INACCURACY FOR NUMERALS IN SIMULTANEOUS INTERPRETATION: NEUROLINGUISTIC AND NEUROPSYCHOLOGICAL PERSPECTIVES

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Introduction

A numeral may be defined as the representation of a number by means of a sequence of written or pronounced words (Deloche and Seron, 1982a, 1982b); a numeral is, therefore, a verbal expression denoting the concept of quantity expressed by a number (Hurford, 1987). Numerals are organized in structured systems and are formed by matching verbal expressions with numerical operations. Linguistically, they are characterized by an extremely reiterative syntax: indeed, the most typical feature of numerals is the possibility to produce an endless series of elements by means of a limited set of instruments to be combined together in various ways (Gvozdanovic, 1992; Hurford, 1987). Moreover, within every single language, numerals form a closed system, characterized by specific features.

The conceptual processing of a number is carried out by means of cognitive mechanisms each of which comprises specific and independent functions (Miceli, 1990). These functions are: a) the phases (comprehension and production); b) the codes (verbal and arabic); c) the modality of expression (written and oral). During the phase of comprehension of a number, a sequence of digits (for example 135) or of number-words (for example "one hundred and thirty five") is processed in order to produce a mental representation of the number. Conversely, during the phase of production the starting point is the mental representation which is to be transformed into the corresponding sequence of number-words or digits (McCloskey et al., 1986). Both within the phase of comprehension and production, another distinction may be traced in the processing of a number, according to the code which is being used, since one can choose between the arabic code (expressed in digits) and the verbal code (expressed in words). These mechanisms, too, are different and
independent from each other (Miceli, 1990). But while the arabic code can only be expressed in writing, by the *graphemic modality of expression*, the verbal code can be transmitted either in writing (*orthographic modality of expression*), or by word of mouth (*phonologic modality of expression*) (Miceli, 1990) (see Figure 1).

![Diagram of the system of numerals]

The present experimental study has been devoted mainly to the analysis of the cognitive mechanisms involved in the processing of numerals in the oral, phonologic modality of expression. This has been done by means of the special task of simultaneous interpretation from one language into another wherein, apart from an initial phase of comprehension and a final one of production of verbal material, there is, somewhere in between, the phase of translation of the numeral into a language other than that of presentation.
Indeed, the *internal processing* of a number appears to take place by means of two separate mechanisms, named *lexical* and *syntactical*. For the internal processing of a number, first of all a *syntactic representation* of that number is built up. In this way, a general scheme for the verbal expression of any number of that particular order of magnitude is given, containing information about the number of digits and the related multipliers (hundreds, thousands, millions...). In other words, the syntactical representation specifies that a given number contains some given orders of magnitude (i.e. thousands, hundreds, tens and units), without making clear, however, how many elements of each it contains. The *lexical representation*, on the other hand, contains the information required to complete the syntactic structure by means of items chosen from the lexicon of number-words. It specifies the basic quantities to be inserted into the empty fields of the syntactic structure. The term "basic quantity" refers to a number between 1 and 9 which can be raised to the powers of ten.

The information jointly transmitted by the two types of representations (syntactical + lexical) univocally determines the selection of one definite item from the lexicon of number-words. However, if on the one hand, the syntactical representation is independent from the modality in which the number has been or is to be expressed, on the other, the mechanisms of lexical completion are specific, in accordance with the modality used (arabic or verbal, verbal orthografical or verbal phonological) (Miceli, 1990). According to this pattern, numerical, orthographical or phonological features are selected, in accordance with the complete semantic scheme of any number.

During simultaneous interpretation, a numeral is transposed from one language into another in a very brief lapse of time, resulting from a partial overlapping of the listening and production phases; the latter begins as soon as the interpreter has listened to a linguistic fragment that is sufficiently long to understand its meaning and to allow its transposition into the target language. However, from the point of view of the *linguistic processing*, the simultaneous translation of numerals greatly differs from that of a coherent text, since numbers are largely unpredictable entities. That means that the structure of a coherent text allows, or even obliges the interpreter to formulate hypotheses about the sequel of the text; but when a numeral appears within the speech, the interpreter is compelled to devote all of his attention to the incoming number and modify accordingly his listening and processing strategies (Moser-Mercer, 1985). This rapid modification is obtained through a sudden shift from a so-called "intelligent translation" (Lederer, 1982) to a very literal transposition (Lederer, 1982). To perform an "intelligent translation" it is paramount to listen to the incoming information for a time lapse that is sufficiently long to understand its meaning. Instead, in the literal transposition a global translation of a single element which cannot be inferred from the context is carried out.
This inevitably leads to an interruption of the mental activity performed to transmit the overall meaning of a message from the source language into the target language.

Contrary to what could be theoretically assumed, empirical data reveal that, during simultaneous interpretation, the most easily translatable elements are often the hardest to understand (Lederer, 1982); these elements are the following: a) names which in the passage from one language to another undergo a simple adaptation (e.g. the Azores / le Azzorre); b) acronyms which need only be converted (e.g. WTO / OMC); c) technical terms (e.g. ladle / siviera) and d) numbers. These elements all have one direct, unequivocal equivalent in the target language.

As for shadowing (i.e. the simultaneous repetition of verbal material in the same language in which it is being presented), the production process is immediate and activated without necessarily resorting to the phases of analysis and internal representation of meaning. Indeed, the type of memory required to perform this kind of task is likely to be of the sensorial auditory kind, rather than semantic and conceptual.

Aim of the present study

The idea for the present study originated from the importance for any interpreter to be able correctly to transpose numerals from and into any of his working-languages, as well as from the high number of errors commonly related to this particular kind of performance.

The issue of the correct comprehension and production of numbers has already been raised from several points of view. More specifically, studies on the cognitive organization of the number system have been conducted to assess normality and pathology in the related functions (see Miceli, 1990; McCloskey et al., 1986; Deloche et al., 1982). Studies have also been conducted on possible cerebral lateralization of specific comprehension and production mechanisms (see Gran et al., 1987; Gran, 1989). The main object of research of these studies was the number considered as a mathematical, rather than a linguistic entity. Only a few studies have actually focussed on the linguistic expression of numbers (i.e. on numerals) by means of the oral modality of expression, rather than the written one (see Crevatin, 1991). Several studies conducted on simultaneous interpretation, too, have made reference to the system of numerals and to the difficulties of its simultaneous translation into another language (Moser-Mercer, 1985; Lederer, 1982; Gile, 1985).

Starting from the literature existing in the different fields of research mentioned above, and with special reference to the research connected with
simultaneous interpretation, the present study was conducted to try and shed light on the neurolinguistic processing of numerals as far as their transposition from one language to another is concerned.

Method

An experiment consisting in the simultaneous interpretation matched against the plain repetition of numerals in different conditions was conducted on 12 experimental subjects attending interpretation courses at the SSLM of Trieste. The trials they had to perform can be divided into three categories: a) simultaneous interpretation of texts containing numerals, to be translated from German into Italian and vice versa; b) translation (from German into Italian and vice versa) of lists of numerals, to be carried out in the same conditions as simultaneous interpretation; c) shadowing of lists of numbers, to be listened to and repeated in the same language of the input (both German and Italian).

All trials were presented monaurally, in order to verify the possibility of hemispheric lateralization in the performance of different types of trials, depending on the nature of the trial itself and on the conditions in which it was performed. This method proved to be as efficient as dychotic (or binaural) listening (see Kimura 1961a, 1961b and 1963) for the assessment of hemispheric asymmetries in the appraisal of verbal auditory stimuli (see Henry, 1983).

If students thought it useful for a better performance of the task, they were allowed to take notes of the numbers present in the text to be simultaneously interpreted, but only in half the number of trials of this kind. For the remaining trials of this type they had to rely just on their memory.

The objective of this experimental study was to try and shed light on the global processes underlying the different kinds of tasks. It was also meant to find out whether some type of error occurred systematically, in order to carry out a deeper analysis of the investigated processes and hopefully single out the phases in which the normal processing is altered.

Subjects

The present experiment was conducted on 12 students attending the SSLM of Trieste, chosen on the basis of the following criteria: a) mother-tongue Italian and strongest foreign language German (or vice versa); the other foreign languages known by the subjects could be (and often were) different; b) all subjects had attended for at least two years the courses in (simultaneous and
consecutive) interpretation from and into German, held at the SSLM; c) the period of time actually devoted to the acquisition of interpretation techniques and practice varied from a minimum of 16 months to a maximum of 64 months, while the average time devoted to such practice varied between 1 and 4 hours a day; d) subjects were aged between 23 and 28; e) all subjects were right-handed, with degrees of hand preference varying from a minimum of +15 and an absolute maximum of +24 according to the hand preference test by Briggs and Nebes (1975). Of the 12 subjects tested, 9 were female and 3 were male.

Experimental material

The experiment was divided into two sections: 1) translation of numerals occurring within texts to be interpreted simultaneously; 2) simultaneous translation and shadowing of lists of numbers without any reference to text-like, semantically structured material. The objective was to verify the hypothesis of more errors being made in "mixed" trials (numbers + texts) than in "pure" ones (numbers only). To this end, the results of part 1 were matched against the results of part 2 of the experiment.

Text material: 8 texts were used, 4 of which in German and 4 in Italian. These texts had been previously revised, so as to ensure the greatest possible homogeneity of some fundamental features. So, for example, in all texts the first part did not contain any numbers, while in the second part there were 14 of them (two for each order of magnitude from units to millions), uniformly distributed within the text. The first part of each text was used as a "warm-up" before passing (without any interruption) to the actual experimental task consisting in the translation of the numerals contained in the text. All 8 texts were informative in nature and did not give rise to any particular problems in terms of vocabulary or structure.

Lists: 8 lists of numbers were used, 4 of which in German and 4 in Italian. Each list contained 35 numerals (5 for each order of magnitude from units to millions). The orders of magnitude being used here were the same which had been used for the numerals in texts. The numbers contained in every single list were different and had been chosen at random. Even their sequence within every single list had been determined at random, drawing lots from the corpus of 35 numbers which were to form that single list. This criterion was followed in order to make the sequence unpredictable, thus obliging the subjects fully to concentrate on the material presented to them.
The lists were presented at such a speed as to compel subjects to a partial overlapping of comprehension (input) and production (output) phases, in order to reproduce the typical condition of simultaneous interpretation. Each list lasted approximately 2 minutes, with a slight difference between German (2'05") and Italian (1'55") due to linguistic features.

The text material was presented at a rate of approximately 110 words per minute. The input material for all trials (texts and lists) had been previously tape-recorded by a natively bilingual female speaker, graduate of the SSLM. This was done in order to assure uniformity of speed and pronunciation for all subjects.

Procedures

Each subject was asked to perform the following series of tasks: 8 trials of simultaneous interpretation of texts, 4 of which to be translated from German into Italian and 4 from Italian into German; 8 trials based on lists of numbers, 4 of which were presented in German and 4 in Italian. Thus, each subject had to perform 16 trials in all.

Before starting the experiment, identical instructions were given to all subjects. It was made clear that during simultaneous interpretation of texts a series of numbers would occur and that the contemporary note-taking of these numbers during interpretation (for memory aid) would only be allowed in some cases. However, this memory aid was optional, so that those students who would not normally resort to this technique were left free to do so also during the experiment. As for the lists, the subjects were always told whether they were supposed simultaneously to translate or repeat the input material. They were told as well that a partial overlapping of comprehension and production would be necessary in any case. During the list-based trials, note-taking was not allowed.

To avoid any possible distortion of the global results of the experiment, the order of presentation of the two kinds of trials (texts versus lists), as well as the sequence of variables within each set of trials was perfectly balanced across the 12 subjects. To prevent an order-effect, all possible combinations were used.

Subjects listened to the incoming material by means of stereophonic headphones presenting the verbal material monaurally (right ear versus left ear). Each experimental session was tape-recorded and subsequently matched against the original to assess the error rate in the processing of numbers on the total of numbers presented. Possible errors in the processing of text material were not considered to be relevant to the aims of the experiment.
The systematic occurrence of the following categories of errors was also to be tested: a) **omissions**: the numeral was left out altogether or replaced by a generic expression such as "alcuni; pochi; grosser Anteil..." (some; a few; a large part); b) **approximations**: even though not completely correct, the answer to the *stimulus* is of the right order of magnitude and is not too far away from the original in terms of quantity. Usually, the subject realizes that there is some difference and shows it through the filling in of phrasal elements (for example: 3,453,000 being translated as "about 3,300,000"); c) **lexical errors**: the order of magnitude of the *stimulus* is maintained, but one or more number-words have been replaced, the error consisting in the mis-production of single figures within the numeral (for example: 293,000 being translated as 230,000; see "lexical mechanism"); the subject never shows awareness of the difference; d) **syntactical errors**: even containing the right figures in their correct sequential order, the number is of a wrong order of magnitude, the error consisting in a relational mis-codification of correctly selected figures (for example: 500,000 being translated as 5,000; 47 being translated as 407; see "syntactical mechanism"); e) **errors of inversion**: the tens were inverted with the units; this error might occur in any position within the number as a result of the partially inverted linguistic structure of numerals in German compared to Italian (for example: 46 being translated as 64; 35,000 being translated as 53,000); f) **structurally incorrect numerals**: difficulties are evident in the relational codification of the lexical elements of a numeral; the rules for the correct verbalization of numbers are broken (for example: 3,455,660 being translated as "tre milioni quattrocentomilacinquantacinque seiccentosessanta"; i.e. three million four hundred thousand fifty-five six hundred and sixty); g) **errors of phonemic perception**: the error can be related to a phonemically wrong perception of the *stimulus* in cases of assonance of particular linguistic features (for example: 16 ("sechzehn" in German) being translated as 60 ("sechzig" in German), because of a wrong perception of the German original); h) **self-corrections**: the subject returns upon a given response to modify it; according to their correspondence to the original, self-corrections can be divided into positive (corresponding) and negative (non-corresponding) ones; i) **other errors**: all possible answers which, though not belonging to any of the previous types, still do not correspond to the *stimulus*. It was mostly impossible to make out the causes of such errors, as well as impossible for the authors to group them together into categories; they were therefore kept apart and form a rather miscellaneous group (for example: 23,000 being translated as 800; 325 being translated as 25; 5,702 being translated as "more than 2,000").
Results

The 12 subjects processed in all 4,702 numerals (12 x 16 trials) with a total error score of 1,475 (31.35%). As far as simultaneous interpretation of texts is concerned, the 12 subjects processed 1,344 numerals totally (12 x 8 texts), with an error score of 934 (69.49%). 494 of these errors occurred during simultaneous interpretation from German into Italian (36.75% of errors on the total of processed stimuli), and 440 occurred during simultaneous interpretation from Italian into German (32.74% of errors on the total of processed stimuli). In both directions of interpretation, the most frequent categories of errors proved to be the following: omissions, approximations, lexical and syntactical errors.

During list-based translation tasks, the 12 subjects processed 1,680 numerals in all (12 x 4 lists), with an error score of 482 (28.69%). 258 of these errors occurred during translation from German into Italian (15.36%), and 224 (13.33%) occurred during translation from Italian into German. In both directions, the most frequent categories of errors proved to be the following: omissions, approximations and lexical errors. Only in translation tasks from German into Italian did frequent errors of phonemic perception occur, while in translation tasks of the opposite direction several structurally incorrect numerals were produced.

During list-based shadowing tasks, the 12 subjects processed 1,680 numerals in all (12 x 4 lists), with an error score of 59 (3.51%). While shadowing in German, subjects made 46 errors totally (2.74%); while, shadowing in Italian, the total score was of 13 (0.77%).

On the global error score of the simultaneous interpretation tasks performed in 8 different conditions, a three-way analysis of variance was conducted (Direction x Ear x Note-taking; Direction = 2, from German into Italian and from Italian into German; Ear = 2, right versus left; Note-taking = 2, allowed versus not allowed). The only significant factor proved to be the direction of interpretation: on average, subjects made more errors when interpreting from German into Italian than in opposite-direction tasks [from German into Italian = 10.28; from Italian into German = 9.16; F (1,11) = 11.18; p < 0.01]. Moreover, the interaction direction - note-taking proved to be significant as well [F (1,11) = 4.95; p < 0.05]. This means that more errors were made when interpreting from German into Italian without note-taking being allowed, than during interpretation from Italian into German without note-taking being allowed [from German into Italian without notes = 10.87; from Italian into German without notes = 9.29; t (11) = 3.89; p < 0.01]. On the other hand, the analysis of error scores in both directions of interpretation, made when note-taking was allowed, did not reveal any specific difference in performance [from German into Italian with notes = 9.7; from Italian into German with notes = 9.04].
On the individual results of list-based translation tasks a two-way analysis of variance was conducted (Direction x Ear). The only significant element here proved to be the direction-ear interaction \([F (1, 11) = 5.25; p < 0.05]\). Indeed, an almost significant tendency was found in the performance of the subjects; comparatively fewer errors were made in the translation of numerals from German into Italian when the input material was channelled to the right ear, rather than to the left [from German into Italian, right ear = 9.33; from German into Italian, left ear = 12.16; \(t (11) = 2.04; p = 0.06\); see Figure 2]. This perceptual asymmetry, however, was not found when the direction of translation was from Italian into German [from Italian into German, right ear = 9.33; from Italian into German, left ear = 9.33; \(t (11) = 0; p = 1\); see Figure 2].

![Bar chart showing number of errors](image)

**Fig. 2:** Mean Errors In The Translation Of Lists Of Numbers  
*Note.* *\(^{*}\): \(p = 0.06\)

A two-way analysis of variance (Direction x Ear) was conducted on the individual results of list-based shadowing tasks. Neither factor nor interaction proved to be significant.

A three-way analysis of variance (Direction x Note-taking x Ear) was conducted on the lexical-error scores made during text-based simultaneous-interpretation tasks. The only significant element proved to be the direction-ear interaction \([F (1, 11) = 4.82; p = 0.05]\). This means that subjects made comparatively more errors during simultaneous interpretation from Italian into German when the input material was channelled to the left ear, rather than to the right (from Italian into German, left ear = 1.83; from Italian into German, right ear = 1.33); on the other hand, however, comparatively more errors were made during simultaneous interpretation from German into Italian when the input material was channelled to the right ear, rather than to the left (from German into Italian, right ear = 1.45; from German into Italian, left ear = 1.29). A three-way
analysis of variance was conducted also on the lexical-error scores made during list-based translation tasks, in analogy to what had been done with simultaneous-interpretation results of this category; however, neither factor nor interaction proved to be significant.

Two separate three-way analyses of variance (Direction x Note-taking x Ear) were conducted on the omission scores made during tasks of simultaneous text-interpretation and list-translation. In both cases, neither factor nor interaction proved to be significant.

Two separate three-way analyses of variance (Direction x Note-taking x Ear) were conducted on the approximation scores obtained during tasks of simultaneous text-interpretation and list-translation. In both cases, neither factor nor interaction proved to be significant.

The most frequent categories of errors were the following: omissions, approximations and lexical errors. More specifically, omissions proved to be the most frequent type of error during simultaneous-interpretation tasks (47.6 % of the total error score in simultaneous interpretation), while lexical errors proved to be the most frequent type during list-based translation tasks of numerals (43.9 % of the total error score in list translation); (see Figure 3).

![Fig. 3: Most Frequent Categories Of Errors In The Two Experimental Conditions (Simultaneous Interpretation And List Translation)](image)

Discussion

Comments can be made on the results in terms of categories of errors and total error-scores. In particular, a relation may be established between specific error-types and the types of trial during which they occurred.
Analyzing first of all the direction of processing, a greater error-score is noticeable in all types of trial (simultaneous interpretation of texts, translation of lists and shadowing of lists) in which subjects were asked to process numerals being presented to them in German, rather than in Italian. To explain this, reference may be made to the length-effect of words on short-term memory; if the words to be recalled are short, the average span of short-term memory (i.e. the subject's ability correctly to recall a sequence of items after a very short lapse of time) will be greater than if the words are long (Ellis, 1992). In other words, it is possible to remember a greater number of short rather than of long words after having been exposed to them briefly.

On these grounds, it has been proved that the time needed to pronounce numerals in any language influences the ability (even of native speakers of that language!) correctly to recall the figures which have been pronounced. Generally, it can be said, therefore, that the average span of short-term memory will be shorter in the case of numerals being expressed in a language in which their verbal codification is comparatively longer than in other languages. So much so, that even native speakers of the language with a longer articulation time show a more limited short-term memory-span for this language than for other (not native!) languages which require less time in terms of word articulation.

This very phenomenon was noticed in the present study. To verify the word-length parameter, the number of words of each list was counted. It is important to remember that all lists were equal in terms of figures, since they contained 5 numerals for each of the 7 orders of magnitude present, with a total of 35 numerals for every list. The following results emerged: the lists of numerals expressed in German contained an average of 211.5 number-words per list, with a total number of phonemes to be articulated well over 1,000; the average time required to tape-record one list had been of 2'05". Instead, the lists of numerals expressed in Italian contained an average of 174.25 number-words per list, with a total number of phonemes to be articulated of about 850 each; in this case, the average time required to read out one list had been of 1'55". This evidence confirmed the authors’ hypothesis of numerals expressed in German being longer than those expressed in Italian, thus leading to a word-length effect on the capacity of subjects to recall the figures correctly.

The greater length of numerals in German when compared to Italian may be partly structurally motivated. Indeed, in German the conjunction "und" (and) is systematically placed between units and tens in all numerals above 20 (e.g. "vierundzwanzig"; twenty four); this is not the case in Italian. An optional element which may have contributed to further enhance the length-effect in German was the unit used to express "one" hundred and "one" thousand (einhundert; eintausend); this element could be left out in German and is totally
absent in Italian (where you would just say "hundred" and "thousand", i.e. "cento" and "mille"); however, during the experiment it was actually used in all lists in German, to favour comprehension.

In order to explain the subjects' higher error scores when listening to German numerals, reference should also be made to their actual mother-tongue. For most subjects, Italian was the native tongue, so that their comprehension of the experimental material was favoured in those tasks in which they were asked to process Italian stimuli. Indeed, it seems that the phase of comprehension is more important in determining the global performance of translation and simultaneous interpretation tasks than the subsequent phases of transcoding and production of response (see Crevatin, 1991).

Apart from language-related effects, differences in performance were also observed according to the different types of tasks. Indeed, the transcoding of numerals occurring in texts, i.e. within semantically linked verbal structures, proved to be more difficult compared with the transcoding of alone numerals, presented in lists totally detached from any textual fabric. This can be ascribed to the high degree of immediacy of this type of information which, contrary to the semantic fabric of a text, requires a different, immediate kind of mental processing, to be translated (Lederer, 1982). The assumption of this difference in processing accounts for the different performance in relation to the type of task.

During the shadowing of lists, moreover, subjects performed yet another type of mental processing, as demonstrated by the extremely low error scores in this type of trial (in any case, scores proved to be higher in German than in Italian for the reasons explained above). To account for such low scores, reference can be made to the particular organization of short-term memory (Sperry, 1987; Djeman & Mateer, 1978; Darr, 1989; Bradley, 1990). This memory function is different from the semantic memory focused on meaning, and is particularly active during the performance of shadowing-tasks, when subjects process input numerals without necessarily associating the verbal material with the concept of quantity being expressed; rather, it seems that the acoustic stimuli are processed by the subjects' sensorial, immediate memory functions so as to produce a simple repetition of what is auditorily perceived. The mental operations required to perform this task are far less complex than those necessary for transcoding (see Squire, 1987).

In post-test interviews, the subjects themselves confirmed this hypothesis declaring that they actively "visualized" the figure to be translated during the list-translation tasks, while "passively" following the input material without making this effort during the shadowing of such lists. Also Deloche and Seron (1982) make a distinction from a cognitive point of view between numeral-
processing tasks requiring a representation of the quantity being expressed, and those tasks in which representation of quantity is not required.

During simultaneous interpretation tasks, the main category of errors was omission, while during list-translation tasks lexical errors were found to be most frequent (see Figure 3). Attentional patterns could account for this difference. For a better understanding, reference is made to a theoretic model in which simultaneous interpretation is defined as a dynamic balance constantly adapting to the conditions in which it is placed to work (Gile, 1985). The model is subdivided into three parts, corresponding to the three main activities an interpreter performs during his task: 1) listening and comprehension effort; 2) memory effort; 3) production effort. These three types of activity are, at least partially, overlapping and merge into a global effort. The interpreter, whose energy for the performance of his job is limited, is constantly apportioning his energy among these tasks, keeping a "balance of interpretation". So, when the effort necessary to perform one of the three tasks grows, this happens to the expense of the remaining two, the global effort remaining constant. Since any of the three activities, however, needs a minimum of energy to be performed, the sudden rise of one of them may cause the energy being devoted to another task to drop beyond the minimum-requirement level. Thus an imbalance is produced, increasing the probability of interpretation errors being made. In any text, therefore, "risk areas" can be identified where a loss of information in the processing of the original is highly probable.

As for the specific case of numerals occurring in a text, the difficulty of their correct perception lies at the source of number-related errors in simultaneous interpretation. This difficulty is to be ascribed to the need for the interpreter immediately to intensify the effort of listening and comprehension in comparison with the other tasks (Gile, 1985). Indeed, correctly to translate a numeral within a text, a sudden shift of strategy is necessary. It is inevitable to activate two different types of memory: the semantic for verbal processing and the operational for the transcoding of the numeral. This means that the interpreter is asked to pass from an "intelligent" translation to a "transcodification", i.e. to the immediate, punctual translation of a contextually unpredictable item which has just one equivalent in the other language (Lederer, 1982; Moser-Mercer, 1985; Gile, 1985). The effort required for this shift of strategy is such as easily to produce the omission of a numeral occurring suddenly within a text.

Quite differently, in the case of numbers alone auditorily presented as a list, no shift of attention patterns seems to be required for their translation, since there is no reference to textual structures bearing a global message in which the numerals are fitted. Therefore, the type of error most probable under these
circumstances is the substitution of some figures within the numeral itself (lexical error).

It has already been pointed out that a difference in performance was found depending on the possibility of contemporary note-taking during simultaneous interpretation of texts, and also in relation to the direction of interpretation. Indeed, while, during simultaneous interpretation of texts from Italian into German, note-taking seemed not to improve the subjects' performance significantly, during interpretation from German into Italian, note-taking of numerals actually proved useful to reduce the number of errors. Apart from the length-effect on memorization, the difference of performance due to the direction of interpretation might be partially ascribed to the different weight the phases of comprehension, transcoding and production have in the two directions. So, when translating from the mother-tongue into a foreign language (as with the passage from Italian to German for the majority of subjects), comprehension seems to be immediate and rather automatic. However, the phases of transcoding and production are perceived as more demanding. Therefore, note-taking during the phase of listening and comprehension proves rather superfluous in this direction laying, if anything, a further burden on the interpreter's attention in also dealing with written (apart from oral) transcoding and production, while already having to concentrate on the text subsequent to the numeral (see Crevatin, 1991). Quite differently, however, when interpreting from a foreign language into his mother-tongue, note-taking proves useful to improve the interpreter's performance. Indeed, a greater effort of comprehension and memorization is required to perform the task, while transcoding and production are perceived, in this case, as the easier parts of the performance. In this condition, the use of a code (such as the arabic figures) irrespective of the language being used offers a valuable "visual" help to the interpreter who puts on paper what he hears, reading it out more effortlessly at the moment of reproducing the numeral in the target language.

Finally, most studies conducted to assess a number-system related lateralization of cognitive functions showed the left cerebral hemisphere to be comparatively dominant in the performance of number-related tasks (Hécaen, 1976; Hécaen & Anguierlegues, 1961; Deloche & Seron, 1982a and 1982b). Also in the present study some evidence was found as to the better performance of the right ear (left hemisphere) in the execution of number-related tasks. This could be noted, for example, in the translation of lists of numbers from German into Italian, where subjects made fewer errors when listening to the input material with the right, rather than left ear. However, when translating such lists in the opposite direction (from Italian into German), the two ears gained equal scores (see Figure 2). Scores were calculated summing errors of all categories (global errors), so that this measure could be taken as an indicator of the
processing-mechanism of numerical stimuli as a whole, from the initial phase of comprehension down to the final one of production.

It has been demonstrated (Sussman et al., 1992; Fabbro et al., 1990; Green et al., 1990) that the linguistic functions used for the translation from a subsequently acquired language into one's mother-tongue seem to be lateralized mainly to the left cerebral hemisphere. Instead, the linguistic functions used for the translation from one's mother-tongue into a foreign language seem to be more symmetrically represented in both hemispheres. The data on numerals emerging from the present experiment appear to be in line with these results. As far as lexical (or figure-substitution) errors are concerned, data seem to speak in favour of a lateralization to the right hemisphere (left ear) when translating from the mother-tongue (Italian) into a foreign language (German). On the contrary, an opposite asymmetry seems to emerge during translation from the foreign language (German) into the mother-tongue (Italian) of the experimental subjects. These results may also be supported by the hypothesis of a greater lateralization of the transcoding and production activities to the right hemisphere when performing from the native into a foreign language (Spiller-Bosatra et al., 1990). Indeed, lexical errors are taken here as a measure of an alteration in the processing of incoming numerals presumably occurring subsequently to comprehension, during the final stages of the interpretation process.

References


