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ILLITERACY AND BRAIN DAMAGE—1. APHASIA TESTING IN CULTURALLY CONTRASTED POPULATIONS (CONTROL SUBJECTS)*

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Abstract—One hundred neurologically healthy adults were tested for their pointing (choosing one of four or six line drawings as the match to an auditorily presented linguistic stimulus), naming (from line drawings), and repetition abilities. All subjects were unilingual adult right-handers. Fifty-seven subjects were totally unschooled illiterates and 43 were fluent readers. Statistically significant differences were found to exist between the scores of the illiterate and literate subpopulations across all tasks. With the focus being placed on these cultural differences, the discussion bears on: (a) the interaction between linguistic and iconographic factors in certain types of naming and pointing tasks currently used in clinical and research aphasiology, (b) some of the linguistic parameters which are apparently at stake in repetition behavior, and (c) the circumstances in which aphasiological research dealing with groups of patients cannot yield reliable data without reference to neurologically healthy controls. It is argued that, when testing brain-damaged patients of different cultural backgrounds, one runs the risk of over- or underestimating the frequency of aphasia if one does not refer to norms which explicitly take educational level into account.‖

INTRODUCTION

DEFINING comprehensive tests for the assessment of speech–language behaviors in brain-damaged subjects has long been a major preoccupation of clinicians involved in aphasia research: MOUTIER's [28] battery, which included a number of tests borrowed from other researchers as well as tests of his own design, was not the first of its kind although it can certainly be quoted as designed to assess all of the linguistic behaviors covered by modern tests. Up until approx. 25 yr ago, such tests were generally if not always used without reference to normative data, i.e. testing of individual patients was aimed at specifying the clinical manifestations of obvious aphasia rather than at detecting its existence. Gathering data in this manner—especially in Western Europe and North America, that is, among populations sharing certain cultural characteristics [20, 30]—has led to the definition of

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‖This is the first of a series of four papers reporting on the results of a research which was originally and to a large extent remained focused on the effects of unilateral brain damage on the speech–language behaviors of unilingual right-handed adult illiterates. The topics of the other papers in this series are (a) "visual neglect" as observed in the type of pointing tasks currently used to test "auditory comprehension" in brain-damaged patients [22]; (b) naming, pointing, and repetition behaviors in illiterate vs school-educated right-handed adults less than 2 months after a first unilateral CVA [23] and (c) naming, pointing and repetition behaviors within the same populations at a 6 month interval following initial testing.

various taxonomies of the aphasias. This conception of aphasia testing is still current (and useful) in clinical neurology. Nonetheless, the most widely used modern batteries, such as the Boston Diagnostic Aphasia Examination (BDAE) [13, 14] and the Western Aphasia Battery (WAB) [16]—as well as other tests recently reviewed by DAVIS [8] and by LEZAK [25]—are accompanied by reference data. These data summarize the testing results of obviously aphasic subjects that are considered to represent known prototypes (Broca's aphasia, conduction aphasia, Wernicke's aphasia, and so forth) and/or those of groups of "normal" subjects. The latter can be constituted of neurologically healthy subjects only [2, 14] but they can also include cases of "non-dominant hemispheric lesions" and "patients with diffuse or dominant hemisphere or subcortical brain damage, but clinically, no aphasia" [17]. The probability of differences linked to the school education level of healthy controls has often been discussed (for a review, see DAVIS [11]), and the existence of such differences has been documented by a few researchers [2]. To our knowledge, however, no major aphasia battery has been published with normative data rated for educational background.

Given the field conditions of our research, we had to resort to relatively simple testing procedures, and given the subject matter of this research—the effects of unilateral brain lesions on the language behaviors of absolute illiterates as opposed to school educated fluent readers—it became evident that we needed to gather a corpus of normative data founded on this particular cultural contrast and restricted to neurologically healthy subjects.

Although it is often viewed as a worthy practice to include IQ measurements in one's experimental procedures when carrying out neuropsychological research with groups of subjects, we have not adhered to this practice in the present study. And although many have argued against the systematic use of IQ tests on the basis of theoretical arguments [15, 18] our decision in this respect was entirely founded on a pragmatic consideration, i.e. no appropriate IQ test has been standardized on lusitaphone illiterate populations. In the present paper, therefore, we limit ourselves to (a) a description of our testing procedures, (b) a presentation of the data gathered by administering these tests to neurologically healthy controls and (c) a discussion bearing on the nature of the "errors" of illiterate vs school-educated subjects when tested with linguistic–iconographic materials and on the circumstances in which aphasia testing can hardly be pursued without reference to norms rated for educational background.

TESTING PROCEDURE

Our practice, at least in the context of the project reported here, has been to study brain-damaged and control subjects by using simple questionnaires and tests. These did not primarily aim at the establishment of construed profiles of normality vs pathology. Above all, they were conceived as research tools yielding measures which were taken to be indicative of performance levels within the various neurologically healthy and brain-damaged groups of our target populations. In other words, our interest did not lie in classification per se but rather in mental representations and processing as well as in their modulation by both biological determinisms (age and pathology in the present case) and environmental pressures (school education in the present case).

An experimental version of the Protocole MT-86 d'Examen Linguistique de l'Aphasie (M1-alpha) [24] was thus adapted to the Portuguese language by two of us (L.S.C. and A.M.S.J.) for use in the present research. M1-alpha is designed as an elementary bedside aphasia screening test. It is comprised of a "directed interview" plus six subtests—"auditory comprehension", "written comprehension", naming, repetition, reading aloud, dictation and copy—which lend themselves to objective scoring. We will now provide a description of those M1-alpha subtests which could be and were used both in the illiterate and the literate subject-populations.

Directed interview

The directed interview resorts to nine predefined sentence stimuli to be uttered by the examiner. Each stimulus includes one or more questions. Some of these are closed questions (e.g. "Do you live in Curitiba?") and are therefore intended to lead to the production of a short response yielding, above all, information as to the listener's auditory

comprehension abilities; others are open questions (e.g. "What do you usually eat for breakfast?") and are therefore intended to elicit the production of longer responses yielding information as to the listener's auditory comprehension and oral speech production abilities. While proceeding with the M1-alpha directed interview as well as when later assessing individual tape recordings, the (previously trained) examiners—all of them speech pathologists or psychologists—were requested to give their personal opinion as to whether or not they thought that each subject tested had (a) proven capable of understanding the questions of the interview, (b) showed evidence of quantitative reduction and/or agrammatism and/or word finding difficulties in spontaneous speech production, and (c) produced utterances containing obviously greater than normal numbers of verbal deviations (word substitutions, circumlocutions), phonemic deviations (phonemic approaches, paraphasias and télescopages), and phonetic distortions [21].

Scored tests

Pointing. The M1-alpha pointing tasks were designed for the investigation of "auditory comprehension". These tasks comprise a total of 11 items. For each of these, the subject is requested to point at the one of several displayed drawings which corresponds to a verbal stimulus uttered by the examiner (since no frequency tables were available for Portuguese at the time the test was devised, the lexical components of these verbal stimuli were chosen on the basis of presumable high frequency and familiarity). The size of each display is 21 × 13 cm. Each verbal stimulus may be repeated once should the subject so demand or should he fail to respond to the first presentation. Only the subject's first response (or, eventually, an absence of response 5 sec after second presentation) is considered in scoring. The M1-alpha includes three such tasks.

For the first five items, the examiner utters "Show me the", followed by a noun, and the subject is requested to point to one of six drawings, the "target", which corresponds to this noun ("word comprehension" subtest). Each display is such that three drawings appear in the upper half, or field, and three in the lower. Moreover, each display is made up, beside the target drawing, of: a drawing related to a semantic foil, one related to a phonological foil, one that constitutes a formal foil (a drawing of an object visually similar to the target), and two drawings without linguistic or visual kinship to the target (neutral foils) (Fig. 1). The five targets were respectively placed in the four outer and in the upper central sixths of the displays.

For the following three items, the examiner says "Show me the drawing where", followed by a sentence of the 'noun + verb" type, and the subject is requested to point to one of four drawings, the "target", which corresponds to this sentence ("simple sentence comprehension" subtest). Each display is such that two drawings appear in the upper and two in the lower half, and, therefore, two in the left and two in the right half. Moreover, the four drawings in each display are related in such a manner (same or related actors, same or related actions, eventually same or related accessories) that each of the three non-target drawings constitutes a semantic–syntactic–phonological–formal foil to the target one (Fig. 2). The targets were placed in the lower left quadrant in two displays and in the upper right quadrant in the other one.

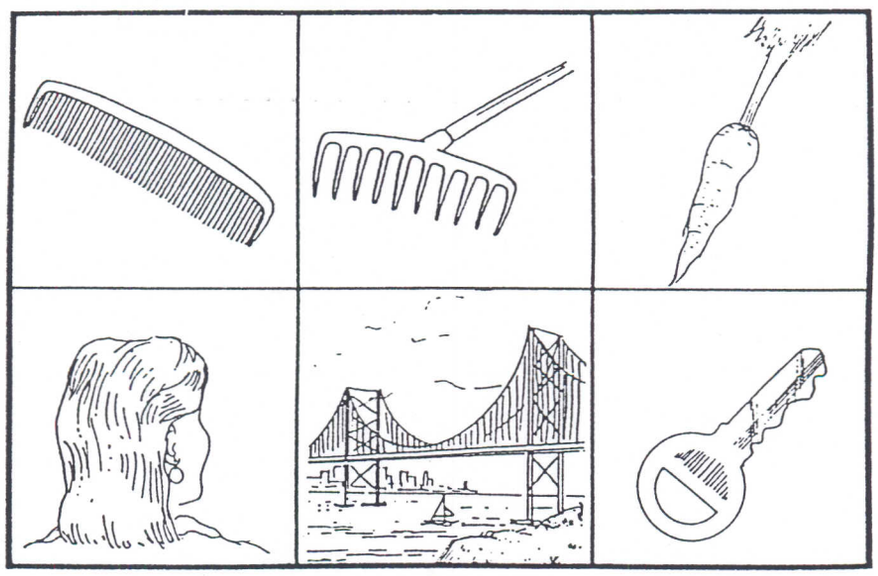

FIG. 1. "Word comprehension" subtest stimulus No. 3 (the target is *pente*; comb).

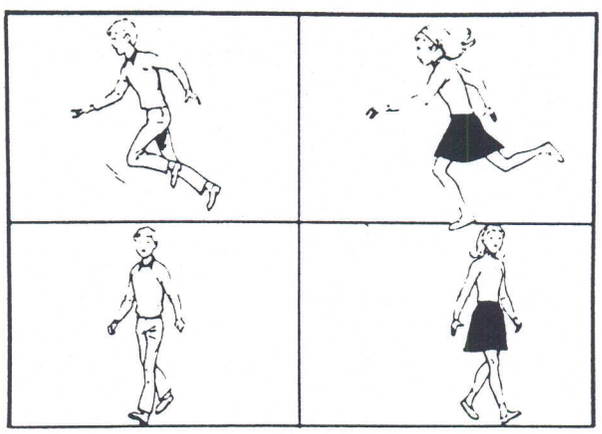

FIG. 2. "Simple sentence comprehension" subtest; stimulus No. 2 (the target is *A menina anda*; the girl walks).

For the last three items, the examiner says "Show me the drawing where", followed by a sentence of the "noun + verb + one or two nominal complements" type, and the subject is requested to point to one of four drawings, the "target", which corresponds to this sentence ("complex sentence comprehension" subtest). Each display is such that two drawings appear in the upper and two in the lower half, and, therefore, two in the left and two in the right half. Moreover, the four drawings in each display are related in such a manner (same actors, same or related actions, same accessories) that each of the three non-target drawings constitutes a semantic–syntactic–phonological–formal foil to the target one (Fig. 3). The targets were placed in the upper right quadrant in two displays and in the lower right quadrant in the other one.*

Repetition. The M1-alpha repetition subtest is comprised of 11 stimuli, that is, eight words (pa, trem, pato, pratos, cavalo, cruzeiros, sabonete, embarcação) and three sentences (O céu esta azul; O cachorro preto grande da vizinha mordeu o menino; Nos lhe daremos desde que ela reclame). The choice of word stimuli was determined by syllabic length and phonological complexity (presence vs absence of consonantal clusters and consonantal or diphthongal endings)†; moreover, all word stimuli were chosen on the basis of presumable high frequency and familiarity. The

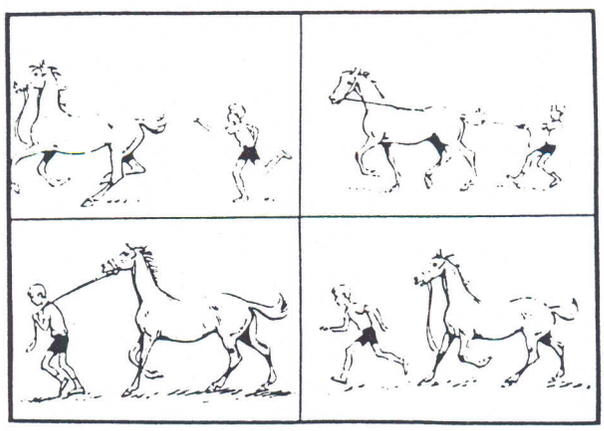

FIG. 3. "Complex sentence comprehension" subtest; stimulus No. 1 (the target is *O cavalo puxa o menino*; the horse pulls the boy).

*In the process of adapting the M1-alpha to the Portuguese language, an obvious and obviously unfortunate imbalance therefore occurred with regard to left-right target distribution in the sentence comprehension subtests [22].

†The M1-alpha repetition task is thus made up of pairs of mono-, bi-, tri- and quadrisyllabic nouns. In each pair, one word is phonologically simple and the other phonologically complex.

choice of sentence stimuli was determined by length and by content in open vs closed class words. The examiner utters each stimulus in turn and the subject is requested to repeat them aloud, without time limitation; each stimulus is presented anew, but only once and if the subject so demands or does not respond to the first presentation. The notation concerns only the subject's first complete response (if any) and bears on the potential existence of an arthric perturbation (phonetic distortions), on the one hand, and, on the other hand, on eventual absence of responses (after 5 sec), eventual word deletions, duplications, etc. in sentence repetition, and potential paraphasic productions (e.g. phonemic paraphasias).

Naming. The M1-alpha naming subtest contains a set of eight simple line drawings (Fig. 4), each corresponding to a presumably high frequency noun. The drawings (21 × 13 cm) are presented one after the other, without any time pressure limits, and the subject's task is to utter the corresponding noun. The target nouns are pente (comb), sino (bell), orelha (ear), violão (guitar), cachimbo (pipe), banana (banana), faca (knife), and gato (cat). For use in Lisbon, the guitar-stimulus of the Campinas adaptation of the M1-alpha is replaced by a drawing representing a television set (televisão) (Fig. 4.4a and b). Each drawing corresponds to a single entity and is designed to elicit, as a first reaction, the production of a single noun (results under singles below, in Table 1). Moreover, upon being presented with the last drawing (cat), the subject is further requested to name four parts pointed to by the examiner (rabo; garras; bigode; olhos—tail; claws; whiskers; eyes) (results under parts below, in Table 1). The notation concerns only the subject's first pertinent response (if any) and bears on the potential existence of an arthric perturbation (phonetic distortions) and/or on eventual absences of pertinent responses (within 5 sec), eventual production of verbal deviations (verbal paraphasias and referential circumlocutions), and eventual production of other types of inadequate responses (e.g. neologisms).

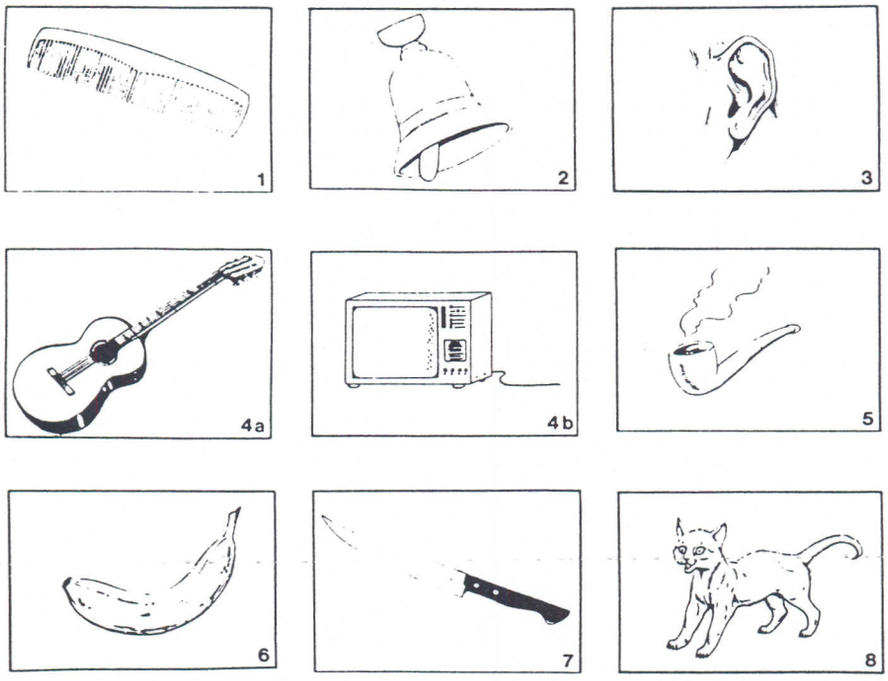

FIG. 4. Naming test; all stimuli.

Table 1. Scores for the naming task, expressed in percentages of inadequate responses per group. Singles and parts are defined in the text. SINGLES (8 items), PARTS (4 items) and TOTAL (12 items): inadequate responses of all types. ANOMIA (12 items): absences of response (5 sec). Vb DEV: verbal deviations, as defined in the text (12 items)

	SINGLES	PARTS	TOTAL	ANOMIA	Vb DEV
Illiterates:	20.6	0.9	14.0	5.4	8.5
Literates:	4.4	5.2	4.7	1.6	3.1

SUBJECTS

The present report bears on 100 neurologically healthy subjects (anamnesis and basic examination) who were tested by speech pathologists, psychologists and neurologists in Brasilia, Curitiba, Lisbon, Recife, Rio de Janeiro, Salvador de Bahia and São Paolo. All subjects were unilingual Lusitanophones and all were right-handed, absolute or preferential, as determined through use of an Edinburgh-like [29] questionnaire comprising 20 items (writing and drawing excluded). Eighty-four subjects were Brazilian and the remaining 16 were Portuguese.

Fifty-seven subjects, including the 16 Portuguese, were totally unschooled, which should be taken to mean that they had neither attended school during their youth nor received formal education at a later period during their life, and they were absolute illiterates (although some had learned to sign their names). The remaining 43 subjects had received between 4 and 15 yr of school education (with an average of 8.2 yr) and thereafter retained writing skills and reading habits. In the present paper, the former group (20 males and 37 females) will be identified as the illiterate subpopulation and the latter group (21 males and 22 females) as the literate subpopulation; no significant difference existed between the two subpopulations with regard to sex distribution (Corrected Chi Square Test: chi square = 1.39; $df = 1$; $P = 0.24$).

All subjects were between 40 and 83 yr old at the time of testing, with an average age of 61.3 yr for the illiterate and 60.0 yr for the literate subpopulations. No significant difference existed between the two subpopulations with regard to age distribution (Mann–Whitney Test: $U = 1134.5$, $P = 0.53$).

RESULTS

With the single exception of the "guitar" and "television" stimuli of the naming task, the Brazilian and Portuguese M1-alpha results were similar both for the illiterate subpopulation and the school-educated one. Thus, Brazilian and Portuguese results will thereafter be presented jointly.

Directed interview

Although occasional phonemic and verbal "deviations" were noted in the spontaneous productions of a small number of subjects of both the illiterate and the literate subpopulations, analyses of the directed interview yielded no results warranting mention in the present context.

Scored tests

On the other hand, pointing, repetition and naming results differed significantly in—neurologically healthy control—illiterates as opposed to school educated subjects (Fig. 5).

Pointing. Pointing error scores for each subtest and for the whole task are summarized in Table 2. These are interesting from two points of view.

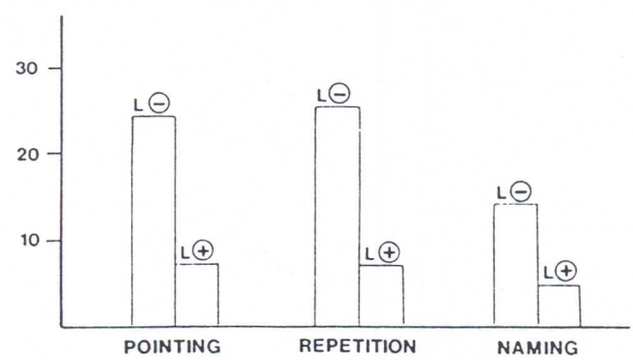

FIG. 5. Percentages of errors in pointing, repetition and naming tests. L −, illiterate subjects; L +, school-educated subjects.

Table 2. Scores for the three pointing subtasks, as expressed in percentages of inadequate responses per group. WORDS (5 items), SIMP SENT (simple sentences, 3 items), COMP SENT (complex sentences, 3 items, and TOTAL (11 items)

	WORDS	SIMP SENT	COMP SENT	TOTAL
Illiterates:	7.4	23.4	53.8	24.4
Literates:	1.4	4.7	19.4	7.2

Each of the five items of the "word comprehension" pointing subtest led to "inadequate" responses by at least one and usually more than one of the 57 illiterates; however, two items of this subtest were adequately managed by all of the 43 literate subjects. Though one of the items of the "simple sentence comprehension" subtest also led to no error on the part of the literate subjects, there was, in both the illiterate and the literate subjects, an overall increase in total number of inadequate responses in this subtest as compared with performance on the word subtest: as expressed in Table 2 (percentages of inadequate responses), the increase was immediately evident in both subpopulations but, in view of the fact that the word subtest included five items as opposed to only three in the case of simple sentences, no entirely appropriate statistical study could be made in this respect.* A significant increase in the production of inadequate responses, involving all three stimuli of the "complex sentence comprehension" subtest in both illiterate and literate subjects, also occurred on this subtest as compared with performance on the simple sentence subtest (Sign Test for Two Related Samples: $P = 0.001$ in both subpopulations).

On the other hand, using the Chi Square Test for Two Independent Samples, it was found that, for each subtest, there were significantly more illiterates than literates who produced at least one inadequate response (Words: chi square = 6.63, $df = 1$, $P = 0.01$; simple sentences: chi square = 13, 11, $df = 1$, $P = 0$; complex sentences: chi square = 17.7, $df = 1$, $P = 0$).

Moreover, with respect to the "word comprehension" subtest, it should be noted that (a) only formal foils led to inadequate responses by a sizeable number of illiterates,† (b) none of the phonological foils led to a single erroneous answer within the control subpopulation, and (c) none of the foils led to a noticeable production of inadequate responses among subjects of the literate subpopulation.

With respect to the "simple sentence comprehension" subtest, it should be noted that (a) six of the 57 illiterates considered that a sketch representing a man drinking constituted an acceptable visual representation of "The man eats", and (b) 20 of the 57 illiterates, as opposed to only three of the 43 literates, considered that a sketch representing a girl running constituted an acceptable visual representation of "The girl walks" (Fig. 2); the difference between the latter two proportions is statistically significant (Test of Significance of the Difference between Two Independent Proportions: $z = 3.3$, $P = 0.0005$) [10].

With respect to the "complex sentence comprehension" subtest, it should be noted that (a) 25 of the 57 illiterate as opposed to only five of the 43 literate subjects considered that a sketch intended to represent a boy pulling a horse constituted a legitimate visual representation of

*Statistical comparison of the three word items which contributed most to the error scores in the word subtest, "mala", "espada" and "pente" in both groups, indicated significant increase of error score in illiterates only (Sign Test for Two Related Samples: $P = 0.005$).

†The only intended "semantic" foil which attracted four of the illiterates as well as one literate subject—handbag, with luggage as a target—could, a posteriori and given the iconographic characteristics of the display, be considered as much a formal foil as a semantic one.

"The horse pulls the boy" (Fig. 3) (the difference between these two proportions is statistically significant: Test of Significance of the Difference between Two Independent Proportions: $z = 3.48$, $P = 0.0002$) [10], (b) less than 50% of the illiterate and barely 75% of the literate subjects pointed to a target intended to correspond to "The dog is walking behind the woman and the car", and (c) 14 illiterate and five literate subjects considered that a sketch intended to represent a small boy pushing a chair on a tall boy constituted a legitimate visual representation of "The small boy pushes the tall boy on the chair".

Repetition. Repetition error scores for the word and sentence subtests are summarized in Table 3. In both subtests, and for both global error scores and phonemic deviation scores, it was found, using the Chi Square Test for Two Independent Samples, that a significantly greater number of illiterates vs literates:

—produced at least one inadequate response (chi square = 14.7, $df = 1$, $P = 0.0001$) or else produced at least one phonemic deviation (chi square = 12.3, $df = 1$, $P = 0.0005$) in word repetition;

—produced at least one inadequate response (chi square = 27.2, $df = 1$, $P = 0$) or else produced at least one phonemic deviation (chi square = 10.8, $df = 1$, $P = 0.001$) in sentence repetition.

Table 3. Scores for the repetition task, expressed in percentages of inadequate responses per group. Words (8 items), sentences (3 items), and total (11 items): inadequate responses of all types. Pm Dev: phonemic deviations (as defined in the text) in word (W) and in sentence (S) repetition

	WORDS	SENTENCES	TOTALS	Pm DEV W	Pm DEV S
Illiterates:	13.2	58.5	25.5	12.1	10.5
Literates:	2.6	18.6	7.0	2.6	0.8

Moreover: in the word repetition task, each of the eight target nouns led to inadequate response in at least one of the 57 illiterate subjects, whereas only four stimuli led to inadequate response in at least one of the 43 literate subjects. The two monosyllabic items, "pa" and "trem", led to few or no inadequate responses by both the illiterate and the literate subjects; other items, such as "pratos", "cavalo" and "cruzeiros", turned out to be particularly difficult for the illiterates, and the latter was also somewhat difficult for the literates as well. When requested to repeat "pratos" (plates) or "cruzeiros" (money), illiterates would often delete the final /s/, that is, the plural morphemic mark.

The first item of the sentence repetition task, "O céu esta azul" (The sky is blue), was produced adequately by 54 of the 57 illiterate and by all of the 43 literate subjects. In contrast, only 10 illiterate and 26 literate subjects repeated the second stimulus correctly, and only five illiterate as opposed to 36 literate subjects did the same when presented with the third item. Especially among the illiterates, the most common inadequate responses were by far (a) the deleting of "preto" (black) or "grande" (big) when requested to repeat the second item, "O cachorro preto grande da vizinha mordeu o menino" ("The neighbor's big black dog has bitten the boy") and (b) the displacing or replacing of one of the closed class items when requested to repeat the third item, "Nos lhe daremos desde que ela reclame" (literally, "We it will-give-you when this you-request", or else, "We will give it to you when you request it"). It should be noted, on the other hand, that the proportions of inadequate responses to the second and third sentence items did not significantly differ among the illiterates (McNemar

Test, bilateral: chi square = 1.46, $P = 0.228$) [32]), both sentences being equally difficult—indeed nearly impossible—to repeat adequately for subjects without school education, whereas these two proportions were significantly different among the literates (McNemar Test, bilateral: chi square = 5.06, $P = 0.024$), the second sentence being more difficult to repeat than the third for school-educated subjects.

Naming. Naming error scores are summarized in Table 1. In this respect, the following differences were found between illiterates and literates (Chi Square Test for Two Independent Samples). A greater number of illiterates produced at least one inadequate response for singles (chi square = 49.9, $df = 1$, $P = 0$); a greater number of literates (sic) produced at least one inadequate response for parts (chi square = 5.9, $df = 1$, $P = 0.015$).

Furthermore, with regard to overall error scores: a greater number of illiterates produced at least one inadequate response (chi square = 41.1, $df = 1$, $P = 0$); a greater number of illiterates produced at least one inadequate response of the anomic type (chi square = 16.0, $df = 1$, $P = 0.0001$); a greater number of illiterates produced at least one inadequate response of the verbal deviation type (chi square = 10.8, $df = 1$, $P = 0.001$).

Moreover: in the naming task, eight of the 12 noun-drawing targets elicited inadequate responses in at least one of the 57 illiterate subjects, whereas five of the stimuli elicited inadequate responses in at least one of the 43 literate subjects. Certain drawings, such as those of the comb, pipe and knife (Figs 4.1, 4.5 and 4.7), elicited few or no inadequate responses on the part of both the illiterates and the literates. Others, such as those of the bell, the television set (Portugal only) and the cat (Figs 4.2, 4.4b and 4.8), turned out to be rather difficult to name by illiterates. One drawing, that of a human ear presented in isolation (Fig. 4.3), was nearly impossible to name for the illiterates, who usually said that they did not know what this drawing represented or else suggested that it represented a duck ("pato") or some part of the human female genitals; this particular item appeared to be somewhat difficult for literate controls as well. Furthermore, item by item analysis shows that the illiterates' superiority in naming "parts" is entirely accounted for by a single item ("whiskers").

It should be noted that deleting the ear-stimulus results from statistical analysis hardly affects the levels of signification related to naming scores (Chi Square Test for Two Independent Samples: chi square = 17.3, $df = 1$, $P = 0$ for "singles" and chi square = 6.0, $df = 1$, $P = 0.01$ for overall error scores).

DISCUSSION

M1-alpha results in control subpopulations

Linguistic vs iconographic factors. The iconographic characteristics of stimuli rather than the lexical limitations of subjects were no doubt to blame for the production of a large number of "inadequate responses" in M1-alpha testing. This was immediately obvious for the illiterate subpopulation and somewhat less so for the school-educated one. In this regard, we will discuss the M1-alpha naming and pointing tasks separately.

Naming

In the naming task, evident iconographic misinterpretations were observed when illiterate subjects identified the ear-stimulus (Fig. 4.3) as representing a "duck", or the cat-stimulus (Fig. 4.8) as representing a type of Brazilian bobcat known as an "onça". Though we ourselves did not perceive iconographic ambiguities in the corresponding drawing, the same

was no doubt also the case when Portuguese illiterates identified the television-stimulus (Fig. 4.4b) as a "door" or a "refrigerator". In other cases, such as those of the bell- and banana-stimuli (Figs 4.2, 4.4 and 4.6), we find it less easy to decide whether or not the inadequate responses of illiterate subjects were related to iconographic factors or to lexical limitations (probably the former, given that bells and bananas are familiar daily life objects corresponding, in all likelihood, to frequent words in the daily language of our illiterate subpopulation). Be this as it may, and in spite of the fact that several of the M1-alpha naming stimuli can, a posteriori, be considered iconographically ambiguous (Figs 4.3 and 4.8), most of these ambiguities were solved by most of the school educated subjects while significantly less were solved by illiterates (see section sub-headed Naming, in the Results). Therefore —and this whether or not one is ready to presume that one has designed testing materials which ought to yield "errorless" performances in healthy adults—reference to normative data explicitly taking educational background into account is necessary when assessing the naming abilities of culturally contrasted populations with tests founded on the presentation of simple line drawings.

The cat's whiskers dissociation in favor of the illiterates appears paradoxical at first sight. However, the paradox is lifted if one accepts the suggestion that most illiterates (55 out of 57 subjects) knew and did not hesitate to use the familiar word, "bigodes" (regardless of whether they had decided that our drawing represented a cat or an "onça"), while several of the school-educated subjects (nine out of 43) rejected "bigodes" as somewhat inappropriate, attempted to call to mind the more specific term, "barbatana", but did not succeed to do so within the allotted time limit (5 sec). If this interpretation is correct, this particular dissociation would indeed point to lexical limitations of a sort in the literate subpopulation. It would also indicate the need, even on "simple" tests, for normative references rated for educational levels.

Pointing

In M1-alpha testing for "word comprehension", the fact that only formal foils led to a sizeable number of inadequate responses within the illiterate subpopulation (e.g. four illiterates pointed to the pencil drawing when requested to point to the "sword" and to the rake drawing when requested to point to the "comb"; Fig. 1) also bears witness to the importance of the iconographic characteristics of drawings used in testing (even word) "comprehension".

On the other hand, it is our impression that linguistic as well as iconographic factors—sometimes the former, sometimes the latter and sometimes both—should be taken into account in the interpretation of the inadequate responses of both illiterate and literate subjects when tested for "sentence comprehension" with M1-alpha materials.

It is likely, for example, that semantic rather than iconographic factors were at play when 35% of the illiterates as opposed to 7% of the school-educated subjects—a statistically significant difference (see section sub-headed Pointing, in the Results)—pointed to the running-girl foil when requested to show the representation of a "girl walking" (Fig. 2). Given that the three subjects of the literate subpopulation who showed this behavior were among those of shorter school education in our sample (two with 4 yr and one with 6), one might suggest that, to these three as well as to the 20 illiterates who showed the same behavior, the concept of walking included that of running (to run = to walk fast?). If so, it would be interesting to determine whether or not the use of a running girl sentence-drawing pair as target would attract responses to the walking-girl foil (work in progress): if not, this

test and similar ones might be used to distinguish between (a) incomplete although hierarchized semantic organization, linked to lack of or to limited school education and (b) aphasic disruption of semantic fields, in which one would not necessarily expect errors to be unidirectional.

Another striking effect, observed mostly on the M1-alpha "complex sentence comprehension" subtest, had to do with the pragmatic parameters of the situations represented in test drawings. This is best illustrated by considering the responses provided by subjects of both subpopulations when requested to point to the horse-pulls-boy target (Fig. 3): nearly half of the illiterates (43.9%) and more than one tenth of the school-educated subjects (11.6%) pointed to the boy-pulls-horse foil. Obviously, this particular "error"—and a few others related to the "complex sentence comprehension" subtest—might be interpreted as a difficulty in understanding reversible sentences. In our opinion, however, it is more likely to have essentially pragmatic roots: given the iconographic characteristics of this M1-alpha stimulus (Fig. 3), and given that, in real life, big horses are more likely to pull small boys than the reverse, one might suggest that a response on the intended boy-pulls-horse foil should be considered as "legitimate". We would not argue against such a claim but rather underline the fact that the number of responses to the ambiguous (intended) foil was significantly greater among the illiterate than among the literate subjects (see section sub-headed Pointing, in the Results). This, once again, demonstrates the need—in aphasiological studies bearing on culturally contrasted populations—for normative references which are rated for educational level.

Linguistic parameters of repetition. Three features of our repetition test results deserve mention at this point.

The first pertains to the frequent deletion of the final (plural) /s/ in "pratos" and "cruzeiros" found among the illiterate subpopulation responses (see section sub-headed Repetition). This behavior might stem from various causes. It might be related, for instance, to putative dialectal differences in plural marking on the part of illiterate vs literate populations (as a matter of fact, a few studies have indicated that grammatical morphemes tend to be replaced or dropped in the speech of dispossessed communities [1]). Another possibility, and one which is in no way incompatible with that above, would relate to eventual lexical processing differences in illiterate as opposed to school-educated subjects: the fact that lusitanophone plurals have at least one more morpheme than corresponding singulars might require extra lexical processing, which might in turn constitute a particular difficulty for the illiterate although not for the literate mind. One should note, however, that this hypothesis runs into some difficulty since another M1-alpha word-repetition stimulus, "embarcacão", is bimorphemic (yet singular) and leads to relatively few errors irrespective of the subpopulation. On the other hand, prefixes and suffixes might entail different lexical processes. In brief, our word repetition results might be compatible with a number of interpretations and future research ought to clarify the underlying mechanisms responsible for the observed behaviors.

The second point concerns the fact that, in both the illiterate and the literate subpopulations (although more frequently in the former), the most common type of inadequate response occurring when subjects were requested to repeat the second sentence (see section sub-headed Repetition, in the Results) was one which did not alter the syntactic validity of the subjects' utterance: in most cases, the deletion of either or of both of the two attributes of "cachorro" (dog), that is, the deletion of "preto" (black) and/or "grande" (big). The deletion of attributes, in recall of this sentence, might in part be related to the fact that, in

spoken Portuguese (at least in Brazil), one never utters two consecutive attributes without an "e" conjunction between them (although omission of such a conjunction is legitimate in writing). Since examiners uttered this particular sentence-stimulus without the conjunction, some subjects may have been confused even if it was presumably understood that sheer repetition of the stimulus was all they were requested to do. Be this as it may, adjectives have been known to be prone to deletion from recall when they modify a noun although not when they carry the commentary of the sentence [11, 12, 26, 27, 31]. This phenomenon, which one can relate to the fact that the latter type of adjective, but very seldom the former, tend to be replaced by neologisms in Wernicke's jargonaphasia [19], might be more apparent in illiterates than in school-educated adults.

Not taking into account that overall error scores for sentence repetition were significantly greater in illiterate than in literate subjects, the last point pertains to the fact that the second and third sentences were equally difficult for the illiterates whereas the error scores of the school-educated subjects were significantly greater for the second than for the third sentence (see section sub-headed Repetition, in the Results). The main differences between these two sentences are, on the one hand, that the former is longer (19 syllables) than the latter (13 syllables) and, on the other hand, that the former contains relatively few closed class words whereas all but two of the words in the latter are closed class items (therefore, inadequate responses related to the third sentence, unlike those related to the second, usually altered the syntactic validity of the subjects' utterances). If length is the responsible factor, one might interpret our results as showing that repetition memory span is shorter for the illiterate than for the literate subjects. However, an alternative or complementary explanation might be that repeating sentences containing numerous closed class words presents a greater difficulty for illiterates than for school-educated subjects. One of us (M.A.P.), having observed that illiterates often have difficulty recognizing closed class words as real words when they are presented isolatedly (work in progress), would tend to favor the latter interpretation.

Reference to neurologically healthy controls in aphasiology. Following the administration of an experimental French version of the M1-alpha to 60 hospitalized adults (30 men and 30 women) with no neurological disorder other than a sciatic disease, DORDAIN *et al.* [9] showed that, on the whole, error scores did not differ in men vs women but were significantly greater in older as opposed to younger subjects, and significantly greater in subjects with limited as opposed to protracted school education. These results are in accordance with ours.

Likewise, after administering the BDAE [13, 14] to neurologically healthy adults, BOROD *et al.* [2] noted that certain individuals, in the terms used by GOODGLASS and KAPLAN [14], "fell short of the maximum raw score by as much as five or six points on four subtests", and that such low scores occurred "invariably in the group of subjects over 60 yr of age with fewer than 9 yr of schooling". The average duration of schooling in our literate subpopulation being 8.2 yr and the average age 60 yr, it can be said that our literate subpopulation data, considered as a whole, are in agreement with the above quotations.

On the other hand, BOROD *et al.* [2] deleted several subtests of the BDAE from their norming research—including "visual confrontation naming" and "word-picture matching"—on the presumption that neurologically healthy adults were not expected to produce inadequate responses in such simple tasks. In spite of the differences between ours and the BDAE naming and word-picture matching tasks, it is our impression that our data confirm the Boston presumption to a large extent in the case of our literate, though not in that of our illiterate subpopulation.

In view of the above, we can summarize at this point what we think might be taken to be a

reasonable attitude concerning reference to healthy controls in modern aphasia testing. In archetypal cases with full-blown speech–language perturbation occurring as the result of an obvious neurological disease, one does not need to explicitly refer to normative data nor, for that matter, to administer a standardized battery, in order to recognize the existence of aphasia in a particular patient, whether young or old, and whether school-educated or illiterate. However, when one is dealing with subjects who are borderline due to their cultural background, or else because the very existence of organic pathology and/or its extent are questionable, or again when one's preconceptions might determine in part one's diagnosis (e.g. in cases of right hemisphere lesions) as well as when one's interest lies in group studies, normalized testing may become a near necessity. In such instances, reference to neurologically healthy controls of comparable cultural background is perhaps not indispensable for subjects who are, say, less than 60 yr of age or so, and who have received at least, say, 8 or 9 yr of school education [2]. However, one can hardly do without it—at least when testing features use of iconographic materials—in any other set of circumstances. Keeping in mind that, in Western Europe and North America, aphasia is more frequent after than before the age of 60 and, moreover, that individuals with less than 9 yr of schooling are not exceptional among European and American elderlies; and also that illiteracy and limited school education still represent the rule (whatever the age groups) in several parts of the world where systematic aphasia testing is in the process of becoming a routine hospital activity, one can state with confidence that culturally defined normative data are needed more often than not, especially in the context of research as opposed to clinical aphasiology. (As a matter of fact, and although certain aspects of oral comprehension testing can hardly be undertaken without resort to iconographic materials, our advice to clinicians involved in routine assessment of illiterates for language disorders would be to avoid founding their diagnoses on the use of such materials unless they are familiar with the limitations which are in this respect attributable to lack of school-education.)

Aphasia testing in illiterates

Barely 30 yr after Broca's discovery, WEBER [33] suggested that learning to read and write might be necessary to promote the actualization of left cerebral dominance for language representation. Many decades later, CAMERON *et al.* [3] claimed that left hemisphere specialization for language is not as absolute in illiterate as it is in literate individuals and, complementarily, that "language patterns are more bilaterally represented" in the former. Unless we misinterpreted their publication on this matter, the empirical foundation of these researcher's claim was that neurologists of the University of Mississippi Medical Center in Jackson, when examining adults with right hemiplegia due to a left hemisphere stroke, reported the existence of an associated "aphasia" less frequently when patients were illiterates than when they were fluent readers (Chi Square Test, $P = 0.02$). Now, it is more than likely that asserting the existence of aphasia in this study depended on non-standardized bedside examination and, furthermore, there is little doubt that any seasoned clinician testing patients for aphasia in this manner will, knowingly or otherwise, require less—by reference to an implicit ideal norm—from an illiterate than from a school-educated patient (which makes intuitive good sense if one does not have the opportunity or the habit of referring to explicit and presumably reliable norms).

On the other hand, DAMASIO *et al.* [6] claimed, in the very title of their original publication on the same problem, that "Brain Specialization for Language Does Not Depend on Literacy". This claim was also based on the study of a group of brain-damaged adult patients

tested in Lisbon, at the Language Research Laboratory of the Egaz Moniz Center. Nonetheless, methodology was not the same in Lisbon as in Jackson: in the Lisbon study, aphasics "were identified by standardized tests", that is, using a local adaptation of the BDAE [5]. These tests, however, were not "standardized" to the point of taking the subjects' cultural backgrounds into account [5]. In other words, it was by reference to a single scale—founded on the scores of patients known to have suffered brain damage and already classified as presenting one type of aphasia or another—that all subjects, whether illiterates or fluent readers, were declared to be either aphasic or nonaphasic, and that the two groups were found to be identical as to frequency and clinical types of aphasia as well as to localization of lesions.

Given that we have found highly significant differences in the results of healthy illiterate as opposed to healthy literate subjects when tested with relatively simple pointing, repetition and naming tasks, and given that the Egas Moniz researchers who tested all subjects by reference to a single norm found no differences between their illiterate and literate brain-damaged subjects, it becomes possible, if not likely, that the frequency of "aphasia" among their patients was either overestimated in the illiterate subpopulation or underestimated in the literate subpopulation. In either case, and whether or not one wishes to insist—as we would—on the universality and ineluctability of the genetic programs leading to left hemisphere specialization for human language, there would no longer be any reason to consider the Jackson and Lisbon data as contradictory in spite of the contradictions in the interpretations which have been attributed to these data [47]. Of course, this suggestion of ours might have to be rejected (a) should one demonstrate, in the Lisbon data, the existence of a comparable discontinuity—comparable not only as to extent but also as to position on the graphic representation of data—between the scores of "nonaphasic" vs "aphasic" illiterates and literates (which we would not at all expect given our own normative data) or else (b) should the Egas Moniz aphasia battery (Token Test included) be shown to be handled similarly by healthy illiterate and healthy literate adults which, to our knowledge, remains to be demonstrated.

REFERENCES

1. BICKERTON, D. The language bioprogram hypothesis. *Behav. Brain Sci.* **7**, 173–221, 1984.
2. BOROD, J., GOODGLASS, H. and KAPLAN, E. Normative data on the Boston Diagnostic Aphasia Examination, Parietal Lobe Battery and Boston Naming Test. *J. clin. Neuropsychol.* **2**, 209–216, 1980.
3. CAMERON, R. F., CURRIER, R. S. and HAERER, A. F. Aphasia and literacy. *Br. J. Disord. Communication* **6**, 161–163, 1971.
4. CURRIER, R. D., HAERER, A. F. and FARMER, L. J. Letter to the Editor. *Archs Neurol.* **33**, 662, 1976.
5. DAMASIO, A. R., Personal communication to A.R.L. and J.M., Royaumont, March 1985.
6. DAMASIO, A. R., CASTRO-CALDAS, A., GROSSO, J. T. and FERRO, J. M. Brain specialization for language does not depend on literacy. *Archs Neurol.* **33**, 300–301, 1976.
7. DAMASIO, A. R. DE S., HAMSHER, K., CASTRO-CALDAS, A., FERRO, J. M. and GROSSO, J. T. Letter to the Editor. *Archs Neurol.* **33**, 662, 1976.
8. DAVIS, G. A. *A Survey of Adult Aphasia*. Prentice Hall, Englewood Cliffs, 1983.
9. DORDAIN, M., NESPOULOUS, J. L., BOURDEAU, M. and LECOURS, A. R. Capacités verbales d'adultes normaux soumis a un protocole linguistique de l'aphasie. *Acta Neurol. Belgica* **83**, 5–16, 1983.
10. FERGUSON, G. A., *Statistical Analysis in Psychology and Education*. McGraw-Hill, New York, 1976.
11. FORSTER, K. and RYDER, L. A. Perceiving the structure and meaning of sentences. *J. Verb. Learn. Verb. Behav.* **10**, 285–296, 1971.
12. FRAUENFELDER, U., DOMMERGUES, J. Y., MEHLER, J. and SEGUI, J. L'intégration perceptive des phrases. *Bull. psychol.* **32**, 883–902, 1981.
13. GOODGLASS, H. and KAPLAN, E. *The Assessment of Aphasia and Related Disorders*. Lea & Febiger, Philadelphia, 1972.

14. GOODGLASS, H. and KAPLAN, E. *The Assessment of Aphasia and Related Disorders*. Lea & Febiger, Philadelphia, 1983.
15. GREGORY, R. L. *Mind in Science*. Penguin, London, 1984.
16. KERTESZ, A. *Aphasia and Associated Disorders: Taxonomy, Localization, and Recovery*. Grune & Stratton, New York, 1979.
17. KERTESZ, A. and POOLE, E. The aphasia quotient: the taxonomic approach to measurement of aphasic disability. *Can. J. Neurol. Sci.—Le journal canadien des Sciences Neurologiques* **1**, 7–16, 1974.
18. LAYZER, D. Science or superstition? A physical scientist looks at the IQ controversy. *Cognition* **2–3**, 263–299, 1972.
19. LECOURS, A. R. On neologisms. In *Perspectives on Mental Representations*, J. MEHLER, E. C. T. WALKER and M. GARRETT (Editors), pp. 217–247. Erlbaum, Hillsdale, 1982.
20. LECOURS, A. R., BASSO, A., MORASCHINI, S. and NESPOULOUS, J.-L. Where is the speech area and who has seen it? In *Biological Perspective on Language*, D. CAPLAN, A. R. LECOURS and A. SMITH (Editors), pp. 220–246, 1984.
21. LECOURS, A. R., DORDAIN, G., NESPOULOUS, J.-L. and LHERMITTE, F. Neurolinguistic terminology. In *Aphasiology*, A. R. LECOURS, F. LHERMITTE and B. BRYANS (Editors), pp. 30–54. Baillière Tindall, London, 1983.
22. LECOURS, A. R, MEHLER, J., PARENTE, M. A. *et al.* Illiteracy and brain-damage—2. Manifestations of unilateral neglect in testing "auditory comprehension" with iconographic materials. *Brain and Cognition*, accepted.
23. LECOURS, A. R., MEHLER, J., PARENTE, M. A. *et al.* Illiteracy and brain-damage—3. A contribution to the study of speech and language disorders in illiterates with unilateral brain damage. *Neuropsychologia*, submitted.
24. LECOURS, A. R., NESPOULOUS, J.-L., JOANETTE, Y., LEMAY, A., PUEL, M., LAFOND, D., COT, F. and RASCOL, A. *Protocole MT-86 d'Examen Linguistique de l'Aphasie*. les Editions de la Côte-des-Neiges, Montreal, in press.
25. LEZAK, M. D. *Neuropsychological Assessment*. Oxford University Press, New York and Oxford, 1983.
26. MARTIN, E. and WALTER, D. A. Subject uncertainty and word class effects in short term memory for sentences. *J. exp. Psychol.* **80**, 47–51, 1969.
27. MEHLER, J., PITTET, M. and SEGUI, J. Strategies for sentence perception. *J. Psycholing. Res.* **7**, 3–16, 1978.
28. MOUTIER, F. *L'Aphasie de Broca*. Steinheil, Paris, 1908.
29. OLDFIELD, R. C. The assessment and analysis of handedness: the Edinburgh Inventory. *Neuropsychologia* **9**, 97 114, 1971.
30. PERRON, C., NESPOULOUS, J.-L. and LECOURS, A. R. Facteurs environnementaux, cerveau, langage et aphasie: de quelques reflexions sur ce thème. In *Communiquer demain*, V. VOIGT-FAMILIADES and O. HÉRAL (Editors). UNADRIO, Nancy, 1983.
31. SEGUI, J. La rétention differentielle des composants de la phrase. *L'année psychologique* **74**, 171–178, 1974.
32. SIEGEL, S. *Nonparametric Statistics for the Behavioral Sciences*. McGraw-Hill, New York, 1976.
33. WEBER, E. Das Schreiben als Ursache der einseitigen Lage des Sprachzentrums. *Zentralblatt fur Physiologie* **18**, 341–347, 1904.