

ILLITERACY AND BRAIN DAMAGE 3: A CONTRIBUTION TO THE STUDY OF SPEECH AND LANGUAGE DISORDERS IN ILLITERATES WITH UNILATERAL BRAIN DAMAGE (INITIAL TESTING)*

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Abstract—This report bears on the behavior of 188 unilateral stroke subjects when administered an aphasia screening test comprising a short interview as well as naming, repetition, word-picture matching and sentence-picture matching tasks. All subjects were unilingual lusophone adult (40 yr of age or older) right-handers. Furthermore, they were either totally unschooled illiterates or they had received school education and thereafter retained writing skills and reading habits. Subjects were tested less than 2 months after a first unilateral stroke. In all tasks, global error scores were greater among left and right brain-damaged illiterate and literate subjects than among their controls. In repetition and matching, these differences were statistically significant for the left but not for the right-stroke groups, irrespective of the literacy factor. In naming, on the other hand, significant differences were found not only for the two left-stroke groups but also for the right-stroke illiterate group although not for the right-stroke literate one. Likewise, some degree of word-finding difficulty and of reduction in speech output as well as a sizeable production of phonemic paraphasias were observed in the interviews of several right-stroke illiterates, clearly less in those of right-stroke literates. These findings lead us to suggest that cerebral representation of language is more ambilateral in illiterates than it is in school educated subjects although left cerebral "dominance" remains the rule in both.

INTRODUCTION

TEACHINGS now more or less accepted concerning the mutual relationships of brain and language might be summarized as follows.

One of the most fundamental tenets of current neurolinguistics, perhaps the foremost, is certainly that, as first suggested by DAX [11] and BROCA [2], a large majority of members of the human species are—as the result of a genetic process which begins during embryogenesis [31]—born with a left cerebral hemisphere that will eventually assume functional "dominance" for language encoding and decoding.

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Another basic tenet of neurolinguistics is that there exists a limited number of human individuals, most of them left-handed or ambidextral (and sharing this characteristic with other members of their family), whose genetic programs are different and who will hence develop a more or less absolute right cerebral hemisphere dominance for language [31]. It is also recognized, on the other hand, that early damage to the left hemisphere, in a subject whose genetic destiny would otherwise have determined left hemisphere dominance for language, can result in cerebral reprogramming, as it were, and eventually lead to right hemisphere take over of cerebral dominance for language.

Yet another fundamental is that no significant actualization of the innate predisposition for functional lateralization can occur without environmental exposure to language. The minimal intensity and duration of this exposure, and the extent of individual variation in this respect, are not precisely known.

Furthermore, although it is generally accepted that cerebral dominance for language—whether left or right—is seldom an absolute phenomenon [1, 15, 18], i.e. although it is accepted that a certain degree of ambicerebrality with a stronger or weaker gradient in favor of one hemisphere exists in most individuals, many of the factors determining the relative participation of each hemisphere remain to be further defined. This is particularly true of environmental factors as opposed to genetic and pathological ones.

Finally, in relation to the latter point, it is not known whether or not exposure to oral language only is sufficient to determine, with regard to linguistic abilities, full actualization of the functional lateralization potential. In spite of past research in this respect, it is not known, for instance, whether or not—and eventually to what extent—the acquisition of reading and writing skills can play a role in this process [16, 23]. This is the subject matter of the present paper. In our opinion, the issue is of undeniable importance: providing even incomplete information which might be brought to bear on it could help to blaze a trail in assessing the impact of essentially historical and social influences on human brain cybernetics.

Research on the potential role of the acquisition of reading and writing skills in the process of left brain specialization for language has thus far been carried out using both the aphasiology and the dichotic listening paradigms. We will now review each of these approaches, beginning with the latter.

DICHOTIC RESEARCH

HANNA DAMASIO *et al.* [10] presented three dichotic listening tasks to 47 right-handed healthy native speakers of the Portuguese language (14 men and 33 women). This population was initially divided into three groups: 16 unschooled illiterates, 10 semi-literates (4 yr of schooling and no further reading-writing habits), and 21 subjects with high school or college education (all fluent readers). The first two groups were later combined into a single one—"dysliterate" subjects—on the basis of similar test results. Comparisons were thereafter made between the 26 "dysliterate" (age range from 26 to 67 yr with a mean of 47.9 yr) and the 21 literate subjects (age range from 20 to 69 yr with a mean of 45.8 yr). Performance on the three dichotic listening tasks showed that, on the whole, "dysliterate" scored at a lower level than school-educated subjects. Moreover, a right-ear advantage was found in both groups when the stimuli were pairs of digits as well as when they were pairs of phonologically different meaningful words (such as *colher* - *arvore* and *meia* - *livro*). On the other hand, when the stimuli were pairs of phonologically similar meaningful words differing only in their

initial consonants (such as *ponte-fonte* and *caneta-maneta*), a right-ear advantage was found in literate and a left-ear advantage in illiterate subjects.

TZAVARAS *et al.* [35] also used the dichotic listening—pairs of digits—paradigm with 111 healthy native speakers of the Greek language; all of them were right-handed and all resided in the Epirus region. Sixty subjects were “illiterates” (10 men and 50 women) and 51 had received at least 12 yr of formal education and were all graduates of Greek high schools (26 men and 25 women). The age range was 23 to 72 yr (with a mean of 48.4 yr) for the illiterate women, 29 to 80 yr (with a mean of 60.0 yr) for the illiterate men, 18 to 38 yr (with a mean of 25.8 yr) for the literate women, and 18 to 48 yr (with a mean of 31.7 yr) for the literate men. These authors confirmed HANNA DAMASIO *et al.*'s [10] finding of a right-ear preference for digits in both the illiterates and the literate subjects. Moreover, the distribution of their subjects on a scale indicating that the relative degree of such a preference led them to conclude, in their own words, “that illiterates show greater right-ear advantage for language stimuli than educated control subjects” (p. 565).

CASTRO and MORAIS [5] studied the dichotic listening behavior of 18 illiterate, 14 semi-literate and 14 literate Portuguese women. Illiterates were totally unschooled; the semi-literate and literate groups were defined by reference to both number of years of schooling and actual reading speed. All but two subjects (one illiterate and one semi-literate) were right-handed. The three groups were homogeneous with regard to age (respective means = 51.8, 50.9 and 50.9 yr). The stimuli were, on the one hand, 48 pairs of phonologically similar words [three types of contrast: voicing (e.g. *cola-gola*), place (e.g. *capa-papa*), voicing and place (e.g. *carro-barro*)] and, on the other hand, 48 pairs of phonologically dissimilar words (the same stimuli were paired in such a manner as to differ in at least the three initial phonemes: e.g. *pato-cura*). An explicit attentional constraint was imposed (which constitutes an essential difference between this study and the one by DAMASIO *et al.* [10]). In these experimental conditions, a right-ear preference was observed for both lists in each of the three groups. Moreover, the magnitude of this preference was found to be roughly the same in illiterates, semi-literates and literates when the authors compared subgroups of similar performance level.

APHASIA RESEARCH

In 1904, less than half a century after the DAX [11] and BROCA [2] historical publications, ERNST WEBER [37] observed several brain-damaged illiterate and nearly illiterate subjects and thereafter suggested that the acquisition of written language—perhaps more than that of spoken language—might constitute significant environmental influence in the process of left-brain specialization for language. In his inaugural dissertation (1908), MOUTIER [27], who was not interested in eventual literacy-aphasia relationships, nevertheless mentioned illiteracy as a characteristic of several of the subjects whom he presented as exceptions to Broca's doctrine (posterior left third frontal lesions without aphasia). Much later, in 1956, CRITCHLEY [6] wrote that Weber's question was pertinent but that the problem he had raised was indeed very complex; Critchley was no doubt correct. The following year, GORLITZER VOX MUNDY [13] reported on the case of his Indian right-handed butler who had a left hemisphere stroke and presented with a severe right hemiplegia but no aphasia. In his report, VOX MUNDY [13] noted that, during his military medical practice in India, he had observed that, following left brain damage, right-handed illiterates either presented mild and transitory aphasias, or else no aphasia at all. VOX MUNDY's [13] conclusions were that

(a) the acquisition of reading and writing skills does play a role, perhaps an essential one, in the process of left brain specialization for language and that (b) cerebral language representation remains ambilateral in illiterates, just as in young children, and that this explains why illiterates do not become severely aphasic or do not show any evidence of aphasia following left brain lesions. A few years later, in the context of a discussion on aphasia, EISENSON [12] asserted that aphasia was "relatively unknown amongst [his] low-level military population" and that American soldiers of this category made "very remarkable recoveries" if they became aphasic at all as the result of gun shot wounds to the left cerebral hemisphere: JAKOBSON [14] retorted that he had observed "rural areas" World War I veterans who were and remained "typical aphasics with the usual speech impairments caused by brain lesions". TIKOFSKY [34] suggested that the distinction between normalcy and aphasia might be finer in illiterate than in literate subjects, the former "having normally a much smaller vocabulary" than the latter. More recently, WECHSLER [38] and MÉTELLUS [25] each reported on one case of aphasia in a right-handed illiterate subject. In the former case, the patient presented with her language disorder resulting from a right hemisphere lesion: in this case of crossed aphasia, the author suggests that right hemisphere representation might have been related to illiteracy. In the MÉTELLUS [25] case, a severe left Sylvian lesion resulted in mild transitory aphasia and the author, although unaware of von Mundy's work on the subject (he states that he knows of no publication on the issue), follows essentially the same trend of thought as had the German physician. Finally, in the context of a discussion with two of us (A.R.L. and J.M.), OVID TZENG [36] mentioned a report from mainland China telling about a high incidence of crossed aphasia among Chinese dextrals (it seems that no mention of the literacy parameter nor, for that matter, of the tone language parameter [16], was made in this report).

Beyond "clinical tales" and discussions among aficionados, systematic research on the literacy-lateralization issue has been pursued and reported by CAMERON *et al.* [3], in Mississippi, and by DAMASIO *et al.* [8], in Portugal.

CAMERON *et al.* [3] reviewed the cases of 62 right-handed and 3 left-handed adults with right hemiparesis or hemiplegia resulting from a left Sylvian stroke. Thirty-seven subjects were said to be "literate" (19 men and 18 women), 14 "semi-literate" (7 men and 7 women), 14 "illiterate" (12 men and 2 women); the average duration of school education was, for each of these three groups, 10.6, 5.6 and 2.5 yr respectively. Transitory or persistent aphasia was observed in 78% of the literates, 64% of the semi-literates, and 36% of the illiterates. A statistically significant difference (Chi Square Test, $P=0.02$) existed between the literate and the illiterate groups as per existence of aphasia. The authors concluded that "language is not as well 'planted' in the dominant hemisphere in illiterates as it is in literate persons [and that] language patterns are more bilaterally represented" in the former (p. 163).

ANTONIO DAMASIO *et al.* [8] reviewed a "random series of 247 adult, focal brain-damaged patients" who were all studied in their laboratory under the same conditions of observation and testing. This population comprised 209 literate patients and 38 unschooled subjects who were "totally unable to read and to write prior to disease" (24 left and 14 right lesions). Within the literate group, 114 subjects (55.2%) presented with "aphasia", presumably resulting from left hemisphere lesions (although this is not specified by the authors). Twenty-one subjects (54.2%) within the illiterate groups were considered as aphasics: 20 of them were right-handed and had suffered a left stroke, and the remaining one was left-handed and had suffered a right stroke. All were classified as presenting with global aphasia (4 cases), Broca's aphasia (10 cases) or "fluent" aphasia (7 cases, including the left-hander). The Token Test

[30] was used for further evaluation of the 20 right-handed left brain-damaged illiterate aphasics as compared to a group of 20 literates "matched for age, sex, type of aphasia, and localization of the lesion": no significant differences in performance were found. DAMASIO *et al.* [8] therefore asserted that the aphasias of illiterates and those of literates do not differ as to "(1) expectancy rate, (2) distribution of clinical types, (3) semiological structure, and (4) score of relevant laboratory variables" (p. 300). Their conclusion is summarized in the title of their report: "Brain Specialization for Language Does Not Depend on Literacy" (p. 300). On the other hand, in the context of an exchange of letters to the editors of the *Archives of Neurology*, CURRIER *et al.* [7] raised questions as to the repartition of left and right brain lesions among the illiterates and literates discussed by DAMASIO *et al.* [8]. In response, DAMASIO *et al.* [9] briefly reported on 225 right-handed focal brain-damaged patients: 191 subjects had suffered left and 34 right brain lesions (the word "random" is not used); 182 subjects were literate and 43 illiterate; there existed no statistically significant difference between literates and illiterates as to the distribution of left versus right hemisphere lesions; among subjects with damage to the left hemisphere, 63% of the literates and 67% of the illiterates presented with "aphasia".

We will now report on an additional research project which focused on the mutual relationships of literacy and brain specialization for language. This research was carried out by the authors between 1980 and 1985 in Brasilia, Curitiba, Lisbon, Montréal, Paris, Porto Alegre, Recife, Rio de Janeiro, Salvador de Bahia and São Paulo.

METHOD

Testing procedure

An experimental version of the Protocole MT-86 d'examen linguistique de l'aphasie (M1-Alpha) [22] was adapted from the Portuguese language and used in the present research. M1-Alpha is intended as an elementary bedside aphasia screening test. It is comprised of a directed interview (9 pre-defined questions) as well as 6 subtests lending themselves to objective scoring. These are auditory comprehension (5 word-picture and 6 sentence-picture matching items), written comprehension (idem), picture naming (12 items), repetition (8 words and 3 sentences), reading aloud (idem), dictation (3 words and 1 sentence) and copy (1 sentence) subtests. A description of the M1-Alpha subtests suitable for use in both our illiterate and literate subpopulations has been provided in the first paper of this series, together with a discussion of the results obtained when the Portuguese adaptation was administered to the first 100 of the 108 neurologically healthy subjects who served as controls in our research [19].

Subjects

The present report bears on 296 subjects (153 men and 143 women) to whom the Portuguese adaptation of the M1-Alpha was administered. The social, biological and pathological characteristics of the first 269 subjects of this population have been discussed in some detail in the second paper of this series [20]. Those of the remaining 27 were comparable. In summary: all subjects were unilingual lusitanophones, all were 40 yr of age or older, and all were right-handed, absolute or preferential (by reference to an Edinburgh-like inventory [28]); some were totally uneducated illiterates as opposed to others who had received at least 4 yr of school education and thereafter retained writing skills and reading habits; some were neurologically healthy (anamnesis and routine examination) as opposed to others who were seen less than 2 months and, whenever possible, more than 2 weeks after a unilateral (left as opposed to right hemisphere) stroke. All of the 188 subjects of the brain-damaged subpopulation (a) reported no past history of neurological illness of any kind and (b) were hospitalized following a first single CVA (spontaneous neurological deficit of sudden onset with unequivocal signs of unilateral hemispheric damage).

Our experimental population was therefore comprised of six groups (Table 1):

the six groups were statistically homogeneous with regard to age (Kruskal-Wallis Test, $H = 7.7$, $df = 5$, $P = 0.17$) [33];

the six groups were not statistically homogeneous with regard to sex distribution (Chi Square = 14.5, $df = 5$, $P = 0.013$); nonetheless, distribution as to sex was comparable in illiterate versus school-educated left-stroke subjects (Chi Square = 1.10, $df = 1$, $P = 0.29$) as well as in illiterate versus school-educated right-stroke subjects (Chi Square = 0, $df = 1$, $P = 1$);

the three groups of the literate subpopulation were statistically homogeneous with regard to number of years of school education (Kruskal-Wallis Test, $H = 0.18$, $df = 2$, $P = 0.92$) [33].

Table 1.

		Controls	Left strokes	Right strokes
IS	Number	62	48	47
	Age	60.3	61.9	60.5
	M/F	22/40	21/27	31/16
LS	Number	46	61	32
	Age	59.3	58.2	64.3
	M/F	24/22	34/27	21/11
	School	8.3	8.6	8.3

IS, illiterate subpopulation; LS, literate subpopulation; Controls, neurologically healthy subpopulation; Left strokes and Right strokes, brain-damaged subpopulation; Number, absolute number of subjects per group; Age, average age per group expressed in number of years. M, F, absolute number of males and females per group. School, average duration of school education in the literate subpopulation, expressed in number of years.

Table 2. Frequency of motor, somesthetic and visual field hemideficits among subjects of the four groups of the stroke population

		Left strokes		Right strokes	
		IS	LS	IS	LS
Hemiplegia or	Absent	0	7	0	0
	Present	100	93	100	100
Hemiparesis	Unassessable	0	0	0	0
Hemihyesthesia or	Absent	31	38	26	31
	Present	48	41	61	63
Extinction	Unassessable	21	21	13	6
Hemianopsia or	Absent	73	69	65	63
	Present	4	7	17	31
Extinction	Unassessable	23	25	17	6

IS, illiterate subpopulation; LS, literate subpopulation; expressed in percentages of subjects per group.

At the time of (initial) M1-Alpha testing, all but 4 of the 188 brain-damaged subjects presented with a hemiparesis (which was transient in certain cases) or with a full blown hemiplegia, including homolateral facial involvement of the central type (Table 2). In the four remaining subjects, all of them literates with left brain stroke, the existence of the lesion was documented by computerized tomography. With regard to somesthesia (hemihyesthesia and or unilateral tactile extinction) and visual fields (hemianopsia and or unilateral visual extinction), examiners were requested to note their observations in terms of "deficit absent", "deficit present" or "deficit impossible to assess with a reasonable degree of confidence" (Table 2). One should note that the latter notation ("unassessable") was used more often for right-stroke illiterates than for right-stroke literates.

RESULTS

Interview

The M1-Alpha directed interview yielded meaningful information concerning both the right and the left brain-damaged populations. These can be summarized as follows.

Comprehension. Left-stroke illiterates were less frequently considered to present with some degree of auditory comprehension disorder in conversation than were left-stroke literates: in this subpopulation, four illiterates were believed to have misunderstood one, and seven more

than one of the nine stimuli of the interview ($11/48 = 22.9\%$ of subjects); in contrast, 8 literate patients were believed to have misunderstood one, and 11 more than one of the nine stimuli ($19/61 = 31.1\%$). No subject with right stroke was judged to have misunderstood more than one question.

Reduction and agrammatism. Suppression or gross quantitative reduction of spontaneous speech production was present in 12 illiterate and 18 literate subjects with left brain lesions; quantitative reduction was also believed to be present in 3 illiterates with right brain lesion. Obvious agrammatism was observed in 2 illiterate and 3 literate left-stroke subjects.

Word-finding difficulties. Among the illiterates, 18 subjects with left ($18/48 = 37.5\%$) and 7 with right stroke ($7/47 = 14.9\%$) were judged as showing obvious conversational evidence of word finding difficulties whereas the same was true in 23 literate subjects with left ($23/61 = 37.7\%$) and in no literate subject with right stroke.

Verbal and phonemic deviations. Within the illiterate subpopulation, 9 left ($9/48 = 18.8\%$) and 3 right-stroke subjects ($3/47 = 6.4\%$) were considered to have produced a greater than normal amount of verbal deviations [17] during the interview; the same held true, within the literate subpopulation, for 11 subjects ($11/61 = 18\%$) with left and 2 with right stroke ($2/32 = 6.3\%$). Phonemic deviations [17], on the other hand, were considered to be abnormally numerous in the productions of 13 illiterates ($13/48 = 27.1\%$) and of 12 literates ($12/61 = 19.7\%$) with left stroke, as well as in those of 4 illiterates ($4/47 = 8.5\%$) but of none of the literate subjects with right stroke.

Phonetic deviations. Production of phonetic deviations, that is, mild to severe arthric disorder, was observed, in the course of the interview, in 14 illiterate ($14/48 = 29.2\%$) and 15 literate ($15/61 = 24.6\%$) left-stroke subjects, as well as in 15 illiterates ($15/47 = 31.9\%$) and 8 literates ($8/32 = 25\%$) with right stroke. Nearly identical judgements as to the existence of an arthric disorder among patients of the four stroke groups were made by the attending speech pathologists after naming and repetition tests.

Scored tests

For reasons pertaining to the field conditions of our research, 3 illiterates (2 with left and 1 with right stroke) were not administered the sentence-picture matching tasks. Moreover, at the time of initial testing, 5 of the 109 subjects of the left stroke subpopulation, 2 illiterate and 3 literate (including 2 cases of full blown jargonaphasia), were *incanalisables*, that is, could be tested neither on production nor on comprehension tasks as they had no understanding of what was required of them. Results to be presented here therefore bear on the M1-Alpha results of: (a) all control subjects, (b) 46 of the 48 illiterate and 58 of the 61 literate subjects with left stroke, and (c) all right-stroke subjects. It should be noted that, on the whole, Brazilian and Portuguese results were not found to differ in any significant manner and are therefore presented jointly in the present context.

The global cultural differences observed between illiterate and literate controls [19] are still there to be seen among illiterate versus literate stroke subjects: in all three tasks—naming, repetition and matching (Table 3)—lending themselves to "objective" scoring and in both pathological subpopulations, the mean overall production of inadequate responses in any given task was significantly greater among the illiterates than among the literates of the corresponding group (Mann-Whitney Test: $P < 0.02$ in all cases) [33].

Naming. The M1-Alpha naming task resorts to 8 line drawings which are presented in succession [19, 21]. Each is intended to elicit the production of one noun (Comb. Bell. Ear. Guitar in Brazil or TV Set in Portugal, Pipe, Banana, Knife and Cat). The last drawing is also

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Table 3. Error scores of control, left stroke and right stroke illiterates and literates in the naming (12 items), repetition (11 items), and matching (11 items) tasks

	Controls		Left strokes		Right strokes	
	IS	LS	IS	LS	IS	LS
Naming	14.1	4.7	32.2	27.7	20.6	10.7
Repetition	25.5	6.9	44.0	27.7	24.1	13.4
Matching	24.0	7.1	43.0	24.5	36.4	21.9

IS, illiterate subpopulation; LS, literate subpopulation; scores expressed in percentages of inadequate responses per group.

intended to elicit the production of 4 additional nouns (Tail, Claws, Whiskers and Eyes), for a total of 12 items.

Each of the 12 noun-drawing targets led to inadequate responses by a sizeable proportion of the left-stroke subpopulation, among both the illiterate and the literate subjects. Although to a lesser degree, most of the targets also led to sizeable production of inadequate responses among the right-stroke illiterates and the same held true for a few targets among the right-stroke literates. With regard to overall error scores (Table 3) and using the Chi Square Test for Two Independent Samples (when resorting to this test in the present study and unless otherwise specified, cut off points were defined by reference to the smallest error score encompassing the behavior of at least 75% of controls), significant differences were found—within the illiterate subpopulation (cut off point = more than two inadequate responses): between control and left-stroke subject ($\chi^2 = 10.35$, $df = 1$, $P = 0.001$), as well as between control and right-stroke subjects ($\chi^2 = 8.09$, $df = 1$, $P = 0.004$); within the literate subpopulation (cut off point = more than one inadequate response): between control and left-stroke subjects ($\chi^2 = 10.7$, $df = 1$, $P = 0.001$), but not between control and right-stroke subjects ($\chi^2 = 1.88$, $df = 1$, $P = 0.17$).

Two types of inadequate responses in naming—production of verbal deviations (word substitutions, more or less adequate circumlocutions) and “anomia” (lack of response after 5 sec or modulatory comments such as “I do not know” or “I know the word but I cannot find it”)—were also studied separately (using the Chi Square Test for Two Independent Samples). This permitted further specification of the naming disorder within two illiterate stroke groups—“Paraphasia scores” (cut off point = more than two verbal deviations): with left stroke: $\chi^2 = 7.09$, $df = 1$, $P = 0.008$, with right stroke: $\chi^2 = 5.12$, $df = 1$, $P = 0.02$; “Anomia scores” (cut off point = more than one anomic response): with left stroke: $\chi^2 = 17.9$, $df = 1$, $P = 0$, with right stroke: $\chi^2 = 2.03$, $df = 1$, $P = 0.15$.

Repetition. The M1-Alpha repetition task is intended to elicit the production of eight words (*pa, trem, pato, pratos, cavalo, cruzeiros, sabonete* and *embarcação*) and three sentences (*O céu esta azul, O cachorro preto grande da vizinha mordeu o menino* and *Nos lhe daremos desde que ela reclame*) [19]. Our Guggenheim results in this respect will be presented following the word-sentence dichotomy.

Each of the eight word stimuli led to inadequate responses by a sizeable proportion of the left-stroke subpopulation, more so among the illiterate than among the literate subjects. Several word stimuli also led to inadequate responses by a sizeable proportion of the right-stroke illiterates. With regard to overall error scores (Table 3) and using the Chi Square Test for Two Independent Samples, significant differences were found—within the illiterate subpopulation (cut off point = more than two inadequate responses): between control and left stroke subjects ($\chi^2 = 20.6$, $df = 1$, $P < 0.0001$), but not between control and right-stroke

subjects ($\chi^2 = 0.22$, $df = 1$, $P = 0.64$); within the literate subpopulation (cut off point = at least one inadequate response): between control and left-stroke subjects ($\chi^2 = 6.24$, $df = 1$, $P = 0.013$), but not between control and right-stroke subjects ($\chi^2 = 0$, $df = 1$, $P = 1$).

One type of inadequate response in word repetition—the production of phonemic paraphasias [17]—was also studied separately. Using the Chi Square Test for Two Independent Samples, a significant difference was found in this respect between controls versus left-stroke illiterates and a nearly significant one between controls and left-stroke literate subjects (no significant differences were found between controls and right-stroke subjects)—illiterate subjects (cut off point = more than two phonemic paraphasias): with left stroke: $\chi^2 = 17.7$, $df = 1$, $P < 0.0001$, with right stroke: $\chi^2 = 0.61$, $df = 1$, $P = 0.44$; literate subjects (cut off point = at least one phonemic paraphasia): with left stroke: $\chi^2 = 3.3$, $df = 1$, $P = 0.069$, with right stroke: $\chi^2 = 0$, $df = 1$, $P = 1$.

M1-Alpha sentence repetition generated large numbers of inadequate responses in all three groups of the illiterate subpopulation and in left-stroke literate subjects. In this respect, the only difference that we found resorting to the same statistical procedure showed that, as compared to controls, a significantly greater number of left-stroke literate subjects produced more than one inadequate response ($\chi^2 = 7.85$, $df = 1$, $P = 0.005$).

Matching. The M1-Alpha matching tasks, which have been described elsewhere in detail [19, 20], are comprised of five word-picture as well as three simple and three complex sentence-picture matching stimuli. Statistical analysis of our Guggenheim results in this respect (Table 3) has also been done using the Chi Square Test for Two Independent Samples. Significant differences between controls versus left and controls versus right-stroke subjects were thus found within both the illiterate and the literate subpopulations. Overall data (11 items) are the following—illiterate subjects (cut off point = more than 4 inadequate responses): with left stroke: $\chi^2 = 15.8$, $df = 1$, $P = 0.0001$, with right stroke: $\chi^2 = 11.4$, $df = 1$, $P = 0.0007$; literate subjects (cut off point = more than 2 inadequate responses): with left stroke: $\chi^2 = 12.2$, $df = 1$, $P = 0.0005$, with right stroke: $\chi^2 = 9.8$, $df = 1$, $P = 0.0018$.

Nonetheless, when analyses were restricted to dimidiated displays (sentence-picture matching) and took target lateralization into account, significant differences were found for both left and right halves of displays in the left-stroke groups but only for the left half of displays in the right-stroke ones [20]—illiterate subjects with left stroke: in left half of display (cut off point = at least one inadequate response): $\chi^2 = 7.6$, $df = 1$, $P = 0.0057$, in right half of display (cut off point = more than two inadequate responses defined by reference to the smallest error score encompassing the behavior of at least 60% of controls): $\chi^2 = 5.1$, $df = 1$, $P = 0.02$; illiterate subjects, with right stroke: in left half of display (cut off point = at least one inadequate response): $\chi^2 = 11.8$, $df = 1$, $P = 0.0006$, in right half of display (cut off point = more than two inadequate responses defined by reference to the smallest error score encompassing the behavior of at least 60% of controls): $\chi^2 = 3.1$, $df = 1$, $P = 0.08$; literate subjects—with left stroke: in left half of display (cut off point = at least one inadequate response): $\chi^2 = 3.8$, $df = 1$, $P = 0.05$, in right half of display (cut off point = more than one inadequate response): $\chi^2 = 4.8$, $df = 1$, $P = 0.028$; literate subjects—with right stroke: in left half of display (cut off point = at least one inadequate response): $\chi^2 = 12.1$, $df = 1$, $P = 0.005$, in right half of display (cut off point = more than one inadequate responses): $\chi^2 = 0$, $df = 1$, $P = 1$.

Moreover, when analyses of the dimidiated displays were restricted to matching errors with both the visual target and the foil response being in the half-display homolateral to the brain lesion, only left-stroke illiterates significantly differed from controls (with a cut-off point = at least one inadequate response: $\chi^2 = 4.47$, $df = 1$, $P = 0.034$). The distribution of

control versus stroke subjects did not permit, in this respect, Chi Square testing of results among literate subjects.

DISCUSSION

As pointed out by Antonio Damasio in the context of a private exchange with the authors, "illiteracy is a far more complex condition than just not knowing how to read and to write. Depending on social circumstances, some illiterates actually live in a stimulating environment where they can [...] gain access to concepts and general information about the universe that are not fundamentally different from those available to literate individuals. In other social contexts, however, illiterates may be culturally deprived to the point that their overall cognitive organization and data base is defective in numerous dimensions". Be this as it may, we will, in the first part of our discussion, try to situate our results by reference to those of others who have also tackled the problem of illiteracy within the aphasia research paradigm. In the second, we will try to relate our results and conclusions to the dichotic data we have reviewed. In the third, we will discuss the particularities of naming behavior among the illiterates. We will conclude in the fourth.

Aphasia research

Let us begin with the following Lapalissade, excerpted from a paper by one of us (A.R.L.) and YVES JOANETTE [18]: "There are two ways of making a diagnosis of aphasia . . . You make Type I diagnosis—the clinical-type—while examining a patient . . . without overt pencil-and-paper calculation of any sort . . . On the other hand, you make Type II diagnosis—the subtle type—as the result of pondering on numerical results properly recorded on data sheet, whether it be by yourself or someone else". In their respective studies of aphasia in illiterates, which led them to conclusions which were apparently in contradiction and certainly led to controversy, CAMERON *et al.* [3] acted as Type I whereas DAMASIO *et al.*—at least if one's opinion in this respect is to be founded on their publications [8, 9]*—acted mostly as sophisticated Type II diagnosticians. Our own study was a hybrid one in this respect: we acted as typical solar-plexus-bound typeoners when assessing patients at bed-side or listening to their tape-recorded interviews, and as typical statistical-analysis-bound typetwoers when it came to dealing with our scored data (naming, repetition and pointing). With regard to the former, our conclusion is compatible with that of CAMERON *et al.* [3] and, with regard to the latter, it is, for the essential part, but with a restriction that should not be taken as trivial, compatible with the conclusion of DAMASIO *et al.* [8, 9].

Type I considerations. Not taking into account two clear-cut cases of crossed aphasia, the neurologists and residents who first saw our subjects labelled only left-stroke as "aphasics" (grossly, between 55% and 60% of cases among both the illiterates and the school-educated). Nonetheless, many of the observations noted by the Guggenheim speech pathologists while interviewing these patients are compatible with the—indeed very cautious—opinion formulated by CAMERON *et al.* [3], that is, "language is not as well 'planted' in the dominant hemisphere in illiterates as it is in literate persons" (p. 163). For instance, reduction of speech

*In the context of a private discussion, Antonio Damasio recently informed one of us (A.R.L.) that Type I considerations were also taken into account in the attribution of aphasiological labels within the two groups of unilaterally brain-damaged subjects reported by the Lisbon researchers [8, 9].

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