), and as "abnormal" what really is the norm. Further, we do not think that low-educated people are necessarily understimulated. Rather, we prefer to think that highly educated people are overstimulated from the point of view of some specific cognitive tasks. This preference, one may suppose, is just a matter of language nuance, but it may be crucial to perceiving and interpreting pathology. When dealing with low-educated individuals, functional scales, as Katzman pointed out (1993), obviously become crucial (Loewenstein et al., 1992). However, functional scales also need to be adapted to conditions of low-educated people.

Capitani, Barbarotto, and Laicana (1996) approached the question from a somewhat different perspective. They proposed that three different patterns of association could be expected between age-related decline and education: (a) parallelism (the age-related decline runs the same course in different educational groups, i.e., no interaction is observed); (b) protection (the age-related decline is attenuated in well-educated participants); and (c) confluence (the initial advantage of well-educated groups in middle age is reduced in later life). Ardila, Ostrosky, and Mendoza (2000) observed an even more complex pattern of interaction between education and cognitive decline associated with aging: parallelism, protection, confluence upward, confluence downward, and undefined. Regression curves were analyzed. Ardila and colleagues concluded that: (1) Lifelong changes in cognition are associated with education. Peak performance on neuropsychological tests by low-educated individuals is observed at an older age than in more highly educated subjects; and (2) there is no single relationship between age-related cognitive decline and education, but different patterns may be found, depending upon the specific cognitive domain.

The direct clinical observation of illiterates and low-educated populations does not seem to confirm the hypothesis that dementia is significantly higher in individuals with low education. For example, in neurological settings in developing countries, dementia seldom represents a reason for consultation in low-educated people. Of course, this can result from the interpretation that aging is associated with cognitive decline, and cognitive decline is not a disease but a normal process. Nonetheless, everyday observation indicates that most low-educated and illiterate individuals continue to be functionally active during their 60s, 70s, and even their 80s and 90s. As an illustration, in rural areas in developing countries, where most people have a very limited level of education, it is extremely unusual to find that somebody, regardless of his or her age, cannot participate to some extent in working and productive activities.

A significant misunderstanding may frequently exist with regard to the effects of education. School attendance does not mean that educated people simply possess certain abilities that low or noneducated individuals do not have. In other words, it does not mean that educated people have the same abilities that low-educated individuals have, plus something else. If comparing two children, one with 10 years of formal education, and the other one with zero schooling, it also means that the zero-education child was performing for 10 years certain activities (working or whatever) that the 10-year education child was not performing. The zero-education child was obviously obtaining certain knowledge that the 10-year education child was not obtaining. Nonetheless, formal cognitive testing is directed to evaluate those abilities that the 10-year education child was acquiring; thus it is not surprising that he or she will outperform the zero formal-education child. At this point, it has to be strongly emphasized that educational level is substantially related to performance on some cognitive tests, but is not systematically related to everyday problem solving (Cornelious & Caspi, 1987). Therefore, it is not totally accurate to assume that low-educated or noneducated people are somehow "deprived." It may be more accurate to assume that they have developed different types of abilities. If tests were based on knowledge associated with low or no education, highly educated people would be at a disadvantage. Regardless that the concept of "cognitive reserve" has become very popular in the dementia literature (e.g., (Sanchez, Rodriguez, & Carro, 2002; Scarmeas & Stern, 2003, 2004; Staff, Murray, Deary, & Whalley, 2004) it may be argued it simply represents a misunderstanding of what illiteracy means.

There is another important observation with regard to the diagnosis of dementia in low-educated people. In DAT, procedural memory (how to do things) is usually much better preserved than declarative memory (awareness of memories; Cummings & Benson, 1992). Quite often, low levels of education are associated with manual activities and procedural learning (e.g., farming, handcrafting, manual labor, etc.). Conversely, higher levels of education are strongly correlated with intellectual activities and declarative memory. Minor intellectual defects may be fatal for highly educated people. Nonetheless, low-educated people may continue working in a roughly normal way, despite minor or moderate cognitive defects. For example, in some rural areas in Colombia it has been observed that individuals with very significant cognitive defects ("dementia") can continue working as coffee collectors in a relatively normal way. The patient simply is taken to the coffee plantation (he cannot go by himself due to the spatial orientation defects), and once at the coffee plantation, he or she can perform the activity of collecting coffee in a roughly normal way. Obviously, this patient is significantly more impaired from the point of view of the neurologist/ neuropsychologist examiner than from the point of view of his own social group.

This observation raises an additional issue: When assessing DAT in manual laborers, procedural memory testing should be preferred. Or, at least, behavioral scales should emphasize the ability to perform lifelong procedural working activities.

Several authors (e.g., Folia & Kosmidis, 2003; Reis et al., 2003) have emphasized that low test performance in illiterates depends significantly on the types of instruments that are used. When the task is changed (e.g., instead of asking to tell animal names, to tell "items that can be found in the supermarket") differences in performance between literate and illiterate participants disappear. Of course, illiterates would perform higher than literate people if tested using the abilities best developed in illiterates (e.g., farming, handcrafting, certain spatial orientation abilities, etc.).

CONCLUSIONS

It is evident that literacy is strongly reflected in the performance of those tasks used not only in psychological, but also neuropsychological evaluation. Very important cognitive consequences of learning to read and write have been suggested: changes in visual perception, phonological awareness, logical reasoning, and remembering strategies (Ardila et al., 2000).

The analysis of performance of illiterate populations on neuropsychological measures suggests that cognitive abilities, as measured by standard neuropsychological tests, are significantly influenced by schooling. However, it is a mistake to assume that the inability to perform simple cognitive tasks, such as those incorporated in current neuropsychological test batteries, necessarily indicates abnormal brain function.

The influence of literacy seems to go farther: Literacy may somehow change the brain organization of cognition. We are far from correctly understanding the influence of external variables on brain organization of cognitive activity. However, it is a fact that educational and cultural variables may affect the degree of hemispheric dominance for language and most likely other cognitive abilities. Some studies about the consequences of brain damage in illiterate populations suggest a more bilateral representation not only for linguistic, but probably also for visuospatial abilities. Apparently, literacy does not change the direction of laterality in the brain organization of cognition, but the degree of this lateralization.

The use of psychometric testing instruments significantly penalizes illiterates. Low performance on neuropsychological tests may not only be due to the undertraining of those abilities included in most tests, but also to lack of familiarity, difficulties in understanding the testing situations, and other confounding variables. Functional scales and some specific tests with ecological significance can represent a more reliable and fairer procedure for assessing illiterate populations.

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