THE ROLE OF NEUROSCIENCE IN THE TEACHING OF INTERPRETATION

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1. INTRODUCTION

The Western way of thinking and living has produced a great number of changes and imbalances in the world, particularly in the relationship between man and nature and in relations between human beings. This civilization, however, has developed a unique and unprecedented approach to the problem of knowledge: the experimental scientific method.

Western men and women have acquired a peculiar and typical attitude toward the problems they are confronted with in the course of their lives, in that they are aware that in order to carry out any activity adequately two essential elements have to be borne in mind: the prosodial aspect (how to do it) and the need to develop a basic theory on the subject, which usually goes under the name of science.

The experimental scientific method initiated by Galileo Galilei is based on successive stages: a) a systematic analysis of previous contributions on the subject; b) the definition of what is known and what is unknown; c) the elaboration of a hypothesis for an as yet unknown phenomenon or for an unresolved problem; d) the setting up of an experiment whose results will either corroborate or disprove the experimental hypothesis and e) the formalization of the new data into a model to be incorporated in basic sciences such as biology and physics. Despite the tremendous upheavals and imbalances caused by the Western way of being and acting, this approach is still highly fascinating particularly because of the practical achievements it has made possible.

This paper regards the problem of simultaneous and consecutive interpretation. There is no doubt that the performance of an interpreter depends on a range of skill (such as knowledge of languages, good sensorial and motor abililities, a disposition to listen to and understand different points of view and different subjects, etc.), which may be summed up in the statement "he/she is or will become a good interpreter". Some people tend to believe that the training of a "good interpreter" is essentially based on the assumption that "one is born an interpreter" and his/her natural skills only need to be trained. This approach, however, is based on a "how to do it" concept or, at most, on rather simplistic notions on teaching methodology for future interpreters.

What we previously defined as the Western approach requires that we also consider the question of interpretation from a scientific-experimental point of view.

2. CONTRIBUTIONS TO THE COMPREHENSION OF BRAIN FUNCTIONS IN THE INTERPRETING PROCESS

As is well known, the human brain is formed of two hemispheres (left and right) which are connected by the corpus callosum and numerous other commissures. In the last few decades it has been possible to study the human brain by comparing the functions and the anatomy of the two hemispheres.

In the second half of the XVIII century the physician and anthropologist P. Broca was one of the first authors to discover that the two cerebral hemispheres have different functions. He showed that in monolingual right-handers the left hemisphere is more involved in the production of articulated speech.

A long series of neurobiological inquiries conducted after the first studies by Broca have identified a number of structural and functional differences between the two cerebral hemispheres. Today most authors agree that the left hemisphere is more specialized in the processing of analytical and temporal information, while the right hemisphere seems to be more involved in analogical and spatial skills. Consequently, in monolingual right-handers the left hemisphere is dominant in the organization of linguistic functions. In this field, however, the right hemisphere is not "dumb", as neurologists tended to believe until a few decades ago. In fact, it is suggested that the right hemisphere participates in important cognitive functions (e.g. face recognition and organization of spatial orientation, emotions, overall attention, sexual functions, etc.). These aspects are of great scientific interest but are particularly difficult to study. (Fig. 1)

Further significant features in the study of cerebral asymmetries are the ontogenesis and sexual differences in hemispheric lateralization. Various studies on this subject have indicated that females attain maturation of the left hemisphere at an earlier age than males and tend to have a more bilateral representation of language. Males, on the other hand, appear to develop the specialized processes of the right hemisphere more precociously and are more left-lateralized for language.

2.1 Methods used to study hemispheric specialization

Various methods have been adopted to study cerebral asymmetries. The following are the most commonly used:

a. Clinical analysis of patients with unilateral cerebral lesions with the aid of in vivo morphological tests, such as computerized axial tomography (CAT) and nuclear magnetic resonance (NMR);

b.Neurosurgical tests (temporary inactivation of one hemisphere by injection of sodium amytal into the carotid of one side, cortical and subcortical micro- and macro-stimulation);

c. Electrophysiological tests (traditional electroencephalography, computerized mapping, evoked potentials);

d. The study of local cerebral blood flow during the performance of mental tasks (xenon 133 inhalation and Positron Emission Tomography - PET);

e. Tachistoscopy;

f. Dichotic listening;

g. Manual-verbal and manual-musical interference paradigm (the tapping method).

Experimental neurophysiological inquiries and the studies described hereafter are usually conducted with the last two techniques (dichotic listening and tapping). These two methods are therefore described in greater detail.

The dichotic listening method was used for the first time by Kimura in 1961. Two different acoustic signals

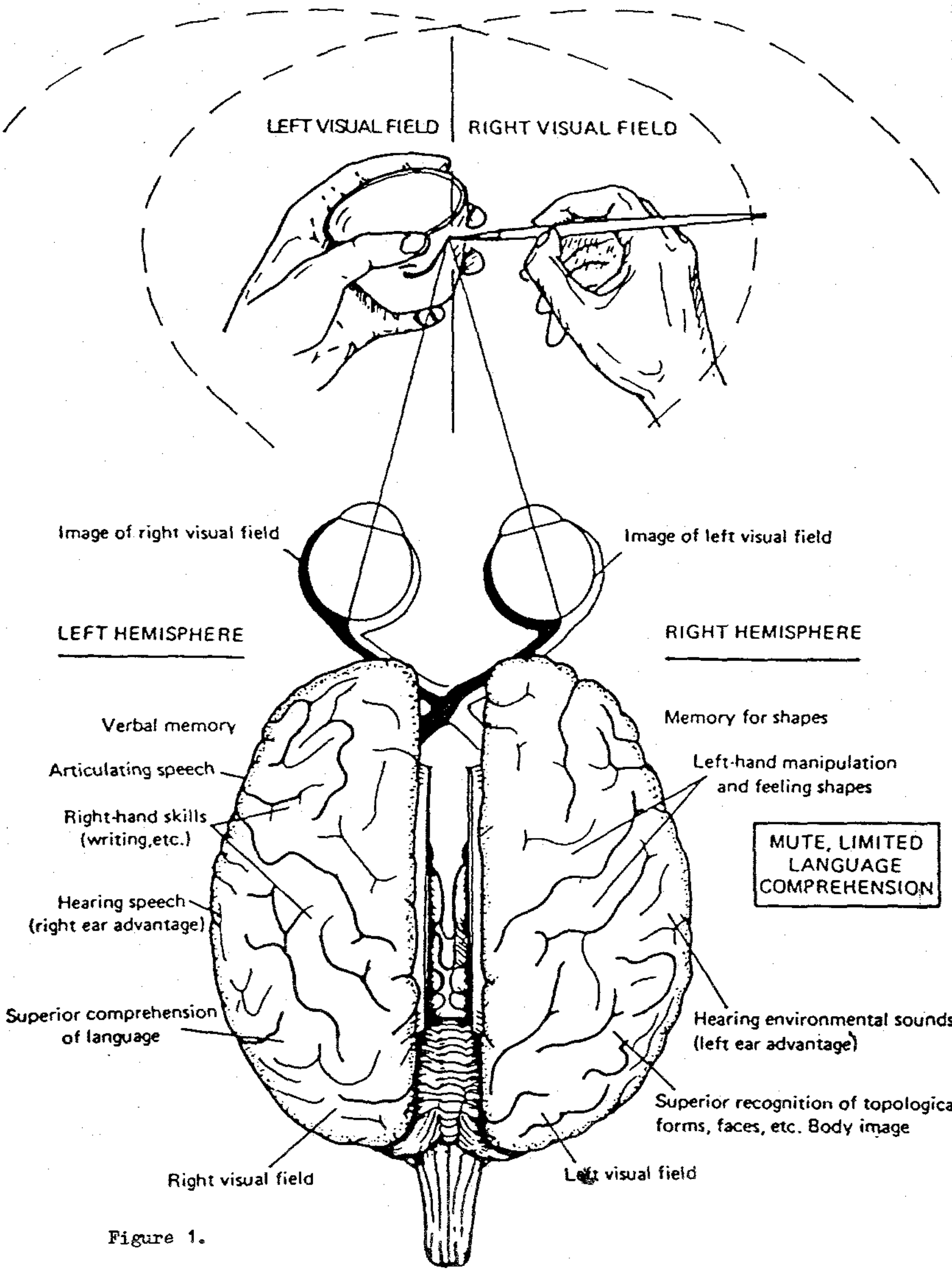
LEFT VISUAL FIELD
RIGHT VISUAL FIELD
Image of right visual field
Image of left visual field
LEFT HEMISPHERE
RIGHT HEMISPHERE
Verbal memory
Articulating speech
Right-hand skills (writing,etc.)
Hearing speech (right ear advantage)
Superior comprehension of language
Right visual field
Memory for shapes
Left-hand manipulation and feeling shapes
MUTE, LIMITED LANGUAGE COMPREHENSION
Hearing environmental sounds (left ear advantage)
Superior recognition of topological forms, faces, etc. Body image
Left visual field

Figure 1.

(numbers , words or syllables) are sent simultaneously to each ear through two earphones, each of which is connected to one channel of a double-track tape-recorder, so that one ear hears channel 1 and the other hears channel 2. The auditory pathways connecting the ears to the cerebral auditory areas are partially crossed. Although each cerebral hemisphere receives signals from both ears, the crossed neural auditory pathways are more effective than the uncrossed. When hypsilateral and contralateral stimuli compete the evidence has shown that the contralateral stimulus inhibits and covers hypsilateral signals. By using this experimental method, right-handers have shown right ear (left hemisphere) superiority over the left ear (right hemisphere) in speech recognition, while the left ear is dominant in sound and environmental noise recognition (Fig. 2).

The <u>tapping</u> manual-verbal interference paradigm developed by Kinsbourne and Cook in 1971 is a simple experimental method used to study cerebral lateralization for some superior cognitive functions such as speech recognition and production. During the experiment subjects are instructed to press a button connected to a digital counter as fast as possible in silence for a given number of trials of 20 seconds each, first with their right index finger (which is controlled by left-hemisphere motor structures due to the crossing of pyramidal pathways) and then with their left index finger (which is controlled by right-hemisphere motor structures). During a certain number of tapping sessions, a concurrent verbal task is performed (such as reciting a series of words, describing a scene, reading, etc.). Percentage interference is calculated for each subject, each task and each hand by using the following formula:

$$\% \text{ Change} = \frac{(\text{No. taps control} - \text{taps concurrent}) \text{X}100}{\text{No. taps control}}$$

By analysing the percentage interference, an index of the cerebro-functional distance between the two concurrent tasks (tapping and speaking) is obtained. In fact, the degree of interference is inversely proportional to the functional distance between the cerebral control centres for index finger movement and those for the control of speech funtions. For example, in monolingual right-handers a verbal task causes greater interference on right-hand tapping (left hemisphere) than on left-hand tapping (right hemisphere) (see Fig. 3).

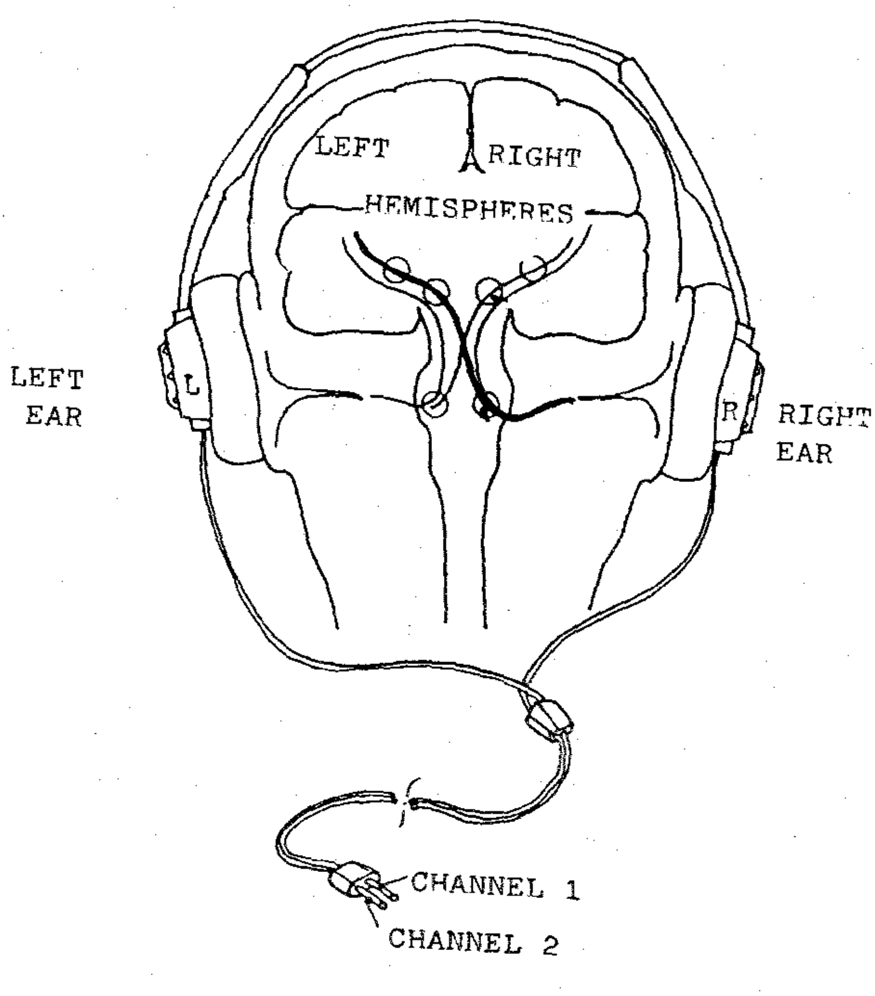
LEFT
RIGHT
HEMISPHERES
LEFT EAR
L
R
RIGHT EAR
CHANNEL 1
CHANNEL 2

FIGURE 2

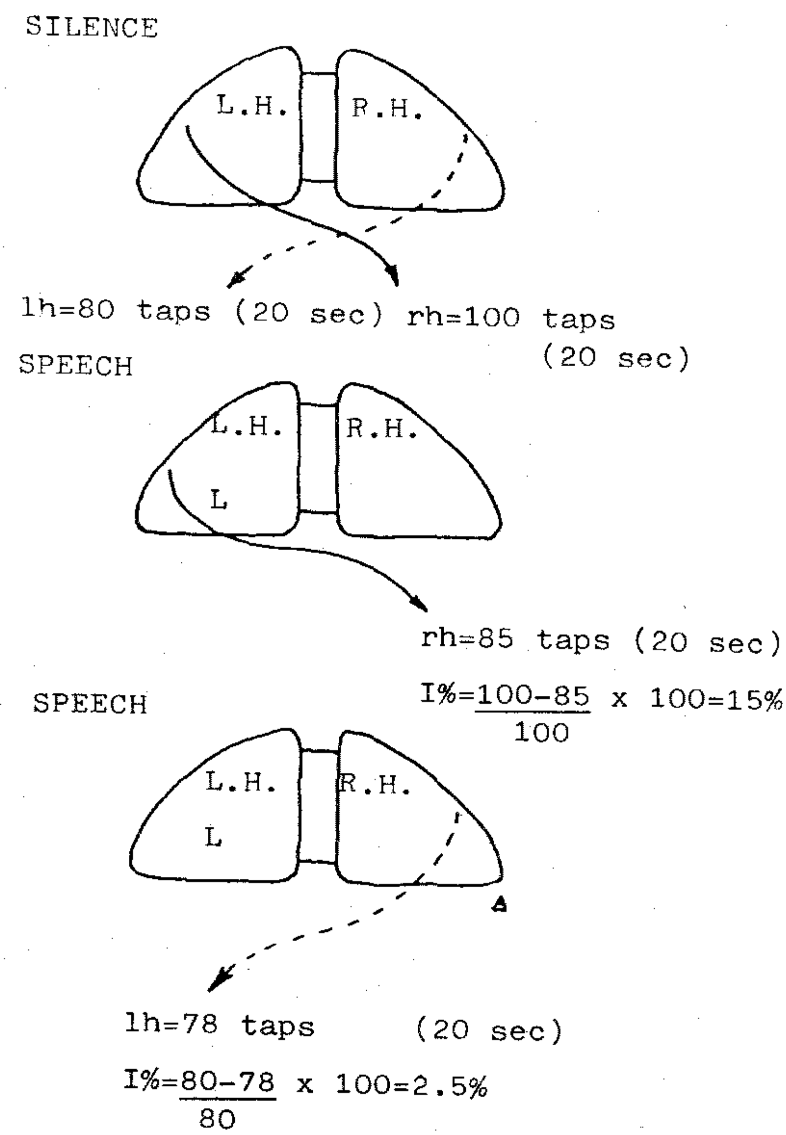
SILENCE
L.H.
R.H.
lh=80 taps (20 sec)
rh=100 taps (20 sec)
SPEECH
L.H.
R.H.
L
rh=85 taps (20 sec)
I%=100-85 / 100 x 100=15%
SPEECH
L.H.
R.H.
L
lh=78 taps (20 sec)
I%=80-78 / 80 x 100=2.5%

FIGURE 3

2.2 Acquisition of a second language in student interpreters

As was mentioned earlier, in most right-handed monolingual adults linguistic functions are represented in the left hemisphere. In fact 1-2% only of this population suffer from speech impairment following lesions of the right hemisphere. Two neurophysiologists (Albert and Obler, 1978) observed, however, that right-hemisphere damage caused language disorders in 10% of bilingual subjects. On the basis of these findings the authors suggested that bilinguals have greater language representation in the right hemisphere than monolinguals.

In later years a number of studies designed to define cerebral lateralization for the different languages known to bilinguals and polyglots were carried out in some universities, particularly in the United States, Canada and Israel. For a review of the literature and the evidence see Fabbro (1986).

Four years ago we started studying three groups of female students at the University of Trieste. The first group consisted of 12 girls attending the first year at the SSLM (Scuola Superiore di Lingue Moderne per Interpreti e Traduttori) with a good knowledge of their second language (English) both in the spoken and written form. The second group was composed of 12 female students, with high proficiency in their second and third languages, who attended the fourth year (second-year interpreting course) at the SSLM. The control group was formed by 12 female students of medicine with a very poor knowledge of English. All the subjects had Italian as their mother tongue (L1); the students of the SSLM had started to learn their second language (L2 - English) after age 11.

Each student was subjected to a dichotic listening test. She was requested to listen to a total of 40 sets of 6 numbers. During the administration of each set of three numbers in either language (Italian or English) were sent to the right ear while, concurrently, three different numbers were sent to the left ear. E.g. the left ear heard the following numbers: tre (L1) eight (L2) uno (L1), while the right ear heard numbers four (L2) sette (L1) six (L2) at the same time. This dichotic presentation with mixed signals in two languages is called the interlingual paradigm. Each subject heard a total of 60 numbers in Italian and 60 numbers in English from the right ear and as many from the left ear. After listening to each set of 6 numbers the student was allowed a few seconds to write the numbers in free recall. The number of figures recalled in Italian and English from each ear was computed for each subject and for each group of students.

The control group displayed a mean recall rate of 49.5 for Italian numbers in the right ear (REI) and of 42.9 for Italian numbers in the left ear(LEI), the difference between the two ears being 6.6 (REI - LEI). The same group showed a mean recall rate of 47 for numbers in English sent to the right ear (REE) and of 42 for numbers in English sent to the left ear (LEE), the difference between the two ears being 5 (REE - LEE). The first-year students of the SSLM recalled an average of 51 numbers in Italian from the right ear (REI) and of 44.8 numbers in Italian from the left ear (LEI) with a difference between the two ears of 6.2 (REI - LEI), while they reported 53.9 English numbers from the right ear (REE) and 49.8 English numbers from the left ear (LEE). The difference between right and left ear for English was 4 (REE - LEE). The group of fourth-year SSLM interpreting students reported 50.3 numbers in Italian for the right ear (REI) and 43.8 for the left ear (LEI), with a difference of 6.5 (REI- LEI). For English numbers this group recalled 50.5 figures from the right ear (REE) and 48.8 figures from the left ear (LEE), the difference between the two ears being 1.9 (REE - REI) (see Fig. 4 and Fig. 5).

Statistical analysis confirmed significant right-ear (left-hemisphere) superiority in all groups for both languages with a significant exception: in the group of fourth-year SSLM students English was bilaterally / symmetrically represented in the two cerebral hemispheres. Moreover, this group also showed right-hemisphere superiority for English as compared to Italian.

Our interpretation of these findings is based on the hypothesis that intensive training in their second language (English) had enhanced right-hemisphere language skills in this group of fourth-year student interpreters. The increased right-hemisphere competence for English had significantly reduced the traditionally reported cerebral asymmetry for language.

These findings were presented at neurobiological meetings (see Fabbro, Gran and Bava, 1987) and used as a basis for considerations on interpreting problems (see Gran, 1986).

2.3 Cerebral lateralization during simultaneous interpreting

Albert and Obler in their book on the neuropsychological and neurolinguistic aspects of bilingualism pointed out that studies should be conducted on cerebral asymmetries during simultaneous interpretation. They suggest that cerebral lateralization in interpreting simultaneously from language A to B may be different than

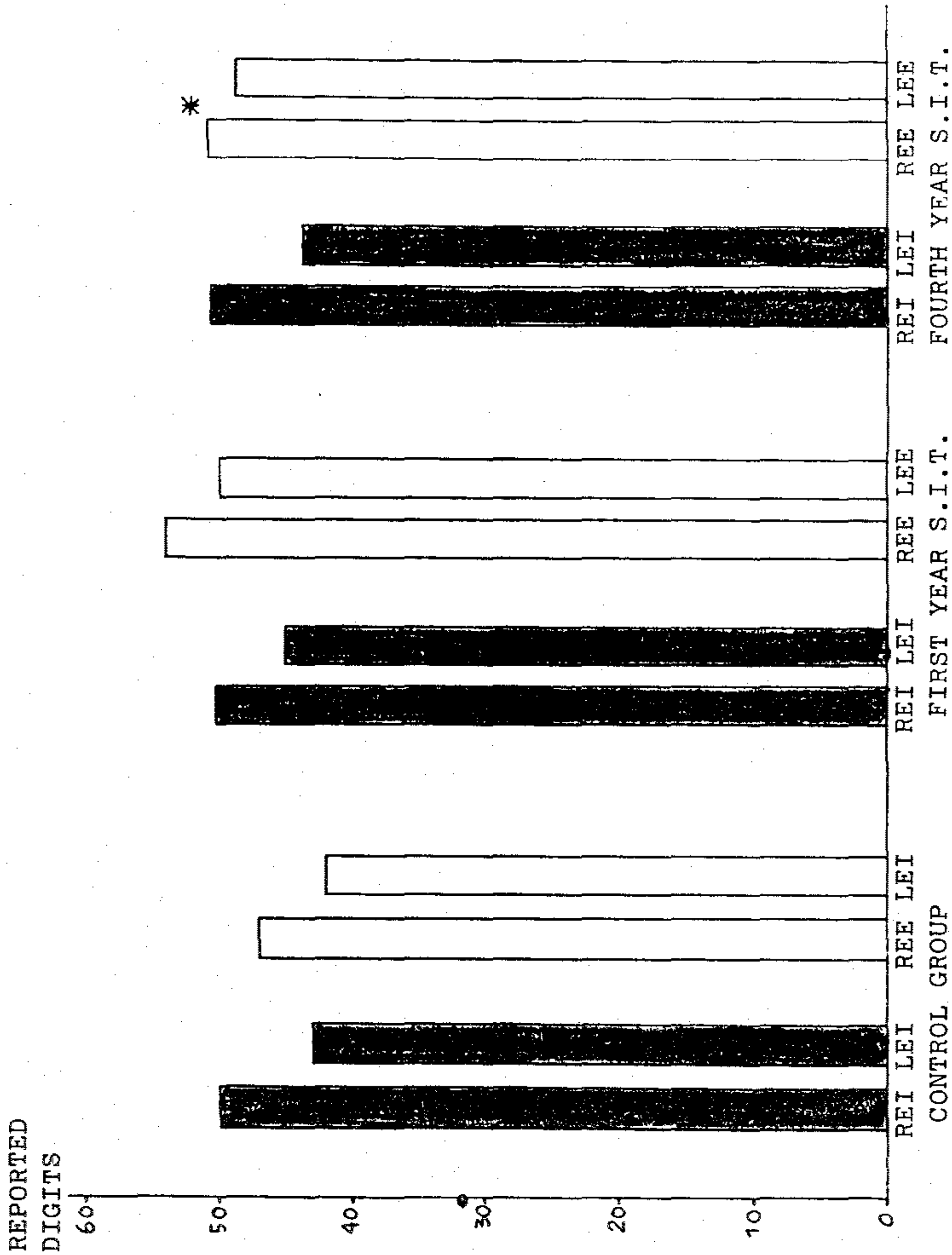
REPORTED DIGITS
0
10
20
30
40
50
60
REI LEI REE LEI
CONTROL GROUP
REI LEI REE LEE
FIRST YEAR S.I.T.
REI LEI REE LEE
FOURTH YEAR S.I.T.
*

FIGURE 4

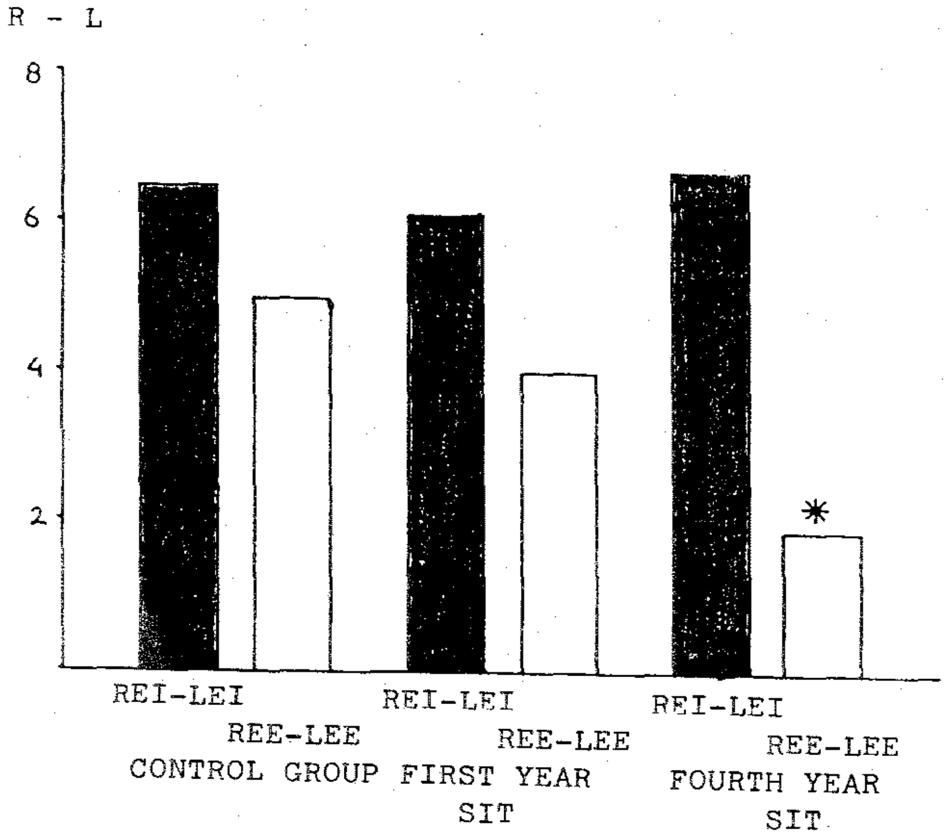
R - L
8
6
4
2
*
REI-LEI
REE-LEE
CONTROL GROUP
REI-LEI
REE-LEE
FIRST YEAR
SIT
REI-LEI
REE-LEE
FOURTH YEAR
SIT

FIGURE 5

in interpreting from B into A (Albert and Obler 1978, p. 253). With a view to inquiring into this aspect of interpreting, last year we carried out an experimental study on cerebral lateralization by using a verbal-manual paradigm (Gran and Fabbro, 1987)

In the first part of the experiment, cerebral lateralization for language was studied in 14 polyglot right-handed female students of interpretation . During the task of reciting the days of the week in Italian (L1), while tapping at the same time, the percentage interference was 9.55% for the right hand (left hemisphere) and 8.99% for the left hand. The percentage change for English (L2) was 8.15% for the right hand and 5.42% for the left hand, while the score for the third language (L3) was 8.66% for the right hand and 6.09 for the left hand. None of the three languages was significantly lateralized, as occurs with right-handed monolinguals who usually show right-hand superiority in verbal-manual interference tests. (Fig. 6).

In the second part of the experiment, the same group of students was instructed to perform a series of tapping trials with the right and left hand and, as a concurrent task, to interpret simultaneously: a) lists of words (mot-à-mot mode) and b) phrases and proverbs which required different syntactical and lexical solutions in the target language to render the meaning of the incoming message. The subjects were required to perform the interpreting trials from English (L2) into Italian (L1) and viceversa.

In interpreting from L2 into L1, the mean percentage interference was 8.64% for the right hand and 9% for the left hand, while the score for interpreting from L1 into L2 was 11.4% for the right hand and 9.89% for the left hand. (Fig 7).

The differences displayed between the two hands - and the two cerebral hemispheres - were not statistically significant during these trials. These findings suggest that there is concurrent participation of both cerebral hemispheres in the linguistic functions involved in simultaneous interpreting. This conclusion confirms the results of the first part of the experiment, indicating symmetrical representation for language in our group of interpreter students.

If both cerebral hemispheres participate in the decoding of the incoming message in the source language and in the motor functions activated for the utterance of the outgoing speech in the target language, the very high

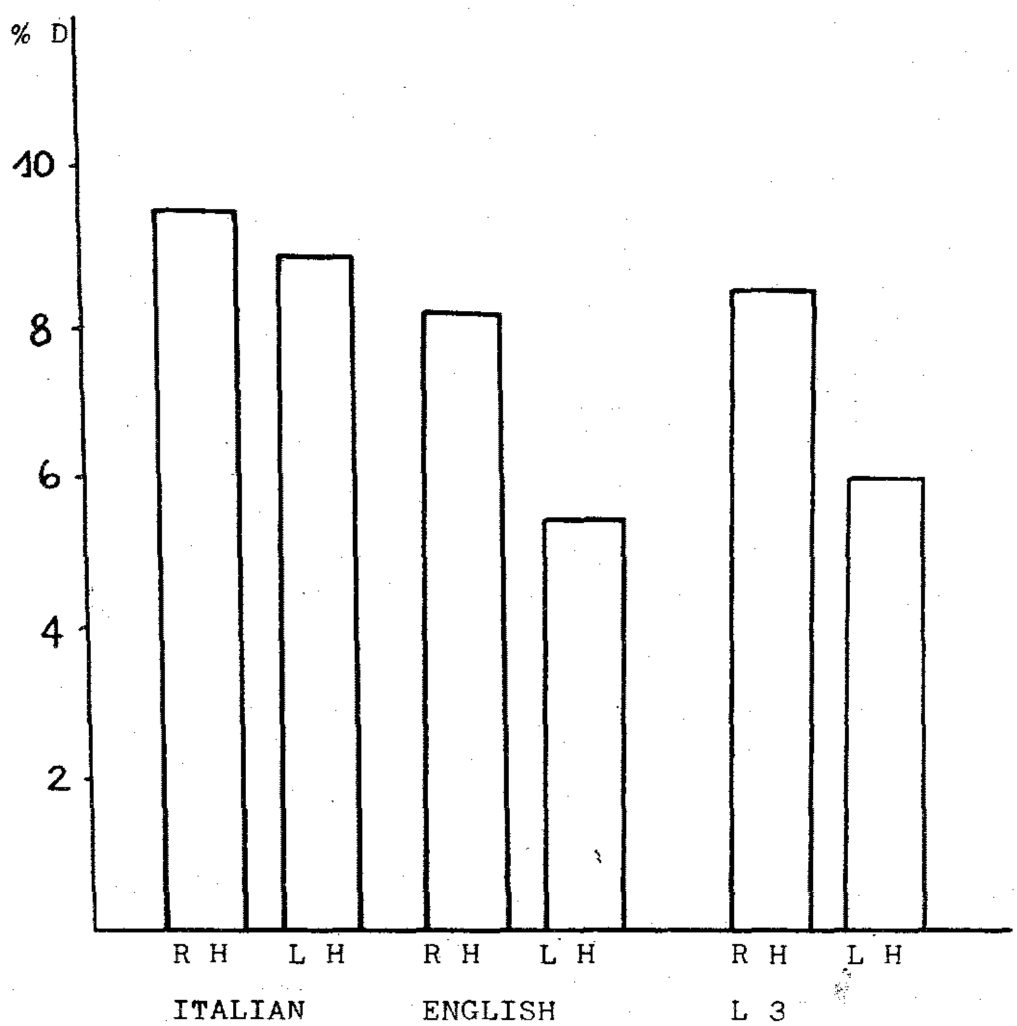

FIGURE 6

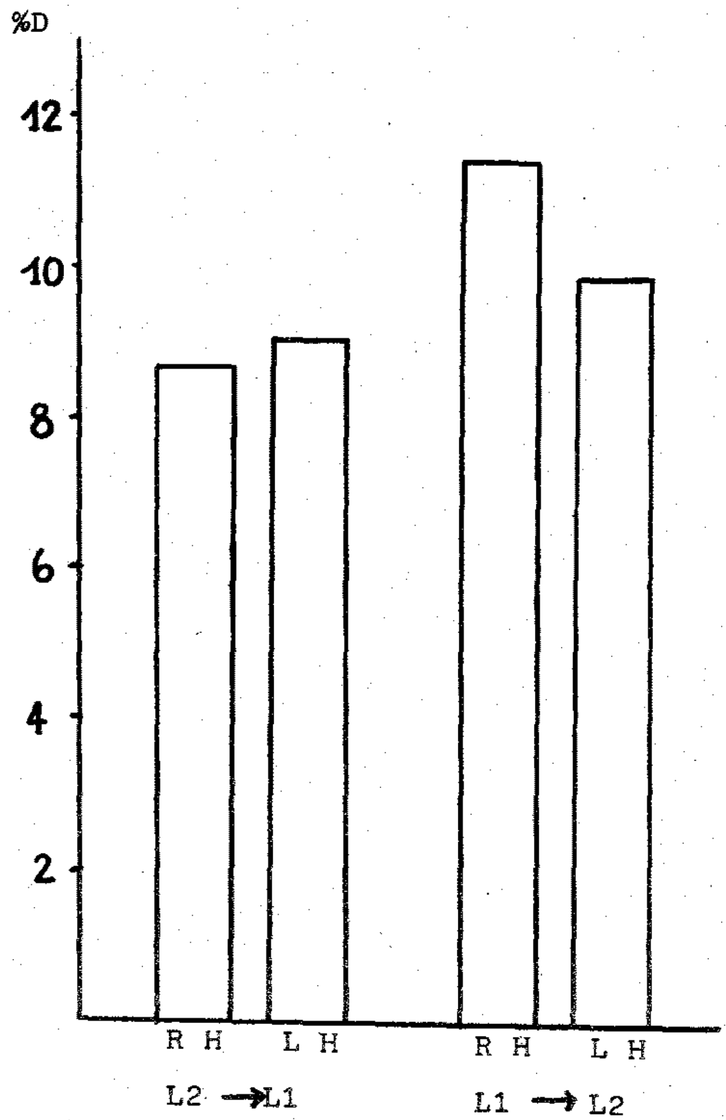

FIGURE 7

percentage of female students and of left-handers at the SSLM can be explained. Since, as is well known, women and left-handers in particular have a more symmetrical cerebral representation for language functions, these groups of subjects are, from this point of view, neurobiologically better suited for interpreting tasks.

3. CONSIDERATIONS FOR TEACHING PURPOSES

The studies conducted on bilingualism suggest that the learning of a second language, by altering the cerebral organization for linguistic and cognitive functions, in some way influences the subtle interactions between left and right hemispheres, and between cortical and subcortical structures, so that the brain of a bilingual or of a polyglot works in a different way than that of a monolingual.

In addition, translation is a highly specific skill which is not necessarily and directly correlated to type of bilingualism (whether early or late) or even to degree of language proficiency. Simultaneous and consecutive interpreting imply additional and different skills from those required for written translation (speed, comprehension of an oral message, elocution abilities, etc.) and involve the activation of highly complex cerebral structures.

Experimental inquiries into specific aspects of cerebral language functions cannot provide answers to highly sophisticated questions on interpreting skills as yet. As was mentioned earlier, however, interdisciplinary research in this area is bound to open up a new approach to teaching techniques that may lead to fruitful findings especially in an era when research conducted for the development of artificial intelligence and translating machines is casting unexpected light upon the functioning of the human brain. A more thorough knowledge of the specific features and skills of left and right cerebral hemispheres will greatly contribute to a better insight into the linguistic and non-linguistic responses and behavioural patterns activated in simultaneous and consecutive interpreting. Moreover, advanced studies in electronic engingeering on speech recognition and production will either confirm or modify intuitive speech comprehension models designed by text linguists. Prospects for joint research in this area are therefore most encouraging.

The first experimental study carried out at the University of Trieste and mentioned in this paper has shown that intensive training in a second language increases right-hemisphere skill for that language, at least in the input stage. Fourth-year students, while maintaining left-hemisphere dominance for their mother tongue (Italian), have shown significant right-hemisphere superiority for English as compared to first-year students and monolinguals. If one considers the highly demanding task of simultaneous interpreting, it emerges that a bilateral cerebral representation of languages enhances the efficiency and , possibly, the resistance to fatigue in professional interpreters.

This finding can be related to previous experimental studies on types of bilingualism. Lambert (1969) illustrated the problems of age of acquisition, acquisitional context, acquisitional manner and usage of a second language. Kolers (1974) showed experimentally that all these factors influence the way languages are presented neurologically. The notion of the compound bilingual (with a single language system comprising both languages) as against the coordinate bilingual (with two non-interfering cerebral language sites) is no longer considered applicable in such simple terms and various parameters have been added to explain why certain groups of bilinguals perform differently under given experimental and environmental conditions. It is now felt that individuals lie along a continuum between the two poles - the compound and the coordinate.

At any rate, the compound- type bilingual (someone who learnt both languages in early childhood without realizing he/she was speaking two different languages) will probably have greater interference problems than a late bilingual who learnt a second language after age 11 and developed two clearly distinct language codes.

In a paper presented at the Colloque International sur la Formation des Interprètes at Mons (Gran, 1987) the question of various types of bilingualism was discussed with specific reference to training problems. It was pointed out that early bilinguals, however fluent in either language, do not always turn out to be excellent interpreters, probably because of interference problems and because they do not always have a real mother tongue nor a solid background in either culture. From the above-mentioned dichotic listening experiment, it has emerged that female coordinate bilinguals are well-suited to become good conference interpreters. These students have a natural fluency in and a solid command of their mother tongue. (Italian, in the cases in question) and should be helped in achieving excellent proficiency in their B language and a sound knowledge of their passive languages. In these cases a comparative analysis of syntactic structures between languages is more useful than in the case of more compound bilinguals, who should be left free to express themselves in a spontaneous manner and be encouraged to improve each of their languages separately.

As regards the second experiment conducted at the SSLM and briefly described in this review, perhaps the most significant findings for practical purposes are the following: a) there are highly significant differences in verbal-manual percentage interference between the word-for-word (6.67%) and the meaning-based (10.67%) modes of interpretation, and b) there is significantly increased disruption in the tapping rate for meaning-based interpretation from L1 to L2 as compared to the L2 to L1 direction

The first finding confirms a subjective impression that the meaning-based approach to interpreting is more demanding, though it usually produces a clearer and more effective version in the target language. This is the first time that modes of interpretation have been cross-analysed, thus providing quantitative data on the fatigue factor. A neurobiological explanation for these results is not easily found. This phenomenon may be rigorously considered from the point of view of motor functions (e.g. meaning-based interpretation involves motor structures of the nervous system more than does word-for-word interpretation) or from the point of view of cognitive or attentive strategies (Keefe 1985). Interpreting teachers recommend that the meaning-based approach be adopted whenever possible. Greater awareness of the degree of fatigue involved in either interpreting mode, however, and a more conscious shift from one mode to the other according to text typology (e.g. political vs. technical speeches) or in order to obtain temporary relief from fatigue, may greatly help students and professional interpreters to modulate their performance on the basis of a better knowledge of the mental processes involved in interpreting.

The second result mentioned above is a further element to be considered in the long-dated debate about whether pivot interpreters should work from their B into their A language or viceversa. In the course of the International Symposium on the Theoretical and Practical Aspects of Teaching Interpretation held in Trieste in November 1986, a very lively debate took place on this subject. Whereas some participants felt that interpreters should always work into their mother tongue which they master in a much subtler and more sophisticated manner, others argued that working from A into B produces a more reliable output with regard to content, though the version in the target language may be less satisfactory from a linguistic viewpoint. Experimental data on this aspect of interpreting provide a useful contribution to the debate in question. Our experimental findings have clearly shown that, at least from the fatigue point of view, interpreting from L1 to L2 is a more demanding task than doing the reverse (L2 into L1). This may seem an obvious fact but it contrasts with the subjective impression held by Italian students and professional interpreters that, because of a better comprehension of the source text and of the possibility of rendering the typically lenghthy Italian phrases and words in a shorter form in English , interpreting from Italian into English is less tiring than doing the opposite (English into Italian). Besides, the same question arises in working from other Neo-Latin languages into English. In the Treisman psychological study in 1965 on simultaneous translation, proficiency and correctness from French into English were higher than in the opposite direction in both French and English-dominant bilinguals. The fatigue factor, however, was not taken into consideration. During their training sessions, therefore, students should be made aware of the fact that a subjective feeling of lesser strain does not necessarily reflect a real condition and that fatigue can be an additional factor in the unconscious production of errors that would not be made under normal conditions. Bearing in mind that output control is more instinctive and therefore more effective in one's mother tongue - though it obviously requires constant refinement - particular attention should be attached to the acquisition of control abilities with regard to speech production in the second language, by carefully monitoring speech degradation due to fatigue and by adjusting the duration of training sessions accordingly.

These are some didactic and practical considerations based mainly on the findings of the initial experiments conducted at the SSLM. It is hoped that this experimental work will be the first step toward the setting up of a more comprehensive research project to be carried out in cooperation with linguists, neurophysiologists and electronics experts.

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